Table 2. Summary of proposed studies and *estimated* costs associated with a future integrated beach/habitat-building flow (BHBF) test.

BHBF Related Experimental Studies	Goal Associated with Study	Hypotheses	Costs Year 1	Costs Year 2
1. SEDIMENT AND CULTURAL STUDIES				
1.A – Sand Budgeting	1.A – Sand Budgeting: (1) reach-based accounting of input vs. export during a future BHBF test, (2) longitudinal patterns of erosion and deposition of sand, and (3) changes in sediment grain size related to enrichment/depletion of sand	1.A – Sand Budgeting: A future BHBF test with sand enrichment similar to the 2004 test will result in bar building comparable to that observed during the 2004 BHBF test. If true, then sand budget will be positive between river-miles 0 and 30 for the period bracketing the tributary inputs of sand and the next BHBF test. If reaches downstream from river-mile 30 are sand-enriched relative to the 2004 test, then bar building in these reaches will be greater than was observed in these reaches during the 2004 test and the sand budgets in these reaches will also be more positive than in 2004.	1.A – $314,767	1.A – $90,516
1.B – Sandbar Depositional Rates	1.B – Sandbar Deposition Rates: improve understanding of time evolution of eddy sandbars and rate of deposition or erosion of eddy sandbars during a future BHBF test to determine optimal BHBF peak duration necessary to achieve management goals.	1.B – Sandbar Deposition Rates: Sand deposition rates during a future BHBF test are regulated by (1) interaction of the flow field with the antecedent bed topography and (2) the upstream sand supply. At a given location and for a given BHBF hydrograph, sandbars grow over time if upstream sand supply is sufficiently large; conversely, if upstream sand supply is insufficient, then	1.B – $90,576	1.B – $84,097

		sandbars will erode.		
1.C – Sandbar Fate: Topographic and Grain-size Responses	1.C – Sandbar Fate: (1) determine if BHBF testing conducted under sediment-enriched conditions can maintain/sustain eddy sandbars and associated campsite area, and (2) whether increased aeolian flux of sand from larger sandbars produced during a future sand-enriched BHBF test can maintain downwind (but upslope) archaeological sites	1.C – Sandbar Fate: a future BHBF test under sand enrichment like those before the 2004 test results in bar building and low-elevation gully infilling comparable to that observed during 2004 test.	1.C – $498,703	1.C –$136,730
2.C – Sandbar Fate: Effects of new Sand Deposits at Cultural Sites		2.C – If reaches downstream from river-mile 30 are more sand-enriched compared to pre-2004-test conditions, then bar building and gully infilling in these reaches will be greater than was observed in these reaches during the 2004 test.		
3.C – Sandbar Fate: Changes in Campable Area		3.C – Larger, dry sandbars will result in increased aeolian flux of sand to downwind dune fields (some of which contain archaeological sites), thereby increasing the preservation potential of some sites.		
2. RIPARIAN VEGETATION STUDIES	2. – Native/nonnative diversity and richness – Compare native/nonnative diversity in established and reworked depositional environments along a hydrological gradient following a future BHBF test.	2. – Hypothesis 1: Native/nonnative species richness ratios are the same across all habitats and surface elevations up to 60,000 csf. Alternative hypothesis: The ratio between native/nonnative richness and cover at sites with established vegetative communities will not change following disturbance because resource availability is limited by the presence of existing species. Bare areas will	2. – $41,816	2. – $30,671

		have ratios of native/nonnative richness and cover values similar to those of established sites. Surface elevation will not have an affect on native/nonnative richness and cover values. Alternative hypothesis: The ratio between native/nonnative richness and cover at sites with established vegetative communities will shift toward an increase in nonnative richness and cover because of the increased nutrient availability associated with the experimental BHBF disturbance. Native/nonnative richness and cover ratios will change by surface elevation with nonnative species decreasing with increasing surface elevations in relation to available soil nutrients. Bare areas will favor nonnative species across all surface elevations.		
3. AQUATICS FISH AND FOOD STUDIES 3.A – Lower Trophic Levels	3.A – Lower Trophic Levels: To determine whether or not a future BHBF test has a neutral, negative, or positive effect on the quantity and quality of food available for invertebrates, and ultimately fishes.	3.A – Lower Trophic Levels: To determine whether or not a short-duration BHBF test in spring initially scours the river bottom causing reductions in algal biomass, but the new algal community is of higher quality, more productive, and is assimilated more efficiently by invertebrate consumers, leading to an increase in annual invertebrate production.	3.A – $146,601	3 – $5,955
4. A – Rainbow Trout Studies –	4.A. – To determine how a future BHBF test affect spawning, survival of early life history	4.A. – Hypotheses that will be evaluated are: (1) a future BHBF test will scour redds	4.A – $43,087	4.A – $0

Early Life History	stages of rainbow trout in the Lees Ferry reach, and potential for simulating downstream migration of age-1 fish.	(spawning nests) but the effect on the juvenile population will be limited because of compensatory survival responses, and (2) a BHBF test will alter the distribution of age-1 fish in the Lees Ferry reach resulting in either higher mortality or migration out of the reach.		
4.B – Rainbow Trout Studies - Displacement	4.B – The goals of this experimental study are: (1) to determine if a BHBF test causes displacement of rainbow trout from the Lees Ferry reach into Marble Canyon and eastern Grand Canyon; (2) to determine if such displacement is experienced differentially among different length fish; and (3) to provide a platform for Grand Canyon scientists to develop skills with acoustic technologies that can be applied to answering questions about native and nonnative fish movement and distribution and sampling efficiencies.	4.B – A future BHBF test will result in displacement young rainbow trout from the Lees Ferry reach into Marble Canyon and eastern Grand Canyon. This trout redistribution will be inversely related to the size of fish.	4.B – $70, 498	4.B – $9,005
Appendix C. Spring Backwater Monitoring	App. C – The goal of this project is to increase knowledge of the physical characteristics of backwater habitats and their use by the fish community.	App. C. – This project will allow for an assessment of the area and volume of these habitats that is available in years with and without a BHBF, testing whether BHBFs create additional backwater habitats that can be used by fishes. The project also allows for evaluation of whether these habitats are used by native fishes before the summer solstice.	App. C – $103,490	App. C – $103,490
5. LAKE POWELL				

5. – Influence of a future BHBF test on Lake Powell Water Quality	5. – Determine how a future BHBF test will alter QW in tailwaters of GCD and Lake Powell fore bay	5. – Determine whether or not a future BHBF test will result in higher nutrient releases and shrinking of the hypolimnion.	5. – $16,925	5.– $7,366
6. LOGISTICAL SUPPORT	6. – Provide efficient and expert logistical support to all aspects of the GCMRC science team during a future BHBF test; collaborate with the NPS to establish an informative public outreach plan to ensure the safety of recreational users of the Colorado River.	6. – N/A	6. – $75,033	6. – $0
ANTICIPATED CONSERVATION MEASURES				
- Kanab Ambersnail Habitat	KAS – habitat at Vaseys Paradise	N/A	KAS – $8,000	KAS – $ 0
- Archaeological Sites (yet to be determined by the GCDAMP and key agencies)	Arch Site Mitigation – Glen Canyon site (cost of mitigating potential impacts to the Glen Canyon site is included in the FY08 archaeological site treatment budget)	N/A	Cultural Sites – See Note	
Public Outreach Activities (yet to be determined by the GCDAMP)	Public Outreach Activities (included in Logistical Support budget; estimated at $15,000 for Year 1, none for Year 2)	N/A	Public Outreach – See Note	
		YEAR 1 AND YEAR 2 TOTALS:	**$1,409,496**	**$467,830**
		YEAR 1 AND YEAR 2 COMBINED TOTAL BUDGET:		**$1,877,326**