

**Review of the Draft Integrated  
Research Plan for the Glen Canyon  
Environmental Studies, Phase II**

**National Research Council  
Washington, D.C. 1991**

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Research Plan for the Glen Canyon  
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Committee to Review the  
Glen Canyon Environmental Studies  
Water Science and Technology Board  
Commission on Geosciences, Environment,  
and Resources

National Research Council  
Washington, D.C. 1991



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This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

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## BACKGROUND

The National Research Council's (NRC) committee to review the Bureau of Reclamation's Glen Canyon Environmental Studies (GCES) (see Appendix A) has been in operation since 1986. The committee has produced several reports, including *River and Dam Management* in 1987 (NRC, 1987), a supplemental letter report in 1988 (NRC, 1988a), and an additional letter report addressed to the Secretary of the Interior in December 1988 (NRC, 1988b).

In its continuing role as a source of advice on the Glen Canyon Environmental Studies, the committee was asked to review and comment on the Draft Integrated Research Plan for GCES Phase II (U.S. Bureau of Reclamation, 1990). The committee met at the end of October 1990 to review the Draft Integrated Research Plan and to prepare this report for the Bureau of Reclamation.

In June 1988, the Department of the Interior directed the Bureau of Reclamation to continue the Glen Canyon Environmental Studies. This directive was justified by the need for further collection and analysis of data in support of operational decisions at Glen Canyon Dam (U.S. Department of the Interior, 1988). Additionally, the Department of the Interior directed that, where possible, the NRC recommendations from its previous reports be integrated into the plan for Phase II of the GCES.

Two particular areas of concern identified by the NRC committee in 1987 were specifically mentioned in the Bureau of Reclamation's Draft Integrated Research Plan for GCES Phase II:

1. The need for a senior scientist to guide the GCES research program, and
2. The need for an integrated ecosystem approach to the GCES program development.

In April 1989, the GCES Phase II Integrated Research Program hired Duncan Patten, director of the Center for Environmental Studies, Arizona State University, as GCES senior scientist. Dr. Patten and the GCES research team developed the GCES Phase II Draft Integrated Research Plan, which is the subject of this report.

## ENVIRONMENTAL IMPACT STATEMENT

In July 1989, Secretary of the Interior Manuel Lujan directed that an environmental impact statement (EIS) be prepared to describe possible environmental effects of the operations of Glen Canyon Dam on the environment in the lower Colorado River. As a result, the focus of the GCES Phase II Integrated Research Program shifted to support preparation of the EIS, including gathering the scientific background information necessary to evaluate the alternative operations of Glen Canyon Dam. Since the announcement of the Glen Canyon Dam EIS, the completion date for the EIS has shifted from five years to 24 months, and then to 36 months. At this time, the date of completion is still uncertain.

### COMMITTEE REVIEW

The GCES Phase II Integrated Research Program has matured under the leadership of Duncan Patten and GCES Program Manager David Wegner. However, contrary to the recommendations made by this committee in its 1987 report (NRC, 1987), Dr. Patten was hired at the Bureau of Reclamation level rather than at the secretarial level of the Department of the Interior. This has hampered his efforts to overcome the conflicts caused by the missions of the various federal agencies with responsibilities for natural resource management in the Grand Canyon. In addition, an advisory board of senior scientists, creation of which was recommended in the 1987 NRC report, has not been constituted yet. This board should be composed of scientists independent of the GCES and of any affiliation with the GCES researchers.

The planning phase of GCES II has been seriously compromised by the demands of the EIS process. The pressures of conducting an environmental impact assessment have pushed GCES II into a research program using the manipulation of releases from the Glen Canyon Dam that, although desirable, must be completed on too compressed a schedule. As a result, the flow manipulation is occurring without benefit of long-term documentation of the ecosystem status and with no long-term routine monitoring program in place. A better synthesis of what is already known would aid in identifying further research needed. Thus, the GCES Phase II Integrated Research Program has continued under difficult conditions including (1) uncertain schedules, deadlines, and funding; and (2) the requirement that the GCES provide information on a schedule dictated by the EIS.

The committee believes that the GCES Phase II Draft Integrated Research Plan has the potential to yield information that will be useful for management decisions in operating the Glen Canyon Dam. However, the committee also realizes that because of the hindrances previously described, there is a risk that the GCES Phase II studies will not yield adequate information for management of the resources at and below Glen Canyon Dam. The recommendations that follow are intended to help clarify the role that the GCES should play in its short-term efforts to prepare the required EIS and in its long-term relationship in the use of adaptive management of Glen Canyon Dam.

### THE NEED FOR A CONCEPTUAL FRAMEWORK

The committee believes that a conceptual framework is needed for the overall GCES Phase II Integrated Research Plan. This framework is understood by the GCES leadership, but it is not formulated in an easily identifiable statement within the documents (U.S. Bureau of Reclamation, 1990) reviewed by the committee. The GCES studies can best be explained and justified to the natural resource managers responsible for dam operations and

environmental protection in the Grand Canyon and to the lay public through such a conceptual framework. In addition, an executive summary should also be written for the two volume set of documents.

Robust ecosystem modeling can serve as a powerful tool for understanding ecosystem linkages and the interdependence of system components. The models are developed, calibrated against field data, and tested against monitoring information to aid learning more than to predict events as if the models were true representations of nature. Flow should be central to the modeling effort for two reasons: first, because it is appreciated as an important independent variable in rivers elsewhere and, second, because it is the variable that is controllable by dam operations. Water flow affects ecosystem function through a number of mechanisms, one of which is sediment transport. Sediment transport and deposition determines the building and degradation of beaches along the Colorado River. Beaches provide the environment for vegetation and much of the terrestrial biota of the canyon as well as recreational amenities. These and other linkages must be explained in a straightforward manner (see paper by Duncan Patten in National Research Council, 1991).

The linkages connecting water flow to the ecosystem also provide a basis for modeling, which will support further understanding of the system. Because of its key regulatory function, flow should be modeled first. Modeling should include the movement of the flood waves that originate from fluctuating flows, and should be calibrated using field data. The sediment transport system should also be modeled. The modeling of eddy systems and their role in transfer of the sediment from the main channel to the beaches is of particular importance. Several related models can be worked on at the same time by different people and can be phased into use for necessary management decisions in the Grand Canyon. A flow model may be useable at the end of the first year, a sediment transport model may be useable at the end of the second year, and a more refined sediment model may be useable after the third year. The feasibility of temperature and habitat modeling should also be explored.

The problem of sequencing the research applies also to the linkage between these ecosystem models and the economic studies. The economic studies of power, recreation, and non-use values need to be designed around the possible changes in flows and consequent impacts on beaches, vegetation, and wildlife: these impacts form the starting point for the economic analysis. Ideally, the economic studies would be implemented after the outputs of the physical and ecosystem models have been obtained. If the economic studies are conducted before such results are in hand, great care must be taken to ensure that these studies--especially the recreation and non-use studies--include the range of possible outcomes that may be predicted by the physical and ecosystem models.

### **Recommendation**

A concise statement should be developed by the GCES scientific research team explaining the GCES Phase II Final Integrated Research Plan, the connections among its components, and its anticipated use in management of the operation of Glen Canyon Dam and the resources in the Grand Canyon. This explicit statement of the research program will also aid the members of the scientific team in understanding their contribution to the overall study. It will encourage the researchers to clarify their scheduling and their dependence on others in the research team, and will assist the GCES leaders in explaining to the managers within the Bureau of Reclamation and the Western Area Power Administration (WAPA) how the data are to be used and when conclusions from the research being conducted during GCES Phase II will be available to assist them in management decisions.

### **A STATEMENT OF ISSUES IS NEEDED**

The GCES Phase II studies are motivated largely by specific environmental and dam operation management issues. These issues are so diverse that they are fully understood by only a few individuals.

#### **Recommendation**

In order to broaden the understanding of issues concerning Glen Canyon Dam and the natural resources in the Grand Canyon among researchers, managers, and interested outside parties, the Bureau of Reclamation should request that a complete written statement of the issues be prepared as soon as possible by a person outside the Bureau of Reclamation, in the form of an Issues Document. This Issues Document should explain the motivations and perspectives of each of the government agencies involved in the management of the Colorado River resources affected by the Glen Canyon Dam. The document should also explain how power production is regulated, describe the vested interests of the Western Area Power Administration (WAPA), and delineate the manner in which WAPA interacts with power users and the Bureau of Reclamation.

In addition, the Issues Document should describe the public interest in recreation, fisheries, and global diversity issues. Specifically, the Endangered Species Act has been invoked recently vis-a-vis endemic fishes in the Colorado River. This issue should be placed in the context of Glen Canyon Dam operations affecting flow, sediment loads, and water temperature. The introduction of exotic species to the river is a related issue.

### **THE ENVIRONMENTAL IMPACT STATEMENT IS NOT A SUBSTITUTE FOR A LONG-TERM MANAGEMENT PLAN**

Phase II of the GCES and the environmental impact statements being prepared by the Department of the Interior and the WAPA are the means by which a broader objective can be achieved. These studies should help define a long-term, adaptive management strategy that maximizes the integration of science research, systems operations, and long-term natural resource management policy. The term "adaptive management" refers to a continual analysis of alternative management strategies, taking into consideration new scientific data and reanalyzing management decisions--an iterative process.

Phase II of the GCES has great potential to produce useful data for the Bureau of Reclamation and the WAPA, but GCES research activities still suffer from a lack of clear understanding about the research program's relationship to the Bureau of Reclamation and the WAPA.

An EIS is intended to provide a sound data base to support major environmental decisions such as those involved in the construction of a major public works project. For this reason, an EIS supports a one-time decision rather than long-term management. An EIS, no matter how well done, is not a substitute for a long-term adaptive management strategy built upon a management-oriented study such as the GCES Phase II Research Program. Adaptive management of Glen Canyon Dam requires a continuing series of flexible responses to information generated by research and monitoring over the life of the dam. In contrast to an EIS, the GCES should provide the scientific support needed for adaptive management.

The committee recognizes that the timing and scope of many GCES activities are being driven by deadlines for the preparation of an EIS. However, the original goal of the GCES was not to help produce an EIS. The objective of the Bureau of Reclamation and the WAPA management must be to protect and enhance the riverine ecosystem of the Grand Canyon, within the constraints of legally mandated dam operations.

#### **Recommendation**

Research and monitoring of the resources in the Grand Canyon must not end with the completion of the EIS, nor should the EIS be considered a substitute for the GCES. The GCES should provide scientific support for the long-term management of the dam that will mitigate adverse effects on the Grand Canyon caused by operation of the dam.

#### **THE TWO ENVIRONMENTAL IMPACT STATEMENTS SHOULD BE COORDINATED**

One EIS is being prepared by the Department of the Interior through the Bureau of Reclamation, and a second is being prepared by the WAPA, which manages and controls the operation of Glen Canyon Dam for the purpose of generating hydropower. The WAPA's EIS is intended to address the impact of WAPA marketing criteria on the Grand Canyon. The marketing criteria are designed to specify the capacity of the hydropower resource at a particular risk of shortage. The amount of marketable resource is directly affected by any policy that sets minimum release rates from the Glen Canyon Dam; minimum release reduces flexibility in the use of the hydropower resource.

There is no explicit mention of minimum flows in WAPA energy contracts. The WAPA's power marketing brochure states that there is no reason to delay issuing of the WAPA's EIS until the parallel EIS is completed by the Bureau of Reclamation, even though the Bureau of Reclamation's EIS is likely to propose that the number of separate minimum flow periods be raised. If the WAPA finishes its EIS before the Bureau of Reclamation does, and if long-term contracts are signed based on existing minimum flows, then there will be major economic and legal constraints on increases in minimum flows that may be recommended by the Bureau of Reclamation's EIS.

#### **Recommendation**

The preparation of the two EISs by the WAPA and the Bureau of Reclamation should be coordinated; the WAPA's EIS should not be completed before the Bureau of Reclamation's EIS is completed and is made available to the public.

#### **PUBLISH PRELIMINARY FINDINGS ON BEACH EROSION**

During the summer of 1990, researchers documented increased erosion of beaches downstream from Glen Canyon Dam. High flows during the mid-1980s removed sediment from pools and deposited it on beaches. In subsequent years, fluctuating lower flows have caused rapid erosion of the new deposits and have undercut some older deposits as well.

The erosion became especially prominent in 1990. A clear understanding of the specific causes, processes, and timing of this recent erosion is critical to (1) the public perception of erosion processes in the Grand Canyon, (2) the design of continuing research in the GCES Phase II Program, and (3) the analysis of environmental impacts of operating strategies for Glen Canyon Dam.

#### **Recommendation**

Experienced researchers, selected by the GCES II program manager, should publish their preliminary findings about the current beach erosion processes occurring downstream from Glen Canyon Dam, rather than waiting for the conclusion of the entire GCES II project. These findings should be published as quickly as possible in a peer-reviewed scientific publication. More detailed explanations with substantiating data can follow at the conclusion of the project.

#### **SEDIMENT QUALITY SHOULD BE ASSESSED**

Sediment quality is an important component of the overall environmental quality of the Grand Canyon environment. Sediment reaching the canyon from tributaries contains naturally high amounts of some heavy metals. Some alternatives for addition of sediments to beaches include artificial introduction of sediments from sources outside the Grand Canyon. However, there is no information on sediment quality in the Canyon, and the GCES Phase II Draft Integrated Research Plan does not address this issue.

#### **Recommendation**

The final GCES Phase II Integrated Research Plan should characterize the sediment in the present Grand Canyon beaches, especially for heavy metals, organic compounds, and radionuclides. The present concentrations should be taken as baseline data for sediment quality, and new sediments that might be added to the canyon should be tested chemically.

#### **CYCLES OF EROSION AND SEDIMENTATION SHOULD BE ASSESSED**

Sediment is alternately stored and evacuated from the floodplains and canyon floors of streams that are tributaries to the Grand Canyon below Glen Canyon Dam. The Paria River, the Little Colorado River, and Kanab Creek, for example, currently store large amounts of sediment. Climatic change and land management adjustments influence the mobility of these stored materials, which at some point in the future may be released into the Grand Canyon. The addition of these sediments may improve the supply of sediments to the main canyon and its beaches.

#### **Recommendation**

The committee recommends that geographic and time boundaries of the GCES Phase II Program remain somewhat flexible to account for the possible movement of stored materials into the Grand Canyon. Just as Lake Powell influences conditions in the Grand

Canyon, so may conditions in the major tributary streams also affect the Grand Canyon's ecosystem. The GCES Phase II Program focuses, of necessity, on short-term phenomena, but longer-term cycles of erosion and sedimentation must also be accounted for, because these cycles are part of the physical framework within which the dam is operated.

### A WATER BALANCE MODEL SHOULD BE DEVELOPED FOR LAKE POWELL

The final GCES Phase II Integrated Research Plan should result in the development of information that improves the accuracy of Lake Powell water balance estimates. Both net reservoir inflows and projected outflows must be studied. Bank storage can now be better estimated, because storage has decreased for several years.

#### Recommendation

A water balance model for Lake Powell is needed. The operation of Glen Canyon Dam is constrained by the storage capacity and minimum storage requirements for Lake Powell. If the GCES should result in recommendations for changes in the operation of Glen Canyon Dam in support of environmental objectives, these changes will be restricted within a range that is set in part by the water storage capacity of Lake Powell. Therefore, it is essential that the water storage capacity be quantified as well as possible. Thus, two variables need special attention: evaporation and bank storage. This attention is necessary for current operations at Glen Canyon Dam and for the later development of a dynamic model of the lake. Evaporation estimates currently used by the Bureau of Reclamation may be too low (see papers by D. Dawdy and T. Hughes in National Research Council, 1991). Bank storage is now estimated as a percentage of change in storage. However, the fraction of bank inflow that returns to the lake is unknown. Given data for both the filling and draining periods for the reservoir, a physically based water balance model of bank storage can be calibrated. In addition, evaporation estimates can be improved.

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## **APPENDIX A**

### **DESCRIPTION OF ORIGINAL GLEN CANYON ENVIRONMENTAL STUDIES\***

The Glen Canyon Environmental Studies began as the result of a December 6, 1982, memorandum from then Commissioner of Reclamation Robert Broadbent. When it became apparent that the operation of suggested rebuilt turbines in Glen Canyon Dam could increase the fluctuations of water levels downstream in the Grand Canyon, private citizens, raft tour operators, anglers, and environmental preservation organizations became concerned about the continued vitality of ecosystems in the Grand Canyon that might be subject to alteration by the fluctuations in flow.

Several groups brought suit against the director of the National Park Service and other Department of the Interior officials in an attempt to prevent the extreme fluctuations in water levels. The Bureau of Reclamation responded by initiating the Glen Canyon Environmental Studies, which were to study the effects of the present and historic operation of the Glen Canyon Dam on the vegetation, wildlife, fisheries, and other environmental resources of the Grand Canyon. It was hoped that the results of these studies would lead to a decision process to determine appropriate long-term operating criteria for the Glen Canyon power plant.

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\*Excerpted from NRC (1987), p. 18-19.