I. Project Title: Gunnison and Green River Basin Sediment Monitoring and Evaluation Program

II. Principal Investigator

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III Project Summary:

The objective of this investigation is to define the relation between streamflow and sediment transport to aide in the evaluation of Service flow recommendations for the Aspinall Unit and Flaming Gorge Reservoir as it relates to endangered fish habitat. Findings from a retrospective assessment determining sediment-data availability and applicability for use in development of sediment-transport equations were presented in 2004. Three years of daily suspended-sediment data collection has been completed at the Green River near Jensen, Utah, and Gunnison River near Grand Junction, CO, USGS streamflow-gaging stations. To determine the utility of using computer models to understand how streamflow and sediment transport relate to endangered-fish habitat, a demonstration project using Multi-Dimensional Surface-Water Modeling System (MD-SWMS) was done. The results of the study were presented during the 2007 USFWS Researcher Meeting. Final publications of project findings are anticipated to be released as a USGS Digital Data Series Report (Data Report) by December 31 2008 and as a Scientific Investigations Report (Interpretive Report) in FY 2010.

IV. Study Schedule: Initial Year 2004 Final Year 2010

V. Relationship to Riprap:

General Recovery Program Support Action Plan I.A.3&4
Gunnison River Action Plan: 1.A. Identify fish habitat and streamflow needs
Green River Action Plan: 1.A. Identify fish habitat and streamflow needs

VI. Accomplishments for 2009:

Sediment data collection FY 2005-2008:

To better understand the sediment transport dynamics in the Gunnison and Green River Basins, automatic-pump samplers were installed at Gunnison River near Grand Junction, Colorado (Whitewater); and the Green River near Jensen, Utah (Jensen), in water year 2005. Suspended-sediment samples were collected at Whitewater and Jensen from mid-March through mid-October. Sample collection intervals were based on variations in streamflow and time between samples. Sample collection efforts in FY 2008 followed FY 2007 guidance. Recurrence intervals for the snowmelt runoff peaks observed in 2007 were 1.2 years for Whitewater (based on peak streamflow for water years 1968-2007) and 1.33 years for Jensen (based on peak streamflow for water years 1965-2007).

Following the snowmelt runoff peak, an emphasis was placed on monitoring sediment transport during monsoonal rain events. Use of a turbidity sensor facilitated the collection of suspended-sediment samples indicative of monsoonal rain events where minimal increases in streamflow coincided with substantial increases in suspended-sediment concentrations. In 2007, at Whitewater 14 monsoonal rain events were sampled; and at Jensen 12 monsoonal rain events were sampled. Sampling ended in October 2007, and the sediment samplers were uninstalled at both gage locations.

In order to determine the daily suspended-sediment load for each site, a combination of daily pump samples and periodic cross-sectional samples were collected. Pump samples define suspended-sediment concentrations at one location in the stream cross section; cross-sectional samples define the average concentration of the entire cross section. These samples define the relation between the pump-sample concentrations and the cross-sectional sample concentrations. Suspended-sediment sample collection at the two sites consisted of about 375 pump samples collected at Whitewater along with 11 equal-width interval cross-sectional samples (2 additional samples for Quality Assurance); about 330 pump samples were collected at Jensen along with 10 equal-width interval cross-sectional samples (4 additional samples for Quality Assurance). Grain-size analysis was computed for all of the Whitewater cross-sectional samples and several of the pump samples. Grain-size analysis was computed for all of the Jensen cross-sectional samples and several of the pump samples.

Bed-material size, cross-sectional depths, and water-surface slopes data collection continued in 2008. These data will be used to estimate incipient-motion using the Shield's Equation. These data will provide perspective regarding the mechanics of sediment movement (maximum grain size

entrained for a given streamflow), over a range of streamflows. Additional measurement of water-surface slopes and bed material size information was collected in water year 2008 at the Gunnison River near Delta (a task added to FY 2008-09 scope of work to compare finding to existing incipient motion estimates for the Gunnison River).

Sediment records calculations:

Preliminary sediment records for Whitewater and Jensen were completed for FY 2005 and presented to George Smith in early spring 2006. Final Records computations have been completed for Whitewater and Jensen, and the data will be uploaded into the USGS National Water Information System database (NWIS). Daily mean suspended-sediment load and daily mean suspended sediment concentration were published in the U.S. Geological Survey Data Series Report 409 (http://pubs.usgs.gov/ds/409/).

Multi-Dimensional Surface-Water Modeling System Demonstration Project:

In March, 2005, the Sediment Sampling Workgroup discussed the need to better understand the mechanisms controlling channel-morphology progression as it relates to changes in streamflow. The adaptation of the Multi-Dimensional Surface-Water Modeling System (MD-SWMS), an existing hydraulic model produced from the USGS National Research Program, was discussed as a possible method to meet this need. Collaboration between personnel from this project and the USGS National Research Program personnel began in 2005 and efforts to produce a demonstration project continued in early FY 2006. In May, 2006, a project was put in place to demonstrate the use of MD-SWMS in USFWS Recovery Program efforts.

On May 8-12, 2006, a five-person survey team comprised of USGS and USFWS personnel collected topological data for use in the Multi-Dimensional Surface-Water Modeling System (MD-SWMS) Demonstration Project. The topological data consisted of bathymetry and flood-plain mapping for a 1.5-mile reach of the Green River near Jensen, UT. The primary focus of the data collection was the collection of topology data relevant to SWMS modeling of sediment mobility in the vicinity of a critical spawning-bar identified by the Recovery Program and USFWS. Existing LIght Distance And Ranging (LIDAR) data was obtained and used as the framework for the flood-plain surveying efforts and RTK-GPS surveying was completed along shallow and exposed bars and in other areas likely to have been significantly changed following the LIDAR imagery collection date (November, 1999).

Bathymetry mapping was conducted using a boat-mounted Acoustic Doppler Current Profiler (ADCP) and echo sounders. The ADCP and echo sounder were used in conjunction with real-time differential-corrected (RTK) GPS rovers to allow for the measurement of bed elevation at each location, relative

to a reference datum. Longitudinal and cross-section bathymetry data were collected in two spatial patterns resulting in a grid of bathymetry data comprised of ADCP longitudinal surveys and Echo sounder cross-sections. The ADCP longitudinal surveys were collected from the upstream reach boundary to the downstream reach boundary parallel to the shoreline. The longitudinal survey paths were spaced approximately 40 feet apart, with 15 longitudinal surveys total. In addition, the ADCP was also used at 5 cross-sections to measure velocity and signal backscatter data for use as a verification dataset for the SWMS modeling. Echo sounder cross-sections were collected throughout the reach perpendicular to the shoreline and were spaced approximately 100 feet apart, with approximately 140 cross-sections total.

Three temporary water-surface elevation gages were installed May 16, 2006, to monitor water-surface changes throughout the snowmelt-runoff period. These gages were downloaded on June 16, 2006; at which time two of the sensors were repositioned at a lower elevation to continue to monitoring water-surface elevations during the summer. The temporary gages were downloaded and removed on July 27, 2006; and covered a range of streamflow values from 1,200 to 19,000 cubic feet per second (ft^3/s) including the streamflow peak for Water Year 2006. The comparison of these gage records to the streamflow-gaging station record was used to determine a stage-discharge relation within the study reach.

To determine the size distribution of bed material at various locations within the study reach, 15 bed-material samples were collected. These data were included in the SWMS sediment mobility modeling.

Multi-Dimensional Surface-Water Modeling System calibration began with the correction and referencing of the topography data to a curvilinear grid system for data interpolation and computational-grid mapping. This series of steps interpolates and fills the topology data set into a seamless 5x5-meter curvilinear computation grid. This grid was then used in conjunction with the water-surface elevation data measured using RTK-GPS rovers and the temporary water-level gages to generate 5 hydraulic models representing 5 specific streamflows. The primary model was derived from the May 8-12, 2006, data collection corresponding to a streamflow of 9,000 ft^3/s. The data sets collected at this streamflow have the most complete water-surface elevation data and were used to gain insight into the hydraulics of the study reach. These insights were useful as a guide for the modeling of the other streamflows (10,600 ft^3/s; 14,100 ft^3/s; 17,700 ft^3/s; and 19,000 ft^3/s). A comparison of water-surface elevations (temporary gages) and discharge conservation (conservation of mass) was used to calibrate the hydraulic models for the remaining streamflows. Calibration of each model was achieved for discharge variation of less than 5 percent from normalized discharge for all five streamflow models (no more than +/– 5-percent variation

in streamflow among the cross-section locations was found in the calibrated models).

January 17-18, 2007, Preliminary findings from the MD-SWMS were presented during the 28th Annual Researcher Meeting in Grand Junction, CO, to demonstrate the ability of MD-SWMS to related streamflow and sediment transport to spawning-habitat suitability analysis.

Using the Multi-Dimensional Surface-Water Modeling System (MD-SWMS), a surface-water hydraulics and sediment-transport model, an analysis of the transport of sediment on known razorback sucker spawning habitat in the Green River near Jensen, Utah, was done for streamflow conditions representative of the spring 2006 spawning and larval emergence period (April 21-May17). MD-SWMS models were developed to calculate the capacity and mode of sediment transport for streamflows of 9,000 and 10,600 ft^3/s. To characterize the hydraulic and sediment-transport conditions for these streamflows, the modeled conditions were compared to field measurements in the spawning habitat and to available water-quality and streamflow data from the USGS streamflow-gaging station located 4 miles upstream (09261000 – Green River near Jensen, UT). Field measurements and sediment-transport modeling of the streamflows indicates that sand was present in areas generally considered to be important as spawning habitat and that the sand was mobilized primarily as bedload (migrating dunes). Previous investigations show that sand dunes are not ideal substrate for spawning success because the fertilized eggs can become smothered by the migrating dunes and are also more susceptible to downstream transport and predation.

The topological data was published in the USGS Data Series Report 409.

VII. Recommendations:

Evaluation of the available sediment data (within the study area) along the main stems of the Colorado, Gunnison, and Green Rivers resulted in the generation of suspended sediment transport equations at 6 sites: (1) Colorado River near Cameo, Colorado-09095500; (2) Colorado River near the Utah-Colorado Stateline-09163500; (3) Colorado River near Cisco, Utah-09180500; (4) Gunnison River near Grand Junction, Colorado-09152500; (5) Green River near Jensen, Utah-09261000; and (6) Green River at Green River, Utah-0931500. It is not well determined what processes are controlling sediment transport in the reaches between these sites. Determination of reach-specific sediment-transport processes may provide a means to extend our understanding of sediment-transport along entire reaches of these rivers. Where these processes are consistent within the river systems, estimates of suspended sediment could be made using streamflow data at sites where only minimal sediment data is available. This would extend the number of location within the Upper Colorado River that suspended-sediment estimates can be

made at to better understand the affect of sediment on endangered fishes habitat.

VIII. Project Status:

A summary of the preliminary retrospective analysis of historic data was completed and presented to the Sediment Sampling Workgroup in March, 2005. A revised handout from the meeting was sent out at the end of December, 2005.

The final year of data collection is complete and the sediment-monitoring stations and turbidity monitors have been removed. Final daily suspended-sediment records computations have been completed for Whitewater and Jensen, and the data have been uploaded into the USGS National Water Information System database (NWIS). Daily mean suspended-sediment load and daily mean suspended sediment concentration have been published in the USGS Data Series Report 409.

The Multi-Dimensional Surface-Water Modeling System (MD-SWMS) demonstration project was completed and presented at the 28th Annual Researchers Meeting in Grand Junction January 16-17, 2007; final publication will occur as a case study in the USGS Scientific Investigations Report (SIR) scheduled for completion in FY 2010.

Analysis of water-surface slope, cross-sectional depths, and bed-material size continued in early FY 2009 and has been used in calculations of entrainment potential in the FY 2010 USGS SIR along with all other interpretive analysis.

IX. FY 2009 Budget Discussion

A. Table 1. Funds provided

Funding Source	FY 2009 - Provided
Recovery Program - BOR	$24,737
State of Wyoming	$25,620
Argonne National Laboratory	$32,600
USGS Coop/DOI Cost-share	$19,043
Total	$102,000

B. Table 2. Funds expended

Funding Source	FY 2009 - Expended
Recovery Program - BOR	$24,737
State of Wyoming	$25,620
Argonne National Laboratory	$27,163
USGS Coop/DOI Cost-share	$19,043
Total	$96,563

C.

A portion of the Argonne National Laboratory funding from FY 2009 was carried over into FY 2010 to finish the USGS Scientific Investigations Report. All carry-over funding will be used in the completion of this task in early FY 10. Extension of the original deadline was done to accommodate additional analysis. The Draft Report deadline was extended to January 30, 2010.

D.

100 % of the Data collection for the Incipient Motion Analysis has been completed in FY 2008; 15 % of the analysis and incorporation of findings into the USGS SIR remains, and will be completed in FY 2010 with remaining funding.

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X. Status of Data Submissions

The USGS Data Series Report 409 was published. The USGS Scientific Investigations Report will be published in 2010.

XI. Signed _Cory Williams_ __11/12/2009__

Principal Investigator Date