Final Report of the GCMRC Socioeconomic Research Review Panel

Report of a Workshop held
December 2 & 3, 2009
Phoenix, Arizona

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Grand Canyon Monitoring and Research Center
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1. Introduction

The Grand Canyon Monitoring and Research Center convened a workshop December 2-3, 2009, in Phoenix to discuss socioeconomic information needs of the Grand Canyon Dam Adaptive Management Program (GCAMP). Attendees included some two dozen members of the Grand Canyon Technical Work Group representing a wide range of stakeholder and management organizations and agencies. Discussion was stimulated by a series of presentations by technical experts with research experience on Grand Canyon issues:

- Dr. John Duffield, University of Montana, Missoula, Economic Values for National Park System Resources within the Colorado River Basin
- Dr. David Harpman, Bureau of Reclamation, Denver, Integrative Recreation Economics Tool
- Dr. Yeon-Su Kim, Northern Arizona University, Flagstaff, Assessing Impacts of the LSSF Experiment on Regional Recreation Economics
- Mr. David Marcus, independent consultant, Berkeley, Glen Canyon Dam Releases – Economic Considerations
- Mr. Clayton Palmer, Western Area Power Administration, Salt Lake City, The Alchemy of Power Economics: Converting Watts to Dollars
- Dr. Thomas Veselka, Argonne National Laboratories, Chicago, Estimating Colorado River Storage Project Power Economics with the GTMax Model
- Dr. Michael Welsh, Christensen and Associates, Madison, GCES Nonuse Value Study

Four of us, designated as independent panelists were also invited to participate in the workshop:

- Dr. Michael Hanemann, University of California, Berkeley
- Dr. Joel Hamilton, University of Idaho (Emeritus), Moscow
- Dr. John Loomis, Colorado State University, Fort Collins
- Dr. Lon Peters, Northwest Economic Research Inc., Portland

Our role as an independent panel was to recommend potential approaches, methodologies, and anticipated timeframes to address the identified socioeconomic needs of the GCDAMP. This document presents our findings and recommendations from the workshop.

2. Impressions from Two Days in Phoenix

The first part of the two-day workshop consisted of presentations by seven technical experts who had experience with socioeconomic investigations of topics related to the Grand Canyon and Glen Canyon Dam. Each presentation was followed by vigorous discussion among all workshop attendees. At the conclusion of the presentations, the workshop participants were assembled into four small groups to brainstorm about the socioeconomic information needs of the GCAMP. These brainstorming results were compiled into a list, and participants were asked to rate the importance of each item, and to specify whether they should be addressed in phase I or phase II of a research program. In the section which follows we separately address our impressions from the presentations and discussions and from the small groups.

a. Inferences from the Presentations and Discussions

Physical and biological issues in the river corridor have been the main theme of GCAMP information gathering and research efforts in the past. While these investigations have been needed and useful (and have provided much information that is a prerequisite for economic analysis), the result has been that funding for actual socioeconomic research has been very limited. The need for more socioeconomic information to help inform tradeoff analysis by the GCAMP has been apparent for some time. This need has been highlighted by several studies including a 1999 National Research Council report, but to date there has been little follow up by GCAMP to fill this information need.

A significant gap in socioeconomic information available to the GCAMP is the lack of up to date market, non-market and nonuse values for Grand Canyon resources. Some of the benefits of Grand Canyon and Glen Canyon resources are defined in or by markets, such as guided tours and hydropower production. However, because other uses such as fishing and white water recreation are not priced in a market, the use of non-market evaluation techniques is necessary to estimate what value these users place on their Grand Canyon experiences. In his workshop presentation David Harpman talked about his "Integrative Recreation Economics Tool" that computerizes the integration of biological and economic information to allow the user friendly estimation of consumers' surplus from recreation use. Of course, use of Harpman's tool requires up to date information on Grand Canyon River recreation use as input – information that is not now being collected in a systematic and comprehensive way for this reach of the Colorado River.

The presentation by Yeon-Su Kim outlined her work on the regional economic impacts of the 2000 steady-flow experiment on the river. Clearly regional employment and income impacts are very important to regional stakeholders even though national economic efficiency impacts are supposed to be the principal basis for making federal resource use decisions (U.S. Water Resources Council,1983). Kim noted that the regional impacts are lessened by the fact that much of the spending by rafters and outfitters immediately leaks out of the region to pay for items not produced locally. In fact several of the larger outfitters are not even based in-state, so their impact on the regional economy is small. Furthermore, many of the rafting-related jobs are seasonal and low paying. The marginal regional economic impact of any river management change would probably be minimal since the number of rafters is strictly controlled and over subscribed. Since the rafter numbers and their costs are quite fixed, we need to find out if there is any change in consumers' surplus if their non-market valuations of their trip were to change as a result of a management shift.

The Grand Canyon is also a national treasure, and people all over the United States attach a value to the continued existence of the canyon, to the possibility that they might want to visit it sometime, and they want to bequeath this treasure to their grandchildren. This nonuse value may in fact be the dominant value that people place on the Grand Canyon. In his presentation to the workshop, Michael Welsh talked about the results from his 1995 study of nonuse values for the Grand Canyon. This work was completed too late to be included in the March 1995 Environmental Impact Statement (EIS) on the operation of Glen Canyon Dam Colorado River Storage Project, although Welsh's work was cited in the final Record of Decision (ROD).

There has been some controversy about estimation and use of nonuse values. However, the National Research Council (NRC) Committee 1996 report on River Resource Management in the Grand Canyon, while acknowledging the controversy about the measurement of nonuse values, states:

> "Although contingent valuation continues to be controversial, there is a growing body of evidence that supports its practical usefulness (Harpman et al., 1995). Contingent valuation is routinely applied with confidence to estimates of use values, and early work on nonuse values is encouraging." (NRC, 1996, page 120)

The NRC Committee notes that "nonuse values have been included in a variety of policy analyses for which changes in the quality or availability of natural resources are an issue." (NRC, 1996, page 119) It goes on to say:

> "Whether nonuse values can be measured with sufficient accuracy to meet high scientific standards is a question still widely discussed among policy analysts and economists. There is, however, a theoretical economic framework sufficient to form a foundation for their use in the GCES. The literature on CVM indicates that accuracy is sufficient to make quantification of nonuse value useful in understanding the balance of values at stake in managing Glen Canyon Dam. This is particularly true given all that can be learned in the nonuse valuation process regarding public views of the resource issues being addressed under GCES. To neglect total values in favor of more narrowly defined use values would be to leave a major gap in the economic studies under GCES and in the Glen Canyon Dam EIS. This would be unjustifiable given that nonuse values can be estimated." (NRC, 1996, page 120)

With regard to the measurement of nonuse value, the NRC Committee found that:

> "The GCES nonuse value studies are one of the most comprehensive efforts to date to measure nonuse values and apply the results to policy decisions. The studies were subject to extensive scrutiny by the interests (agencies, advocacy groups) participating in GCES and also to intensive review by a panel of professional economists with no stake in the outcome of the studies." (NRC, 1996, page 135)

Similarly, the US General Accounting Office Assessment of the Glen Canyon EIS stated that:

> "The Glen Canyon Dam's EIS nonuse value study was carried out in a manner consistent with contingent valuation and survey research guidance developed to produce high-quality contingent valuation studies. Nonuse values were estimated for the level of change associated with each examined alternative compared to the no-action base case. As such, no estimate for the level of nonuse values associated with the No-Action Flow alternative is provided. The study produced results that suggest that there are substantial nonuse values associated with each of the examined alternatives to current operations at the Glen Canyon Dam." (GAO, 1996, page 133)

In short, while there is controversy regarding the use of contingent valuation in general, nonuse value was recognized by the National Research Council Committee as being relevant to decisions

regarding the operation of Glen Canyon Dam. CV is the only method for estimating nonuse values in the Grand Canyon. We do not believe there are grounds for controversy regarding the particular implementation of CV done by Welsh.

Budget constraints, along with a lack of enthusiasm for nonuse values on the part of the Technical Work Group have meant that little subsequent work on nonuse values has been done. Our impression from listening to the discussion at the workshop (and perhaps partly as a result of what people learned at the workshop) is that the TWG is now much more open to a research program that would estimate changes in nonuse values due to the implementation of various of management alternatives in the Grand Canyon and at Glen Canyon Dam.

Apparently the National Park Service (NPS) is prepared to proceed with needed socioeconomic research. John Duffield's presentation was evidence that NPS is willing to independently fund research, including non-market and nonuse approaches, needed to make management decisions.

Hydropower economics was a point of contention at the workshop. We heard presentations by Tom Veselka, Clayton Palmer, and David Marcus. The main points of difference seemed to revolve around the value of Glen Canyon capacity, how changes in the operation of Glen Canyon Dam would affect Colorado River Storage Project (CRSP) electricity costs, and the degree to which actions at Glen Canyon might be mitigated by the fact that CRSP is closely integrated with other hydropower resources markets by the Western Area Power Administration. We comment on these issues below.

b. Lessons from the small groups

Participants met in four small groups at the end of the first day of the workshop to brainstorm about information needs for GCAMP decision making. Each group then reported four or five of their top information needs or research questions to the meeting facilitation team. Further discussion then led to modification, merger or bifurcation of some of the questions, eventually resulting in list of 24 questions. Workshop participants were asked to score the questions one through five for their importance to GCAMP decision making (five being most important). They were also asked to indicate whether the issue should be addressed in phase I or phase II of a research program. Participants voted using radio frequency clickers linked to a computer to preserve anonymity. The results are presented in table 1.

Following the voting, the group discussed both the results and the procedure for voting. Comments included: "the voting was too hurried to give proper time for thinking", "several of the questions were similar which made it hard to vote, and "we had neither the time not information to consider budget realities". Clearly, both the statements of the questions and the rank ordering of their importance should not be accepted as definitive. The phase I – phase II results are especially questionable because people did not have any information on budget realities when they voted.

Table 1: Questions Developed by Small Groups on First Day of Workshop

(All participants, Ranked by Importance Score)

Item		Importance Score	Phase Score
B	How do high flow and other experiments affect recreation (river rafting fishing guides and other associated businesses, including tribes)?	4	1.2
H	Having heard two distinct views, what is the value of hydropower capacity of GCD?	4	1.2
W	Determine impacts on marketed hydropower and recreation values of alternative flow scenarios in real time to support decision making.	4	1.4
Q	What is the total non-use value for natural cultural, and recreational resources along the river?	3.8	1.5
D	What are the points of disagreement on methodologies and assumptions in regard to power analysis?	3.6	1.2
E	What would a consensus interagency methodology for modeling hydropower and recreation (e.g., fishing and rafting) economic outcomes look like?	3.6	1.5
A	What are the attributes of of the river that are important to recreational users?	3.5	1.3
G	What are the use and nonuse costs and benefits of HFE including the marginal costs and benefits of changes in HFE duration and size?	3.5	1.4
O	What is the economic benefit of river recreation to tribes?	3.5	1.5
U	What is the value of clean power generaton at GCD nationally?	3.5	1.5
C	Do we need to determine the value of specialness" of resources such as hydroelectric power generation; visitor satisfaction; value of beaches to support rafting; values of high visibility wildlife e.g. peregrine falcon, big horn sheep; and value of a blue ribbon trout fishery?"	3.4	1.6
L	What is the sociocultural impact of recreational use in the Colorado River on native american values associated with resources and places in the Grand Canyon?	3.4	1.6
M	Can the values of dependable power and water supplies be reflected in future economic analysis?	3.4	1.6
T	What are the non-use values for different resources (including the tribal perspective) so we can include these values in trade-off analysis?	3.4	1.4
I	What is the base case on optimal power generation?	3.2	1.5
N	How much weight should non-use values be given compared to market and non-market use values?	3.2	1.5
R	What are the socioeconomic benefits and costs of hydropower generation from HFE to tribal communities?	3.2	1.6
V	Can we obtain an assessment of alternative economic consequences associated with different flow regimes at GCD from one or more CRSP customers, including indirect impacts?	3.2	1.5
F	Integrate all use and non-use socioeconomic data into a conceptual model.	3.1	1.7
J	What are the requirements for economic information in GCPA, ESA, NHPA, NEPA, CRSPA, etc.?	3.1	1.4
P	What is the socioeconimic impact of mechanical removal of non-native fish and other actions?	3.1	1.4
S	What is the total economic impact to upper basin water users from changes to power generation from base case?	3.1	1.6
X	Can contracting for firm power WAPA be adjusted to be more flexible for current hydrology and operations without affecting the Basin Fund?	3.1	1.7
K	What are the associated costs to hydropower of non-TCD warmer releases?	2.8	1.8

In developing the recommendations which appear in the following section we chose to use this list of questions in the spirit in which they were originally generated – as brainstorming results. We took the list as a starting point to stimulate our thinking, and as a check-list to be sure we did not miss important subject areas. We tried to account for the overlap between several of the statements. We tried to account for the inherent sequential nature of some of these tasks – you need to collect this information before you can do that kind of study. We tried to anticipate likely future agency budget realities.

3. Context for Economic Analysis

Before we discuss recommendations, it is important to first outline some basic concepts of economic analysis that provide important background for our recommendations.

a. The economic measure of value

Federal principles and guidelines state that the federal objective of water and related land resources planning is to contribute to the national economic development, consistent with protecting the environment (U.S. Water Resources Council, 1983) In addition, the principles and guidelines state that contributions to national economic development are increases in the *net* value of the national output of goods and service, *expressed in monetary units*. This is a restatement of the conventional monetary metric of value used in economics. Economists measure welfare in monetary terms by its *income equivalent* – the change in income that is equivalent, in terms of its impact on a person's welfare, to the change in question. The source of the welfare change could be an increase in net income, in which case the change in net income is the direct measure of economic value. If the welfare change is a change in the price, quality, or access to items that are of value to a person (regardless of whether they are marketed goods and services or non-marketed items), the economic value, in monetary terms, of the change in the price, quality or access to those items is the change in the person's income that would have an equivalent impact on his or her welfare.

In general, there are two ways to define an income equivalent, known as the *willingness to pay* (*WTP*) measure of income equivalence and the *willingness to accept* (*WTA*) measure. Suppose the change generates an improvement in the person's welfare. The WTP measure of income equivalence is the maximum amount of money the person would be willing to pay (i.e., the maximum reduction in his net income he would be willing to endure) in order to obtain the change rather than go without it. The WTA measure of income equivalence is the minimum amount of compensation (i.e., the minimum increase in his net income) he would be willing to accept in return for foregoing (giving up) the change. If the change is directly a change in net income, then there is no difference between the WTP and WTA measures of income equivalence – they are both equal to the change in net income. If there is some type of change other than a direct change in net income, then the WTP and WTA measures can be different. Based on existing research, a general presumption is that the WTP measure is likely to be somewhat smaller in absolute value than the WTA measure, but this may not always be true. More importantly, the federal principles and guidelines state that the WTP measure of value is to be used in water and related land resource planning.

When the change involves the price, quality or access to a marketed commodity and the person

whose welfare is being measured is a consumer of the affected item, the WTP and WTA are essentially equivalent to what is known as the change in *consumer's surplus* – the change in consumer's surplus is used as an approximation to both the WTP and WTA measures. When the people whose welfare is affected consist of both producers and consumers, the income equivalent of the aggregate impact on their combined welfare is referred to as change in "*producers plus consumers surplus*" – it is the sum of the change in net income for the producers and the change in consumers surplus (the income equivalent of their change in welfare) for the consumers.

It is important to note that, even for a marketed item, the economic *value* of the item is *not* the same as its price. For example, the total price to fish or raft in the Grand Canyon National Park can be quite high; it can include the cost to travel the Grand Canyon area, the fee paid to a guide or outfitter, as well as various other costs. The total price could be, say, $350. But that does not necessarily measure the value to the individual from fishing or rafting at the Grand Canyon. His value cannot be *less* than the $350 price because – unless he badly miscalculated -- he would not have chosen to make the trip. But his value can certainly be *more* than the $350 price. Suppose that his value for the trip, as measured by WTP, is $500.[1] Then, he would have been willing to pay up to $500 to take the trip. But, since the price of the trip is only $350, he receives a *net benefit* amounting to $150. Suppose, for example, that it became impossible to take the trip to the Grand Canyon due, say, to a change in reservoir operations. He would lose a consumption experience which he values in monetary terms at $500 – that is his *gross* loss of benefit. But he avoids an expenditure of $350, and he is now free to spend that money on something else. His *net* loss is $150, the amount by which his gross loss would have exceeded his cost – that is his consumer's surplus.[2] It is his "profit" as a consumer, and it can be seen as analogous to the profit that a firm makes.[3] Because it relates in this case to the person's enjoyment of a marketed item – namely, commercial rafting at the Grand Canyon– it is said to be a *use value* for the Grand Canyon.

The above illustrates the importance of the emphasis on *net* as opposed to gross benefit -- net benefit equals gross benefit minus cost. There is also an important economic issue associated with the measurement of cost. The economic cost of an item is defined as the economic value of whatever is sacrificed or foregone in order for the item to be provided. This is not limited to the actual outlays required to obtain the item; it also includes what economists call the *opportunity costs* associated with the provision of the item. The opportunity cost is the value of the *best* alternative that is foregone when the item is supplied. In the recreation context, the time spent travelling to the site may have an opportunity cost component, namely the income foregone when time is not spent earning money but is used instead for recreation. The opportunity cost of time is

[1] It might be even higher as measured by WTA, e.g., because a trip was already "purchased" and was now being withheld or taken away.

[2] The numerical values used here are made-up in order to illustrate the concept of consumer's surplus. However, empirical studies of commercial rafting in the Grand Canyon demonstrate that commercial boaters obtain a sizeable amount of consumer surplus even after quite large commercial fees (Bishop, et al, 1987).

[3] Technically, it is the WTP measure of consumer's surplus. There is also a WTA measure of consumer's surplus, when gross value is measured with the WTA measure. In practice, consumer's surplus is often measured as an ordinary demand curve, in which case it approximates both the WTP and WTA measures of net value.

regularly considered in recreation economics studies.

By a similar logic, the fixed capital costs of currently existing power plants do not constitute a net economic cost to society associated with changes in operations. These fixed costs are considered *'sunk' costs* because the decision to build the power plant has already been taken and the plant is already in operation. Existing fixed costs are not an economic cost of the alternative power plants' operations. But capital costs of new power plants, not currently existing but expected to be built in the future to make up for a reduction in hydropower generation at Glen Canyon Dam, *do* count as a real economic cost associated with a change in operations. In economic terminology, payments to cover the fixed capital costs of existing power plants would be considered "*transfer payments*." Transfer payments reflect a redistribution of income from one group in society to another, and do not reflect a real economic cost to society.

Similarly, the gross economic value of an output is not necessarily the actual revenue received from its sale – it is the value to the recipient of the commodity, based on what it would cost to receive a similar flow of service from an alternative source. Thus, if hydropower from Glen Canyon Dam is sold for $0.5/Kwh but the cost to supply electricity from an alternative source using fossil fuel, say, is $0.8/Kwh, which sets the market price in the Western power grid, the value of electric power generated at Glen Canyon Dam is $0.8/Kwh, not $0.5/Kwh. In economic parlance, the difference -- $0.3/Kwh -- is an economic transfer from the owner of Glen Canyon Dam to the contractors who receive power from Glen Canyon Dam. Like other transfer payments, it involves the redistribution of income from one group in society to another, but not a real economic cost to society.

The foregoing discussion, including the distinctive economic treatment of transfer payments, highlights the difference between an economic analysis of costs and revenues and a financial or accounting analysis of costs and revenues. A financial analysis focuses on the actual revenues and costs accruing to a particular agent; an economic analysis focuses on the real economic costs and benefits to society associated with those financial flows. Therefore, a financial analysis includes transfer payments, while an economic analysis of the sort required by the federal principles and guidelines excludes them.

b. Other Measures – Regional versus National, and Other Metrics

It is sometimes desired to analyze the economic effects of a water project not nationally but within a local economic region, for example the region where the project is located. It is sometimes desired to assess the economic effects in terms of metrics other than the income equivalent of the aggregate impact on welfare (i.e., producers plus consumers surplus); the other metrics may include impacts on employment, output, and sometimes tax revenue. It is common to use an input-output model for regional analyses and calculation of these other metrics. Here we add a note of caution about such analyses.

While there may be a strong local interest in regional effects, it should be noted that the federal principles and guidelines stress the national perspective and assert the primacy of national economic development. Moreover, there are some substantive economic issues that arise when a regional analysis is conducted using input-output analysis, even if the metric employed is impact on local income.

First, the conventional input-output models do not account for consumer's surplus. At best, they account for changes in producers' and consumers' incomes, but they do not allow for the welfare effects of any changes in prices, quality or access to commodities, and they do not account for the income equivalent of such welfare changes (i.e., the change in consumers surplus).

Second, when the economic analysis is conducted for a local region there is almost inevitably some economic leakage, defined as the difference between total sales in the region and income (value added) generated in the local region (Loomis and Walsh, 1997).This leakage consists of payments for goods and services imported into the region from outside, and income payments (including interest, rents, profits and taxes) by producers and consumers within the regions to economic actors outside the region. Given such leakage, the impact on income generated within the region is only a fraction of the total sales generated within the region.[4] The change in total regional sales without a correction for leakage is therefore not an economically meaningful welfare metric, although it is commonly computed in regional input-output analyses.

Third, the conventional input-output analyses ignore substitution between economic changes occurring within the local region being considered and economic changes occurring elsewhere in the national economy. An increase in employment in the local area may cause in-migration to the region and a corresponding decrease in employment outside the region. Viewed from a national perspective, what is happening may simply be a relocation of production, employment and income from one region to another, rather than a net increase nationally. This is a transfer, which has no economic significance nationally. Similarly, a change in taxes is simply a transfer, not a real economic change. In fact, if there is full employment in the economy generally, the increase in regional employment projected by an input-output model is unlikely to be realized: it is simply not credible.

In short, if it is desired to produce a regional analysis, the analysis should at least be consistent with sound economic practice. Leakage has to be accounted for. Offsetting economic changes occurring outside the region should be noted. The only meaningful monetary measure of welfare is income and income-equivalent measures of change in welfare. Other monetary metrics that do not measure this, such as changes in regional sales, are not economically meaningful, cannot validly be combined with income equivalent welfare measures, and should be discarded. The number of jobs created may be a metric of interest, but the credibility of such estimates depends on justifying the implied assumptions about existing unemployment.

c. Long and Short Run Analyses

Any analyses should account for differences between the long run (LR) and the short run (SR). For example, the imposition of changes in operations at GCD will change the distribution of electricity generation in the SR, before new power plants can be built or the transmission system reconfigured. That is, in some periods the output of GCD will fall (rise) and the output of other generators will rise (fall). In the LR, changes in GCD operations may cause changes in the

[4] This is less of an issue at the national level, because imports of goods and services from other countries and income payments to persons in other countries are a much smaller fraction of national value added.

quantity and location of newly built generators, as well as investments in transmission. Present value analysis can be used to eliminate differences in cash flows of different operating regimes. One possibility to keep in mind is that any reductions in capacity at GCD will simply *accelerate* the construction of new capacity somewhere in the area covered by the Western Electricity Coordinating Council (the WECC coordinates electricity service and system reliability in all or parts of 14 western states plus parts of Mexico and Canada), which implies that the economic cost of such reductions in capacity is the acceleration of the investment (e.g., moving from 2017 to 2016), not the entire cost of the investment itself.

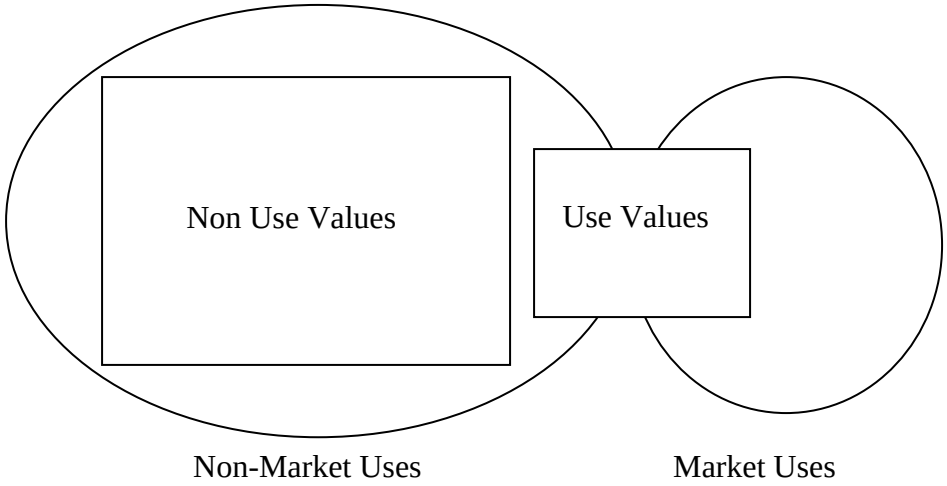
d. Use value, Non-Market Value, Nonuse Value

As noted above, people who visit the Grand Canyon to sightsee or participate in outdoor recreation such as fishing or boating obtain a *use value* from their visit, which can be measured in monetary terms by their WTP measure of net welfare change (their consumers surplus). The unique nature of the Colorado River through the Grand Canyon and the presence of endangered species yield benefits to people who may never set foot in the Grand Canyon. These are *nonuse values* because they occur off-site, usually at homes or households. Nonuse values were also called "passive use values" by the U.S. District Court of Appeals (1989) in upholding the inclusion of option value and existence values in Department of Interior Natural Resource Damage Assessments. Existence values are the benefits individuals receive from the knowledge that the natural environment of the Colorado River and its native and endangered species are protected for themselves and future generations (Krutilla and Fisher, 1975; Hanemann, 1994; Richardson and Loomis, 2009).

Nonuse values are also measured in monetary terms by people's WTP for protection of the unique natural environment and native and endangered species of the Grand Canyon. Nonusers' WTP may be paid in the form of a higher utility bill or higher taxes, as nonuse values are public goods, like national defense. As with other public goods, people generally pay for them through taxes. Regardless of whether people actually pay for their nonuse values, the satisfaction they receive from the knowledge that the Colorado River through the Grand Canyon is protected, along with the native and endangered species, is a real economic benefit to society. There does not need to be an actual payment (a financial cash flow) to generate an economic benefit. The benefits exist independent of whether an agency can capture these as increased tax revenues or increments to utility payments. Figure 1 illustrates the relationship between non-market value (the entire circle) and the primary components: (a) use values (e.g., recreation) and (b) nonuse values.

While the relative proportions of use and nonuse values will vary from resource to resource, Loomis, et al.'s (2005) comparison of use values and nonuse values (see also Welsh, et al., 1995) in the Grand Canyon indicates that the nonuse values dominate use values in the Grand Canyon. In part this is due to the cap on rafting use, but in part due to the public good nature of nonuse values. Everyone in the U.S. (or even the world) can receive the satisfaction from knowing the Colorado River through the Grand Canyon and its native and T&E species are protected, without having to visit.

Figure 1. Market and Non Market Values of the Colorado River & Native & T&E Species in the Grand Canyon



e. Relation Between Data Collection, Surveys, and Economic Analysis

Economic analysis requires data. The data used by economists often comes from a variety of sources. Economists often use data from published sources. For example, the regional economic models presented by Kim during the first day of our workshop relied heavily on published US government sources.

In other cases economic analysis may rely primarily on in-house company or agency information. The analysis that we propose below for the hydropower system will rely significantly on Glen Canyon operating data and on information on the characteristics and operation of the regional power coordinating agencies.

The economic analysis of recreation and of nonuse values requires a different approach. Since the needed data is not available from published sources or agency operating data, it must be obtained using surveys. The only way to measure a rafter's willingness to pay for the rafting experience is to elicit that response with a well designed survey of river users. To estimate the net economic value of the rafting experience, one also needs estimates of what the rafters actually did pay, which can also come from the survey. The estimation of nonuse values also depends heavily on contingent valuation survey approaches. A systematic program of survey data collection must be an integral part of the GCMRC socioeconomic research program.

4. Recommendations for Surveys and Studies

The following are our recommendations for surveys and studies that should be conducted by GCMRC. We begin with a discussion of some of the considerations and constraints that shaped our recommendations.

a. Considerations

Past GCMRC budgets have focused largely on biological and physical issues. While this has provided much useful background information, it has left little of the available resources to support socioeconomic studies. We realize that making major shifts in this research program budget will be difficult and will take time. In making our recommendations we have tried to be sensitive to these budget constraints, personnel constraints, and timing realities.

Of course, the budget, personnel and timing realities will depend on the perceived urgency of the socioeconomic studies. It is our conclusion that the socioeconomic analyses recommended below are important for Grand Canyon policymaking, so we recommend that these studies be initiated as soon as possible, and pursued expeditiously. However we recognize that the policy making context could change in ways that make it more urgent to have the socioeconomic research results sooner. If that happens, and if that urgency is backed up by budget and personnel increases, then the analysis might proceed faster than shown in the timeline below.

A socioeconomic research program will follow a logical sequence. Some things must be done before others. The process generally starts with problem identification, a search for existing data and related work, and discussions of appropriate analytical models. Often information from one stage of analysis serves as input to a subsequent stage. (For example, collection of data on river use and user spending must precede the building of an economic impact model.) Some studies are simply harder to do than others, and might be deferred to give GCMRC more time to acquire experience doing socioeconomic research, and to allow more time to plan such studies. (For example, studies of Grand Canyon nonuse values are inherently more complex than studies of the economic value of river use.)

All work should be peer-reviewed throughout, to enhance credibility and acceptance. Allowance must be made in the research timeline to allow for this peer review.

b. Hydropower

The main effect of any changes in the operation of Glen Canyon Dam will most likely be a change in the timing of hydropower generation during the course of the day, the week and the year, rather than any change in the total Kwh generated at GCD over the course of the year. But, because electric power has a different economic value at different times of the day, the week, and the year, this can translate into an economic cost. To assess the economic cost it is necessary to look at the real economic value of the power generated at GCD rather than the contract prices at which much of the power is sold. As indicated in section 3a, the GCD contract prices may involve economic transfers and therefore understate the economic value of this resource.

GCD and the CRSP system are embedded in the larger western power grid (the WECC). Similarly, the utilities to which CRSP sells power are embedded in the WECC. Therefore, in principle, the market by reference to which the economic value of GCD power is determined is not the CRSP system but the WECC. At any point in time, it is the marginal price of electricity in the WECC that determines the economic value of power generated at GCD.

As indicated in section 3a, the capital costs of existing power plants, whether in CRSP or the

WECC generally, do not constitute a net economic cost to society of changes in operations. They are sunk costs, and they do not count as an economic cost of the existing power plants' operations. As a general statement, there currently exists excess capacity in the WECC. But, to the extent that, at some point in the future, reductions in power generation at GCD require an increment in generating capacity somewhere in the WECC system, the marginal cost of this extra capacity *would* count as a real economic cost. It would not necessarily be the cost of additional capacity in CRSP – it would be the cost of additional capacity anywhere in the WECC system to which WAPA and/or WAPA contractors have access. Moreover, it would be determined by the capital cost associated with the cheapest alternative source of additional capacity, which could be based on non-fossil fuel, and could take the form of investments in the promotion of energy conservation (a.k.a., "negawatts").

We were told at the meeting in Phoenix that the existing power contracts for GCD expire in 2024. This creates the possibility that, when new contracts are negotiated for post-2024, it would be possible (and desirable) for WAPA to seek contract modifications that take into account the power generation impacts of any modification in GCD operations. The opportunity for contract adaptation should be factored into the economic assessment of the economic costs of changes in GCD operations for the period after 2024.

The first step is to establish a "base case" against which various scenarios for hydroelectric operations can be compared. The base case, and all scenarios, must be developed in sufficient detail that existing modeling tools can be used to estimate economic effects. Given the nature of markets in the western U.S., such detail should include, at a monthly level, peak (hourly) output, and peak and off-peak energy output. More sophisticated analyses may require even more detail, e.g., hourly or even within-hour energy production in the base case and relevant scenarios. Although the development of a "base case" is likely to be contentious, we recommend that current operations be considered the "base case", but that operations in some historical period, defined by a lack of environmental constraints, also be modeled, so that arguments about cumulative changes in equity can be considered.

Once a base case is established, alternative scenarios for future operations must be clearly defined at the same level of detail (e.g., peak demand and peak and off-peak energy). Given the alternatives, existing models used by WAPA to optimize the operation of the integrated system of generation resources should be used to determine if all consequences of changed operations can be managed within the WAPA marketing area, or if electrical (and thus economic) "spill-over" effects will alter generation patterns, market prices or transmission bottlenecks elsewhere in the WECC system. If the effects of changed operations at Glen Canyon can be managed by WAPA without economically significant changes in the rest of the western U.S., then the economic consequences of such operations will be limited to WAPA's customers, and the modeling effort limited. However, at this point there is no way to know if such changes will spill over into the rest of the WECC system beyond WAPA without actually checking this using a model of the WAPA system and checking changes at flowgates where WAPA interconnects with the rest of the WECC.

We have focused so far on requirements for the analysis of the economic impacts of changes in GCD operation The analysis should also incorporate an assessment of the financial effects on individual WAPA contractors. As explained in section 3a, the analysis of financial effects tracks

flows of funds, e.g., changes in WAPA's overall revenue requirement or transfers between WAPA customers. Financial effects are important to those who are actually paying the bills, but economic effects are important from a national policy perspective.

We recommend that WAPA's existing power flow models be used to analyze the expected effects of changes in generation at Glen Canyon Dam, including effects on (a) generation (federal or non-federal) within the WAPA system, (b) loadings on transmission lines, (c) ability to meet reliability criteria, and (d) spot market prices at the Palo Verde Hub. These effects should be estimated for a near-term year (e.g., 2012) and a long-term year (e.g., 2020), because in the long-run more changes can typically be made via investments that could mitigate any short-term effects.

If WAPA's power flow models demonstrate changes in flows at the border of WAPA's system, or at interconnection points with other systems, then a more extensive modeling effort will be required, to check for changes in the above four indicators (generation, transmission, reliability, and hub prices) throughout the WECC. Again, a near-term year and a long-term year should be modeled.

Any economic effects should be identified with specific parties, both inside WAPA and elsewhere in the WECC system. Candidates for such identification include the following: WAPA's customers, end-users of WAPA's customers, other end-users in the WECC, other producers inside the WAPA marketing area, and producers outside the WAPA marketing area but inside WECC.

The power modeling effort can be spread out over time, initially focusing on the WAPA marketing area using existing models, while soliciting qualification statements from entities (vendors) that maintain power flow models of the entire WECC. If the existing models show effects outside the WAPA marketing area, additional analysis for the entire WECC should be performed.

Because western power markets probably do not meet the definition of "perfect competition", some effort should be taken to account for market imperfections. It is at least theoretically possible that changes in operations at Glen Canyon Dam will provide opportunities for some suppliers to exercise market power, at least in the short run. (Entry in the long run *may* eliminate such concerns: additional generation and transmission resources may be built.)

To the extent that repeated analyses of power market impacts are required as part of the future decision-making during the extended experimentation contemplated under the Adaptive Management Plan, it may well be possible to ease the calculations by developing a simplified response-surface model, embodied in a spreadsheet, linking changes within the CRSP service area to impacts on prices and capacity requirements within WECC.

In addition to the economic and financial analyses discussed above, economic impacts will also be of interest to policy makers. Thus, input-output models such as IMPLAN could be used to estimate changes in employment, income, and government tax revenues, due to changes in operations at Glen Canyon Dam. The relevant geographical area would be the CRSP service area. However, the limitations inherent in such models should be noted, and leakage must be accounted for.

Finally, changes in generation patterns may result in changes in emissions of carbon dioxide and other sources of environmental consequence. Again, commercially available models are capable of estimating emission changes. Any solicitation of vendor qualifications should include the ability to model power flows, economic consequences, and environmental effects.

USGS should first seek access to a model of the WECC system and may wish to issue an RFQ for providers of such access to obtain preliminary estimates of the expected cost of estimating the net economic effects of changes in operations at GCD.[5] It would appear that this task could be accomplished during the current fiscal year (FY10) if staff is available to formulate (scope) the problem, and to seek and evaluate responses. These estimates could then be used to establish a budget for FY11, for actual modeling work within the WAPA marketing area based on an RFP and bids from qualified firms. During FY11, information generated by the WAPA modeling effort would then be used to develop budgets for FY12 and beyond, once a determination is made about the potential geographical scope of economic effects. Table 2 summarizes these modeling suggestions.

Table 2

Date	Task(s)	Responsible Parties
FY2010	Define GCD operational base case and change cases	GCMRC, with cooperation from WAPA
	Solicit firms for WECC analysis (RFQ for engineering, financial, and economic analyses)	GCMRC, with cooperation from WAPA
FY2011	Model WAPA's system with changes in GCD operations; check flowgates between WAPA and rest of WECC; establish framework for economic and financial analyses	Consultant, with cooperation from WAPA
FY2012	Conduct economic and financial analyses, for WAPA and its customers and, if necessary, WECC	Consultant, WAPA, GCMRC

c. Recreation

As noted above, studies of the economics of recreation are generally based on data from surveys of recreation users. Table 3 provides a taxonomy of the different users of the Grand Canyon, the providers of recreation and the economic impact areas (i.e., counties and reservations) that merit detailed economic study. Several of these groups have not been studied in decades, despite the regional and national prominence of fishing and rafting in Glen and Grand Canyons. Each row can be thought of as one survey that captures multiple values. Repeating surveys over time creates consistency of data collection over time, and allows for tests of responses to specific events (e.g., experimental releases, extreme weather events). In each case, the first step is to find out what related survey data already exists or may be collected in the near future (perhaps by state or other federal agencies)

[5] It may be possible to utilize a non-proprietary model of the WECC system such as the SWITCH model recently developed at UC Berkeley.

Table 3: Economic Effects of Resource Use Proposed for Near-Term Studies

	Users		Providers	County/Reservation Incomes
	Values	Attitudes		
Glen Canyon Anglers (FY11)	Benefits	Preferences	Outfitters	Impacts
Day Use Rafters (FY11)	Benefits	Preferences	Outfitters	Impacts
WW Rafters (FY12)	Benefits	Preferences	Outfitters	Impacts
Diamond Creek to Mead (FY12)	Benefits	Preferences	Enterprise	Impacts

Implementation and Economies of Scale in Recreation Surveys

For each type of recreational user in each location a single survey will be able to provide information on visitor preferences, visitor benefits (i.e., net WTP or consumer surplus) and expenditures. This expenditure data can be used in the IMPLAN regional input-output model to estimate the positive economic impacts to the surrounding counties and Indian Reservations in terms of direct and indirect personal income and employment generated. The indirect effects capture the multiplier effects from subsequent rounds of spending in the surrounding region. Separate interviews with the guides and the tribes will be needed to obtain their expenditures associated with the guiding, access fees, food, and other costs. We recommend that the economic impact analysis use two impact areas. For consistency with past research, it would be appropriate to use the counties surrounding the Grand Canyon. However, since many outfitters have their base of operation in Nevada or Salt Lake City, it would be appropriate to show results using a broader multi-state economic impact area.

FISCAL YEAR 2011

We recommend that the Glen Canyon angler and rafting surveys begin in FY 2011, as this is a small geographic area with a well defined user group. The angler surveys could be done by partnering with Arizona Fishing and Game (AZFG). An efficient division of labor would be for joint design of the survey, AZFG implementation of the angler survey (as state agencies are not subject to federal review by OMB), and data analysis and report writing by USGS/NPS, NAU or contractors. The Glen Canyon rafter survey may be able to be done in conjunction with the planned river recreation surveys by John Duffield (Bioeconomics) as part of the NPS assessment of benefits of river recreation in the Colorado River watershed. The GCMRC surveys should build upon Bishop, et al.'s past surveys (1987) and Duffield's (2009) to maintain consistency in questions over time.

FISCAL YEAR 2012

In FY 2012 we recommend that whitewater boaters (private and commercial) be surveyed in the Grand Canyon. For comparability of data and comprehensiveness of analysis, we recommend that the survey collect information on preferences, economic benefits to the boaters themselves, and their expenditures. Interviews with the outfitters will be needed to obtain the outfitters' expenditures for commercial trips. The data from private boaters, commercial passengers and outfitters can then be analyzed to estimate use values of whitewater boaters (i.e., consumer

surplus), and the economic impacts to surrounding counties (and states) of the income and employment associated with whitewater rafting. Since several commercial outfitters are located outside of the surrounding counties we recommend that the economic impact analysis also be performed using surrounding states such as Nevada and Utah to more completely reflect the personal income and employment supported by whitewater rafting. This would be consistent with the west wide service area used in the hydropower analysis. The GCMRC surveys should build upon Bishop, et al.'s past surveys and Duffield's to maintain consistency in questions over time.

In addition, surveys should be initiated in the Diamond Creek to Lake Mead stretch of the Colorado River. This segment has been experiencing increased use, both as the last days of a Grand Canyon trip, but also as separate day and short overnight trips. The Hualapai Tribe uses this stretch for their guided trips as well, yet little is known about the recreation benefits to the visitors or the regional economic impact of these trips. Discussions with Hualapai Tribe and other outfitters to obtain information to perform a regional economic impact analysis should be a high priority in FY12.

Maintaining a Monitoring Cycle and Special Use Surveys Related to Experiments
Since the Grand Canyon Protection Act specifically mentions recreation as one resource to be monitored, GCMRC, NPS and AZGF, should periodically resurvey all users groups and river segments specified in Table 1 on a rotating cycle. Thus, once the first pass of surveys is completed in FY 2013, in FY 2014 it will be time to repeat the Glen Canyon anglers and day use boaters survey. Likewise in FY 2015 it will be appropriate to repeat the Grand Canyon whitewater boater and Diamond Creek-Mead surveys.

In some cases, these surveys will serve as a baseline and allow measurement of effects of experimentation in Glen and Grand Canyon. However, if large experiments are planned, it would be important to do pre-experiment visitor surveys and post experiment visitor surveys to assess the economic effects of these experiments on visitor benefits and the regional economy.

These proposed recreation use surveys address Questions B, W (part), A, O, L, G (part), C, and R identified at the December Socioeconomic meeting.

d. Tribal

Native Americans account for a significant portion of the total population most directly affected by GCD operations, namely residents of northeast Arizona.[6] About 85% of the most directly affected Indian population live on Indian Tribal reservations in that region of Arizona (NRC, 1996, page 138). The Tribes have a variety of interests in any change in the operations of GCD. They claim some degree of sovereignty over portions of the river and its associated environment. They were the original inhabitants of this region and have strong religious and cultural attachments to the landscape and its fauna and flora. As the National Research Council noted:

> "In terms of cultural and historic traditions and beliefs and practices, the Native American peoples are the population at risk relative to dam operations." (NRC, 1996, page 140)

[6] In 1990, they accounted for 49% of the population of Coconino, Apache and Navajo counties, as cited by National Research Council (1996, p. 138).

In addition, in some cases (especially the Hualapai Tribe) they derive significant income from river-based recreational and other enterprises. However, while the Native American Tribes were belatedly included in the group of Grand Canyon Environmental Studies (GCES) cooperators convened by the BOR, their distinctive interests and the impact of dam operations on them received very little attention in the GCES studies. The NRC 1996 report criticized GCES for having been slow to incorporate the Tribes in the group of GCES cooperators. It clearly implied that it felt the Tribes had received inadequate consideration in the GCES process. Clearly, a socioeconomic research program for the GCMRC needs to recognize not only the **economic** impacts but also the **social** impacts on the Tribes that result from changes in dam operations. The Tribal social impacts may suggest both opportunities and constraints that should be considered as changes in river operations are contemplated.

The most effective way to accomplish this is to design and implement a survey of the Tribal populations. Information to be covered in this survey should include:

- Attitudinal questions
- Impacts of flow regimes

Tribal representatives should be invited to participate in the development and testing of the survey instrument. To the extent that they may already have information on issues covered by the survey from their own sources, that information should be consulted in the design of the survey. For example, the survey could be a mail or phone survey of residents of the Tribe reservation, and Tribe members living off the reservation, using contact lists provided by the Tribes.

The tribal survey will address issues O, L and R raised at the December 2009 Socio-Economics workshop.

e. Nonuse Surveys

Nonuse values were recognized by the National Research Council Committee on River Resource Management in the Grand Canyon as "an acknowledged dimension of comprehensive environmental studies." The Committee went on to comment that "nonuse value seems particularly relevant in the case of the Grand Canyon because of the high aesthetic and intangible values attached to the region nationally and internationally and by Native American Tribes." It noted: "Even so, and perhaps for this very reason, the BOR long resisted inclusion of nonuse values but in 1995 acceded to them as an addendum to the EIS." This is the study by Welsh, et al. 1995. Referring to the information in this study, the Committee stated "the information itself is clearly warranted as a component of GCES." [7] (NRC, 1996, page 28)

It is now almost 15 years since that study was conducted. Much has changed including the management scenarios in the Grand Canyon and the demographics of the U.S. population, especially in the Four Corners Region. As recommended by the National Research Council in its report "Downstream", these nonuse values are quite important to understanding the public

[7] The Committee also stated that "GCES has illustrated the need for the inclusion of nonuse value studies in similar projects" (NRC, 1996, page 6-7).

benefits of alternative management strategies in the Grand Canyon.

We recommend that in the upcoming fiscal year (2011) that the 1994 nonuse value study be reviewed and a determination made of what changes need to be made to the questionnaire. In conjunction with this it may be beneficial to hold a one day workshop on the conceptual basis for and methods for conducting nonuse value surveys in order to prepare TWG and GCMRC staff for this effort. The effort will require an interdisciplinary effort with hydrologists, fish biologists and anthropologists to obtain data on key environmental variables such as beaches, game, native and endangered fish, and the status of cultural resources in the Grand Canyon. The linkages between flow and other management actions and these resources need to be identified so that survey scenarios can be developed that better match current management options under consideration by AMWG, TWG, and GCMRC. By tying flow-related changes to the environment to the nonuse value survey, the incremental or **marginal** nonuse values can be estimated that are most useful for evaluating potential management actions in the Grand Canyon.

The study and survey revision steps should be in consultation with the National Park Service's nonuse value study that John Duffield is currently leading. Initial focus groups to refine the revised survey should occur in Fiscal Year 2011. Formal pre-tests and piloting of the survey and OMB clearance would be a priority in Fiscal Year 2012. Full implementation of the study should be scheduled and budgeted for Fiscal Year 2013. This survey should be repeated at least every decade or when major changes to the operation of Glen Canyon dam or major experiments are being considered so as to provide public input on the consequences to nonuse values of different management alternatives.

The non use value surveys will address issues: T, Q, G (part), C (part), and N raised at the December Socio-Economics review team meeting.

5. Implementation

a. Staffing and Agency Costs

- Staffing. We have mentioned staffing at various points in this report. As the GCMRC shifts to greater emphasis on socioeconomic studies, GCMRC staff with resource economics expertise will be required to conceptualize the required studies, to initiate RFPs and help secure study funding, and to provide study oversight. Resource economics staff will also be needed to help interpret study results and to outline the implications of these results for agency policy. Additional resource economics staff will be required to do this effectively. This assumes that most of the socioeconomic research will be conducted by outside consultants. If some of the studies were to be conducted in-house, the requirement for additional staff would be much greater.

- Agency costs. In addition to the staffing needs noted above, there will be other additional agency costs. These will include costs for outside consultants, costs for conducting surveys, and perhaps other data acquisition costs. The GCMRC also needs to plan for the additional operating costs that will be needed if the added resource economics staff is to be effective.

b. Collaboration

As noted above, the fishing surveys should be undertaken in collaboration with Arizona Fish and Game. The recreation use surveys should be undertaken in cooperation with the NPS effort lead by Duffield, et al. Other possibilities for collaboration, especially for data collection, should be investigated. Possibilities include collaboration with river guide organizations and the tribes.

c. Budgeting

The following is our suggestion for a budget timeline with our rough estimates of costs. We have tried to recognize budget realities, personnel limitations, and logical project sequencing. Depending on the perceived urgency of the socioeconomic analysis, and fund availability, it might be possible to accelerate the timeline.

Fiscal Year 2010

- Initiate RFQs for power models (consultants, perhaps NAU or other qualified entity). No additional budget will be required if this is done by existing staff. However, it might be worthwhile for GCMRC to consider enlisting some additional socio-economic expertise, perhaps from David Harpman or another similarly qualified expert, when developing the RFQs, in which case some additional funding may be required to support this activity in FY10

Fiscal Year 2011

- Initiate recreation surveys of Glen Canyon anglers and day-use rafters $50,000 - $100,000
- Identify tribes for specific surveys of preferences and attitudes $5,000
- Offer "Nonuse Values 101" to educate staff on topic $15,000 (plus participation of David Harpman)
- Power modeling. Cost depends on whether there is a non-proprietary model of WECC and, if not, the cost of access to a proprietary model.

Fiscal Year 2012

- Conduct power flow studies that show the financial and economic consequences of Glen Canyon management alternatives on WAPA, WAPA customers and the Upper Basin Fund. $50,000
- Recreation surveys continue, now covering white water users including Diamond Creek to Mead rafters $100,000 - $150,000
- Prepare surveys of tribal preferences and attitudes $20,000
- Conduct focus groups and piloting of Non Use Value survey, and initiate OMB clearance. ($200,000).
- Power modeling. Cost to be determined.

Fiscal Year 2013

- Expand power flow studies to include the financial and economic consequences of Glen

- Recreation surveys continue, repeating the coverage of Glen Canyon and day-use $150,000
- Add tribal surveys. $60,000
- Conduct full nonuse value survey. $500,000

Fiscal Year 2014

- Develop "real-time decision-making spreadsheet" ($50,000 - $100,000)
- Recreation surveys continue, repeating coverage of white water users $150,000

d. Policy and legal analyses

The basic question is: How will the market, non-market use and nonuse values be integrated into policy analysis? We recommend that DOI Office of Policy Analysis and/or DOE and/or WAPA develop a policy position paper on how the dollar values of market, non market and nonuse values will be used in the different decision making processes such as NEPA analysis, adaptive management and in any benefit-cost analysis.

Resolving these questions of how market, non-market use and nonuse values should be integrated into Grand Canyon policy formulation would address questions X, J, F raised at the December Socio-Economics workshop.

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