Project Title
Suspended-sediment monitoring in the upper Green River

Bureau of Reclamation Agreement Number:
R17PG0047

Reclamation Agreement Term
Oct 1, 2021 – Sept 30, 2023

Note: Recovery Program FY22-23 scopes of work are drafted in May 2021. They often are revised before final Program approval and may subsequently be revised again in response to changing Program needs. Program participants also recognize the need and allow for some flexibility in scopes of work to accommodate new information (especially in nonnative fish management projects) and changing hydrological conditions.

Lead Agency:
U.S. Geological Survey

Principal Investigator:
David J. Topping
Research Hydrologist
USGS Grand Canyon Monitoring & Research Center
2255 North Gemini Drive Flagstaff, AZ 86001
(w) 928-556-7396
(c) 928-266-2392
Fax: 928-556-7100
dtopping@usgs.gov

Category:
X Ongoing project
__ Ongoing-revised project
__ Requested new project
__ Unsolicited proposal

Expected Funding Source:
X Annual funds
__ Capital funds
__ Other *[explain]*

Relationship to RIPRAP:
Green River I.D.2.b.(2): Monitor changes in the magnitude, timing and size distribution of sediment.

Study Background/Rationale and Hypotheses:

This Scope of Work describes work to be completed by the U.S. Geologic Survey (USGS), Southwest Biological Science Center, Grand Canyon Monitoring and Research Center (GCMRC) for the Upper Colorado River Endangered Fish Recovery Program (UCREFRP) to continue the collection of high-resolution suspended-sediment (SS) data using multi-frequency acoustics on the Green River near the USGS gaging stations near Jensen and at Ouray, UT. Work under this Interagency Acquisition Agreement (Agreement) will span fiscal years FY2022 through FY2023. Additional funding, tasks, and products will be developed in an annual work plan and will be detailed accordingly in future modifications to this Agreement.

Background and Introduction

Within the Green River basin, the highest reach-habitat scores for species and life stages are in the Split Mountain Canyon to Desolation Canyon reach. Habitats with high scores in this restricted-meander reach include connected backwaters, side channels, flooded tributary mouths, and flooded bottomlands (LaGory et al., 2003). All are low-velocity habitats that serve as critical nursery areas for Colorado pikeminnow and razorback suckers. The extremely dynamic nature of backwaters and side-channels demands a greater understanding of the geomorphic processes that form and maintain those instream habitats. Additional research is needed to verify the existing conceptual model of backwater formation and more fully understand underlying geomorphic processes. Studies are also needed to address the effects of both base-flow and high-flow variability (inter-annual, intra-annual, and within day), and the sediment-transport dynamics associated with those flows, on backwater and side-channel habitat availability and conditions (LaGory et al., 2003).

The Peak Flow Technical Supplement (LaGory et al., 2015) identified SS monitoring in the upper Green River with the highest priority category. Such monitoring has to be conducted over a long enough period to cover the broad range of streamflow and sediment-supply conditions that occur within the Green River, especially within the Split Mountain to Desolation Canyon reach (LaGory et al., 2015). To date, this project has conducted such continuous SS monitoring at multiple stations on the Green River, two of which have been funded by the UCREFRP within the Split Mountain to Desolation Canyon reach near Jensen and Ouray, UT. The reach between Jensen and Ouray, UT is home to 16 priority floodplain wetlands (Figure 1). The Jensen and Ouray streamflow gaging stations bracket this reach. The SS data from Jensen and Ouray provide the ability to construct continuous mass-balance sediment budgets in order to determine whether reach-scale sediment accumulation or evacuation occurs within this important reach of the Green River. Determination of whether segments/reaches of a river system are accumulating or evacuating fine sediment (sand, silt, and clay) depends on the ability to accurately measure the mass flux of sediment entering and exiting that reach. Continuous measurement of SS transport at high temporal resolution is the only way to accurately calculate the mass flux of SS (Topping and Wright, 2016). In addition, continuous SS monitoring provides the ability to investigate patterns in SS transport that occur during discrete flood events (e.g., spring snowmelt floods, high flows driven by convective thunderstorms) and whether those patterns are caused by conditions of sediment surplus or deficit (Dean et al., 2020).

The study uses continuous SS measurements to determine whether the Jensen-to-Ouray reach, is gaining or losing sediment, and whether such changes in sediment and thus changes in sediment-associated habitat are driven by changes in flow (determined by Flaming Gorge Dam and the Yampa River), changes in the sediment supply, or both. Accumulation of sediment within this reach is hypothesized to be associated with channel simplification and loss of backwater habitat for native and endemic fish. Conversely, evacuation of sediment from this reach is hypothesized to associated with an increase in channel complexity and an increase/improvement in backwater habitat for native and endemic fish. This study is evaluating this hypothesized link between changes in sediment mass balance and instream habitat in the Green River through resurvey of historical cross sections first surveyed in the 1980s and 1990s; preliminary results from this aspect of this study will be included in the 2021 Final Report for the first 5 years of this study.

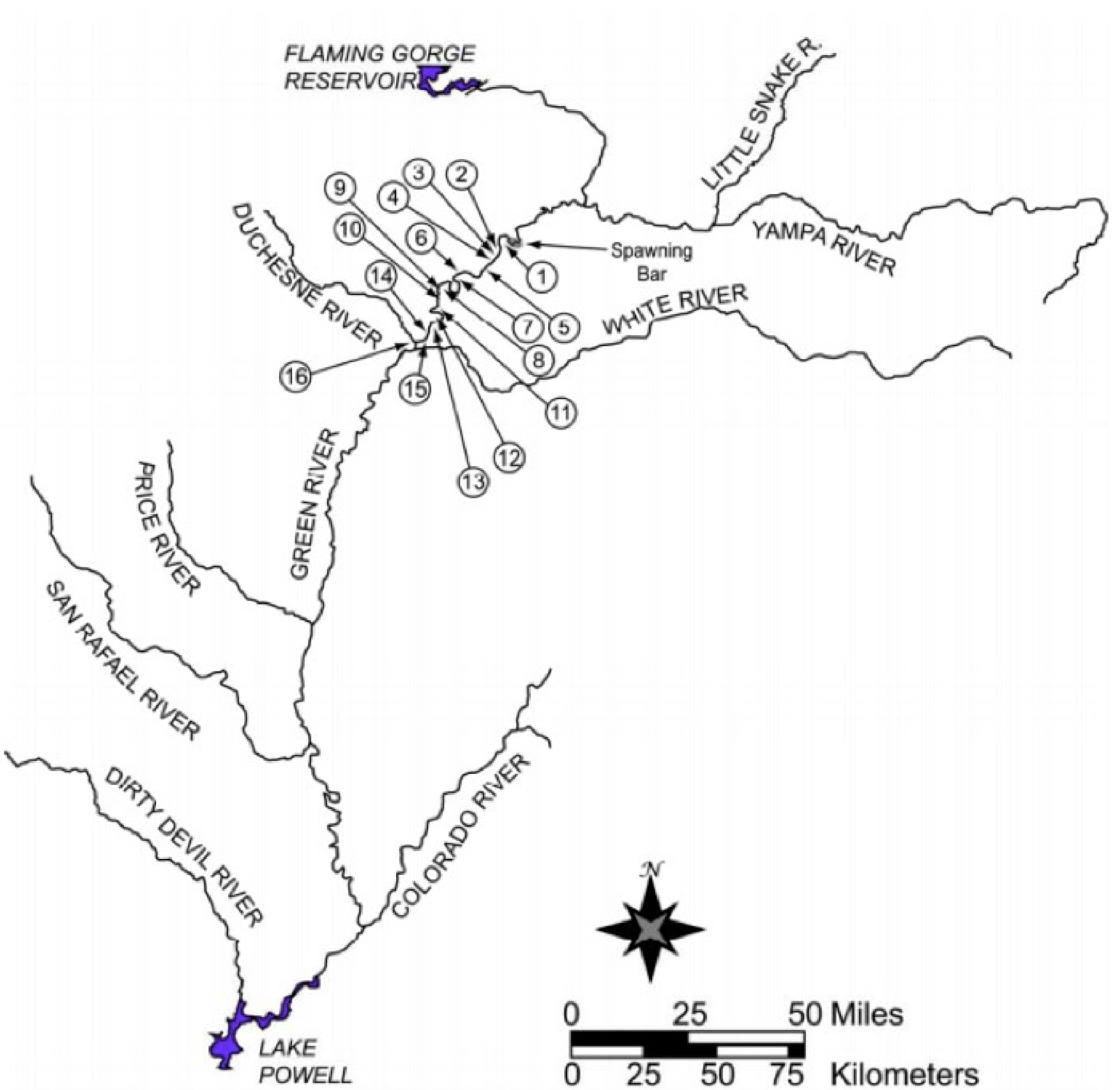

Figure 1. Green River study area showing locations of 16 priority flood plain wetlands (from Hayse et al. 2005, and Valdez and Nelson 2004). Location 1= Thunder Ranch, 2 = IMC, 3 = Stewart Lake, 4 = Sportsman's Lake, 5 = Bonanza Bridge, 6 = Richens, Slaugh, 7 = Horseshoe Bend, 8 = The Stirrup, 9 = Baser Bend, 10 = Above Brennan, 11 = Johnson Bottom, 12 = Leota ponds, 13 = Wyasket Lake, 14 = Sheppard Bottom, 15 = Old Charley Wash, 16 = Lamb Property. From Hayse et al. (2005) with permission.

Figure from: Bestgen, K. R., G. B. Haines, and A. A. Hill. 2011.

Recent data (at www.gcmrc.gov/discharge_qw_sediment) and publications indicate that paradigms about fine-sediment transport in the Green and Colorado river systems are largely based on 1950s-era measurements and need substantial revision. Moreover, because large changes in sediment transport in the Green River occur independently of water discharge as a function of changing sediment supply, ongoing continuous SS measurements are required to monitor/evaluate how dam operations and proposed upstream water development affect sediment/habitat in this river system (Topping et al., 2018; Dean et al., 2020). Topping et al. (2018) showed that natural changes in sand transport associated with changes in grain size arising from the downstream migration of sand waves have affected sand transport in the Green River downstream from the Yampa River confluence as much as have operations at Flaming Gorge Dam. In addition, they showed that sand transport in the Green River has decreased over time in response to the coarsening of the bed sediment associated with these sand waves, which were generated during rare large floods on a Little Snake River tributary during March 1956, 1962, and 1966 (the largest occurring in 1962). Farther downstream, Dean et al. (2020) showed that since closure of Flaming Gorge Dam, sand transport in the Green River has been characterized by two periods of increased sand transport associated with increased tributary sand supply interspersed with longer periods of progressive decline in sand transport. The large floods in the Little Snake River basin in the early 1960s and a regional tributary flooding event in July 1977 both caused short-term fining of the sand and elevated sand-transport rates in the lower Green River. Following each of these periods of elevated upstream sand supply, the sand in the lower Green River coarsened and sand transport declined independently of water discharge over decadal timescales. On an annual basis, Dean et al. (2020) showed that snowmelt floods with longer rising limbs may deplete the upstream sediment supply and maintain channel geometry/fish habitat in the lower Green River more effectively than shorter-duration snowmelt floods with higher peaks.

This natural variation in the upstream sediment supply has combined with upstream water development to cause large decreases in both silt-and-clay and sand transport over multi-decadal timescales. For example, during 2014–2019, the mean-annual load of sand, silt, and clay in the Green River measured passing Mineral Bottom was ~4.4 million metric tons (https://www.gcmrc.gov/discharge_qw_sediment/station/CL/09328920#). Pre-dam sediment transport data summarized by Andrews (1986), and other 1950s-era data collected by the USGS, indicate that pre-dam transport of sand, silt, and clay past Green River, UT, was ~15 million tons/year — an amount >3 times more than that measured at Mineral Bottom in 2014–2019. Because sediment-transport changes over time in response to changes in both streamflow and the upstream sediment supply (owing to natural and human-exacerbated processes), river management cannot be based only on streamflow and previously collected SS datasets (even those <1 decade old) but rather requires ongoing continuous measurements of SS transport.

<u>Value of Data Collected</u>

Currently, the UCREFRP is engaged in multiple related efforts to understand relations between endangered fish, flow, channel habitat, and the sediment transport processes that shape these systems. These efforts benefit from an in-depth understanding of the sediment-transport dynamics within the Green and Colorado rivers, and how those dynamics affect available critical habitat. Identification of fluvial geomorphic flow and sediment-supply thresholds above which physical processes (e.g., sediment transport, channel change, floodplain inundation) are significantly altered help identify flow thresholds associated with critical habitat features and the streamflows needed to maintain and improve riparian and aquatic ecosystems.

On the Green River the UCREFRP is interested in: (1) describing and quantifying the existing range of sediment conditions as a function of the magnitude and timing of inputs of sediment and water; and (2) understanding if/how sediment balance/imbalance propagate downstream. This requires developing a sediment mass balance as a function of historical and existing flows; and determining the annual flow volume and nature of streamflows required to transport the range of sediment delivered to these river reaches, which in turn requires a robust sediment monitoring campaign using continuous measurements at high temporal resolution, such that the sediment evacuation/accumulation can be measured independently without relying on inherently inaccurate sediment rating curves.

This Green River monitoring in this project provide an important tool to evaluate the Green River flow recommendations (e.g., Muth, et al. 2000) and complements similar monitoring efforts upstream and downstream of the Jensen-to-Ouray reach. On the Yampa and Green Rivers in Dinosaur National Monument, the National Park Service (NPS) and the GCMRC have worked collaboratively since 2012 to collect continuous SS data at four USGS gaging stations (Green River above Gates of Lodore, CO; Yampa River near Maybell, CO; Little Snake River near Lily, CO; and Yampa River at Deerlodge Park, CO). On the Green and Colorado Rivers near Canyonlands National Park, the NPS and GCMRC have worked collaboratively since 2014 to maintain collect continuous SS data at two USGS gaging stations (Green River at Mineral Bottom near Canyonlands National Park, UT; and Colorado River at Potash, UT). These sediment data are being used to develop relationships between Green River streamflow, sediment supply, and sediment transport during both natural floods and upstream dam releases to meet NPS management objectives in Dinosaur National Monument and Canyonlands National Park. Results from the first phases of these monitoring efforts have been published in the Journal of Geophysical Research: Earth Surface (Topping et al., 2018; Dean et al., 2020).

Results from this Project to Date

Our results to date indicate that net deposition or erosion of sand in the Jensen-to-Ouray reach during annual floods is controlled by systematic inter-annual changes in the upstream sand supply and not directly by the discharge of water. The upstream sand supply in this segment, in turn, is controlled by the interaction of Flaming Gorge Dam releases with Yampa River streamflow. This modulation of the upstream sand supply depends on the duration of higher discharges within the dam releases and not on the peak discharge of these releases.

The above-described physical behavior is best demonstrated by data collected during 2017 and 2019. Detectable net deposition of sand in the Jensen-to-Ouray reach occurred during only the 2019 annual flood, when the duration of higher discharges released from Flaming Gorge Dam was short and the duration of higher discharges in the Yampa River was long (Figure 2). Consequently, the upstream sand supply was enriched in 2019, as evidenced by the much higher suspended-sand concentrations at Jensen than at Ouray (Figure 3a). Conversely, the greatest net erosion of sand from this segment occurred during the 2017 annual flood, when the duration of higher discharges released from Flaming Gorge dam was long and the duration of higher discharges in the Yampa River was short (Figure 2). Consequently, the upstream sand supply was depleted in 2017, as evidenced by the comparatively low suspended-sand concentrations at Jensen over most of March–July (Figure 3b). The change in sand mass in the Jensen-to-Ouray reach was smaller during the annual floods in 2018 and 2020, which had intermediate durations of higher discharge from the dam and the Yampa River. Although a similar dependence of the silt-and-clay mass balance in this segment on the relative durations of higher discharge within the Flaming Gorge Dam releases and the annual flood of the Yampa River was observed, this relation is less certain than that for sand.

The mass balance of sediment in the Jensen-to-Ouray reach is therefore not controlled by the peak discharge of the annual flood in this segment nor by the peak discharge released from Flaming Gorge Dam. The peak discharge of the 2017 annual flood near Jensen, 18,300 ft^3/s, was actually slightly smaller than the 20,900 ft^3/s peak discharge of the 2019 flood. Similarly, the peak discharge of the 2017 dam release at Gates of Lodore, 8,720 ft^3/s, was also slightly smaller than the 8,910 ft^3/s peak discharge of the 2019 dam release. Net sediment erosion occurred during the smaller 2017 flood, whereas net sediment deposition occurred during the larger 2019 flood. Thus, depending on the degree to which changes in fish habitat are related to the mass balance of sediment in this reach, the amount and quality of fish habitat may be unrelated to peak flood discharge. Instead, changes in fish habitat may be controlled by the changes in the upstream sediment supply that are driven by the interaction of Flaming Gorge dam releases with Yampa River streamflow. Additional years of continuous SS data collection near Jensen and Ouray under differing streamflow/sediment-supply conditions are required to verify this likely causal relation between dam releases and sediment mass-balance/fish habitat in the Jensen-to-Ouray reach.

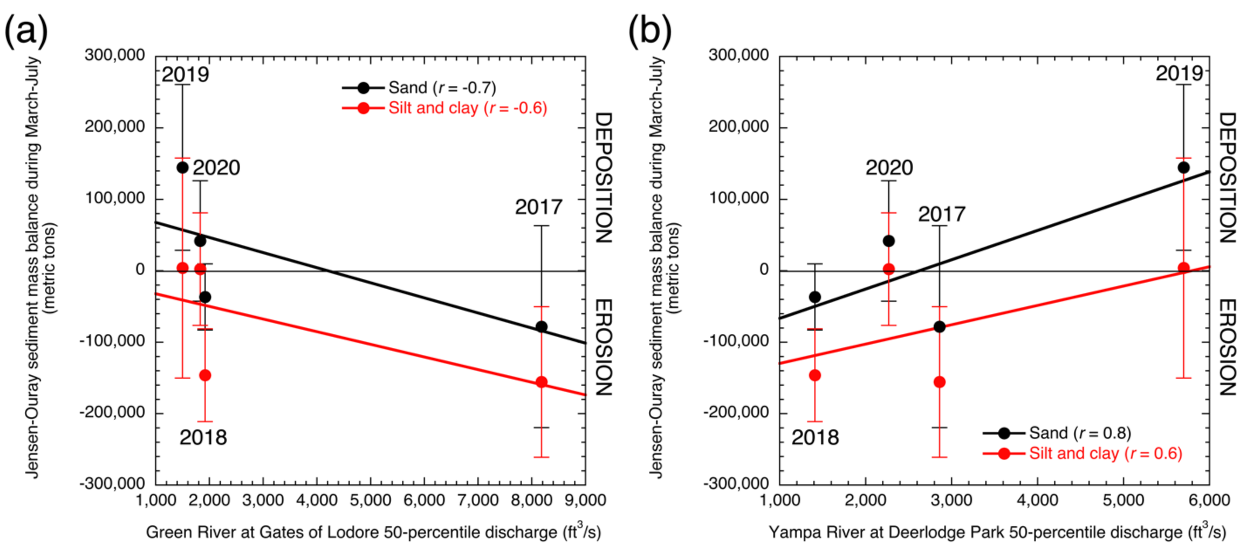

Figure 2. Mass balance of sand and of silt & clay in the Jensen-to-Ouray reach during March–July of each year plotted as a function of the March–July 50%-percentile discharge in **(a)** the Green River at the Gates of Lodore and **(b)** the Yampa River at Deerlodge Park. Least-squares linear regressions with correlation coefficients (*r*) shown. Positive values of the sediment mass balance indicate net deposition during the March–July period of the annual flood; negative values of the sediment mass balance indicate net erosion during the March-July period of

the annual flood. The median (50%) discharge during March–July is used as a proxy for the duration of higher discharges during the annual flood.

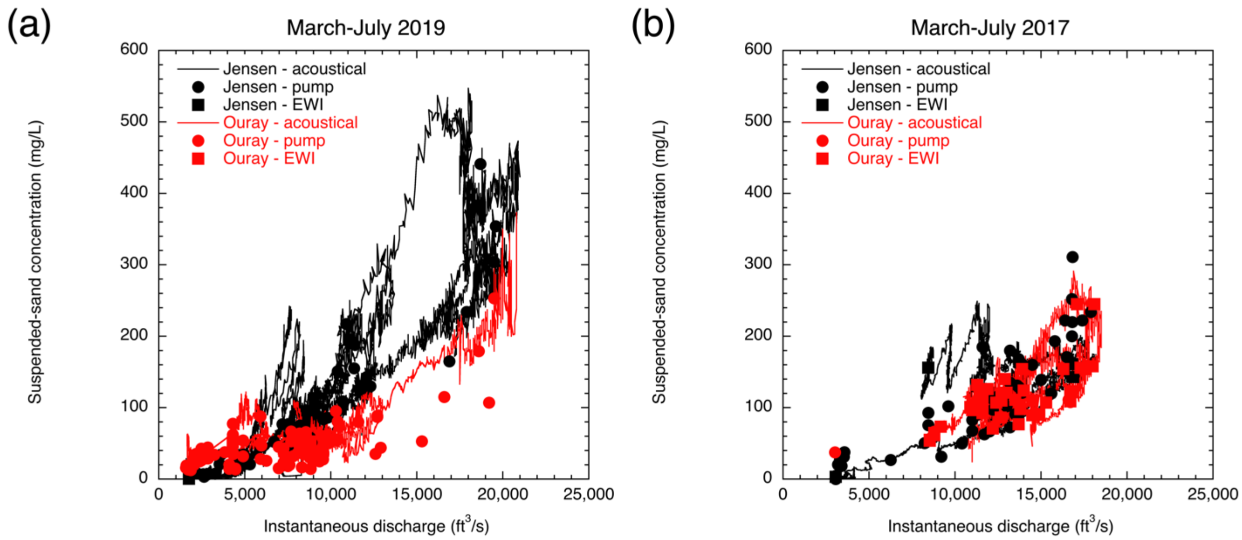

Figure 3. Suspended-sand concentration plotted as a function of the instantaneous discharge of water during **(a)** March–July 2017 and **(b)** March–July 2019 at Green River above Jensen, UT, and the Green River above Ouray, UT, stations. Different measurement types indicated.

Study Goals, Objectives, End Product(s):

Study Goals and Objectives

The purpose of this project is to continue the collection of SS data to help the UCREFRP better understand geomorphic processes that form and maintain habitats important to Colorado pikeminnow and razorback suckers in the Green River, including connected backwaters, side channels, and flooded bottomlands. To this end, this project collects high-resolution suspended-sediment data using multi-frequency acoustics, calibrated pump samples, and conventional equal-width-increment (EWI) measurements near the USGS gages on the Green River near Jensen and at Ouray, UT.

This project addresses the need to improve our understanding of how changes in sediment supply and transport associated with river regulation affects the critical habitat and life cycles of endangered fish. Riverine ecosystems are shaped by the flow regime and supplied sediment, and water development and river regulation can substantially alter both of these phenomena. Potential additional water development projects on the Yampa and White rivers (including potential new dams) highlight the need to understand how changes in flow and sediment transport will affect these ecosystems. In that context, the costs and benefits of changing flow regimes must be evaluated: (1) for the direct impact of flow on ecosystem function and (2) for the indirect impact that flow exerts on sediment transport that in turn determines the quantity and quality of aquatic and riparian habitats.

End Products

1. Digital 15-minute sediment transport databases (with metadata) for the two stations on the Green River are served at the http://www.gcmrc.gov/discharge_qw_sediment website and updated quarterly. In addition, user-interactive sediment budgets are served at this website for the reach of the Green River between the Jensen and Ouray stations;
2. Digital databases (with metadata) containing the laboratory analyses of all physical suspended-sediment samples collected to calibrate and verify the 2-frequency acoustical installations on the Green River;
3. Digital database (with metadata) containing the topographic resurveys of ~27 cross sections established in the Jensen to Ouray reach beginning in the 1980s is maintained; and
4. USGS Open-File Report to be submitted at the end of the period of performance in FY2023 describing the results from the work will be completed once data have been collected and analyzed

    This USGS Open-File Report will update the Open-File Report published at the end of the original FY2017-2021 period of performance and will include error analyses, calculations of the loads and grain-size distributions of SS, and analyses of the flow relations between the two stations and conditions most important for the transport of different quantities and grain-size distributions of the sediment forming the templates of the Green River. In addition, updated $\alpha-\beta$ analyses (Rubin and Topping, 2001, 2008; Dean et al., 2020) will be provided to determine whether the bed sand at each of the two stations is coarsening or fining. These analyses are complementary to the user-interactive sediment budgets described above. Fining of the bed sand is generally associated with channel infilling and loss of backwater habitat, whereas coarsening would be associated with possible enlargement of backwater habitat.

    This Open-File Report will contain the relevant information that can be used by UCREFRP to evaluate environmental flow recommendations for the Green River. In addition, data and analyses from this project will likely be published in one or more peer-reviewed journal articles in the open scientific literature.

In addition to the Open-File Report, annual written updates and presentations at the Researcher's Meeting will continue to be provided to the UCREFRP.

Study Area:
This study is conducted in river reaches at sediment monitoring stations located upstream from the USGS Green River near Jensen, UT, and Green River at Ouray, UT, gaging stations. These sediment monitoring stations are referred to as the Green River above Jensen, UT, and Green River above Ouray, UT, stations and are located on the map at: https://www.gcmrc.gov/discharge_qw_sediment/stations/DINO. The above Jensen station is located at the downstream end of the Split Mountain Campground in Dinosaur National Monument and the above Ouray station is located at the fish observation deck in the Ouray National Wildlife Refuge. The sediment data collected at these two sediment monitoring stations is used in conjunction with the streamflow data collected at the near Jensen and at Ouray gaging stations to the calculate continuous sediment fluxes and loads used in sediment budgeting.

The Green River near Jensen, UT, 09261000 streamflow gaging station is operated by the USGS as part of the National Streamflow Information Program in cooperation with the Central Utah Water Conservancy District and the U.S. Fish and Wildlife Service. It is in Uintah County, Utah, with a drainage area of 29,660 square miles and a contributing drainage area of 25,400 square miles just downstream of the confluence of the Green and Yampa Rivers. Both the Green and Yampa Rivers are subject to potentially substantial new water development to support extraction of nearby oil and gas resources and potential trans-basin export to satisfy municipal and industrial needs in eastern Colorado.

The Green River at Ouray, UT, 09272400 streamflow gaging station is operated by the USGS as part of the National Streamflow Information Program in cooperation with the U.S. Fish and Wildlife Service. It is in Uintah County, Utah, with a drainage area of 31,060 square miles and a contributing drainage area of 26,800 square miles. It is upstream from the confluences of the White and Duchesne Rivers.

Study Methods/Approach:
The work proposed herein is a continuation of work funded by the UCREFRP that has been conducted at the above Jensen and Ouray sediment monitoring stations since 2013 and 2017, respectively. This work utilizes a combination of 15-minute acoustical measurements and episodic conventional and calibrated-pump SS samples to provide continuous measurements of suspended-silt-and-clay concentration, suspended-sand concentration, and suspended-sand median grain size at these two stations (Topping and Wright, 2016). These concentration data are converted to loads, which are differenced between these stations to construct continuous mass-balance sediment budgets for silt and clay and for sand for the Jensen-to-Ouray reach of the Green River (Topping et al., 2018). The changes in silt-and-clay and sand mass are then interpreted to inform whether certain combinations of flow and the upstream sediment supply tend to result in infilling or evacuation of sediment from this reach. As stated above, net accumulation of sediment is hypothesized to be associated with channel simplification and instream habitat (e.g., backwater) loss/degradation, whereas net evacuation of sediment is hypothesized to be associated with increases in channel complexity and increases/improvements in instream habitat. To confirm the river environments (i.e., instream habitats) where the net changes in silt and clay mass and sand mass identified in the continuous mass-balance sediment budgets have occurred, ~27 cross sections established in the Jensen to Ouray reach in the 1980s and 1990s are episodically resurveyed; the first of these resurveys occurred in October 2020.

The acoustical SS-measurement technique used in this project is a “state-of-the-science” outgrowth of research conducted by scientists at the USGS-GCMRC in the Colorado River in Grand Canyon National Park and the Rio Grande in Big Bend National Park (Topping et al., 2004, 2006, 2007, 2016; Wright et al., 2010; Topping and Wright, 2016). In addition to being used at the above Jensen and Ouray sediment monitoring stations on the Green River, a five-station monitoring network using this approach on the Colorado River in Grand Canyon National Park informs management of Glen Canyon Dam (Griffiths et al., 2012; Grams et al., 2015; U.S. Department of the Interior, 2016a, b; Topping et al., 2021). This approach is also being used to inform river management on the Rio Grande in Big Bend National Park (Dean et al., 2016), the Green and Yampa rivers in Dinosaur National Monument (Topping et al., 2018), the Green and Colorado rivers in Canyonlands National Park (Dean et al., 2020), and the Chippewa River in Wisconsin (Dean et al., in prep.).

Prior to the development of the Topping and Wright (2016) acoustical technique, time-invariant relations between water discharge and sediment concentration (i.e., sediment rating curves) were typically used to estimate sediment loads. This simple and convenient approach, however, commonly result in errors in sediment transport that exceed 900% (Walling, 1977) and in errors in daily sediment loads as high as 4000% (Glysson et al., 2001) because the concentration of suspended sediment and the instantaneous discharge of water are not well correlated in most rivers. This poor correlation arises because of discharge-concentration hysteresis in one or more size classes of the suspended load during floods or periods of higher discharge. Because of this hysteresis, the only *a priori* accurate method to calculate sediment loads in rivers is to use SS measurements that are independent of water-discharge data. The acoustical technique of Topping and Wright (2016) satisfies this constraint and provides for the making of the accurate continuous SS measurements required to know whether sediment accumulation or evacuation has occurred over a long river reach, and how such changes in sediment mass balance directly relate to changes in flow and the upstream sediment supply. This information is required to predict the impact of future water development on sediment-related instream habitat with the accuracy required for making sound management decisions and recommendations.

All data collected by this project are served at the following website (Sibley et al., 2015): https://www.gcmrc.gov/discharge_qw_sediment/. At the above Jensen and Ouray sediment monitoring stations, these data include: (1) 15-minute acoustical SS measurements, (2) calculated 15-minute bedload estimates based on episodic measurements of dune migration, (3) episodic bed-sediment measurements, and (4) episodic SS measurements made using conventional depth-integrating samplers deployed across the full width of the river (i.e., EWI measurements) and calibrated automatic pump samplers. In addition, the continuous mass-balance sediment budgets for the Jensen-to-Ouray reach used to inform habitat management in this reach are served at this website (as are other sediment budgets for other reaches upstream on the Green and Yampa rivers). The details of how bedload is calculated on the basis of episodic bedform-migration measurements and EWI measurements is described in Topping et al. (2018).

Task Description, Deliverables and Schedule:
This project operates and maintains 15-minute two-frequency-acoustical sediment-transport monitoring stations located upstream from the USGS Green River near Jensen, UT, and Green River at Ouray, UT, streamflow gaging stations (as described above). These sediment monitoring stations are visited multiple times each year for maintenance. During these visits, EWI calibration and verification suspended-sediment measurements, bedform-migration measurements are made. It is anticipated that 4-6 sample collection visits will occur during the year depending on field staff availability and the range in streamflow and suspended-sediment concentrations. Access to the sites will be by vehicle/foot for maintenance visits and by foot or boat during sample collection visits. The first resurvey of the ~27 cross sections in the Jensen-to-Ouray reach occurred in October 2020; subsequent resurvey of these cross sections may occur in FY2024 if funding is available to compare the ongoing continuous sediment mass balance with changes in sediment/habitat in these cross sections.

- All acoustical, and physical, suspended-sediment data are uploaded to the GCMRC website at http://www.gcmrc.gov/discharge_qw_sediment/ quarterly as proof of the work completed.
- Annual written reports and annual presentations at the Researcher's Meeting will

continue to be provided to the UCREFRP.

- The topographic data from the cross-section resurveys will be maintained in the USGS Sciencebase website and also available through http://www.gcmrc.gov/discharge_qw_sediment/.
- The results of all work under this agreement will be available for publication by the USGS. Final product will be a scientific paper or papers and/or USGS series as described above.

Budget Summary:

FY Year	USGS-GCMRC	
2022	$34,767	
2023	$37,019	
2024		
2025		
2026		
Total		

Reviewers:

References:

Andrews, E. D., 1986, Downstream effects of flaming gorge reservoir on the Green River, Colorado and Utah: Geological Society of America Bulletin, v. 97, p. 1012-1023.

Bestgen, K. R., G. B. Haines, and A. A. Hill, 2011, Synthesis of flood plain wetland information: Timing of razorback sucker reproduction in the Green River, Utah, related to stream flow, water temperature, and flood plain wetland availability. Final Report to the Upper Colorado River Endangered Fish Recovery Program, Denver. Larval Fish Laboratory Contribution 163.

Dean, D. J., Topping, D. J., Schmidt, J. C., Griffiths, R. E., and Sabol, T. A., 2016, Sediment supply versus local hydraulic controls on sediment transport and storage in a river with large sediment loads: Journal of Geophysical Research: Earth Surface, v. 121, p. 82–110. https://doi.org/10.1002/2015JF003436

Dean, D. J., Topping, D. J., Grams, P. E., Walker, A.E., Schmidt, J. C., 2020, Does channel narrowing by floodplain growth necessarily indicate sediment surplus? Lessons from sediment transport analyses in the Green and Colorado Rivers, Canyonlands, Utah: Journal of Geophysical Research: Earth Surface, v. 125, e2019JF005414. https://doi.org/10.1029/2019JF005414

Glysson, G. D., Gray, J. R., and Schwarz, G. E., 2001, Comparison of load estimates using total suspended solids and suspended sediment data, in Phelps, D. and Sehlke, G., eds., Bridging the gap: Meeting the world's water and environmental resources challenges: American Society of

Civil Engineers World Water and Environmental Resources Congress, Orlando, Florida, May 20-24, 2001, Proceedings, doi: 10.1061/40569(2001)123

Grams, P. E., Schmidt, J. C., Wright, S. A., Topping, D. J., Melis, T. S., and Rubin, D. M., 2015, Building sandbars in the Grand Canyon: EOS, Transactions of the American Geophysical Union, v. 96, (11 pp.). https://eos.org/wp-content/uploads/2015/06/2015EO11.pdf?adaf16

Griffiths, R. E., Topping, D. J., Andrews, T., Bennett, G. E., Sabol, T. A., and Melis, T. S., 2012, Design and maintenance of a network for collecting high-resolution suspended-sediment data at remote locations on rivers, with examples from the Colorado River: U.S. Geological Survey Techniques and Methods 8-C2 (44 pp.). https://doi.org/10.3133/tm8c2

LaGory, K. E., Hayse, J. W., and Tomasko, D., 2003, Recommended Priorities for Geomorphology Research in Endangered Fish Habitats of the Upper Colorado River Basin: Environmental Assessment Division, Argonne National Laboratory. https://coloradoriverrecovery.org/documents-publications/technical-reports/isf/GeomorphologyFinal.pdf

LaGory, K. E., Chart, T., and Mohrman, J., 2015, A Strategy to Evaluate Peak Flow Recommendations for Sediment Transport and Habitat Maintenance in the Upper Colorado River Basin: A Technical Supplement to the Green River and Aspinall Study Plans, Coordinated by Upper Colorado River Endangered Fish Recovery Program. https://coloradoriverrecovery.org/documents-publications/technical-reports/isf/Lagory%20et%20al%202015%20-%20Tech%20Supple%20-%20Feb%202016.pdf

Muth, R. T., Crist, L.W., LaGory K. E., Hayse, J. W., Bestgen, K. R., Ryan, T. P., Lyons, J. K., and Valdez, R. A., 2000, Flow and Temperature Recommendations for Endangered Fishes in the Green River Downstream of Flaming Forge Dam. Project FG-53, Upper Colorado River Endangered Fish Recovery Program. https://www.coloradoriverrecovery.org/documents-publications/technical-reports/isf/flaminggorgeflowrecs.pdf

Sibley, D., Topping, D. J., Hines, M., and Garner B., 2015, User-interactive sediment budgets in a browser: A web application for river science and management: Proceedings of the 3rd Joint Federal Interagency Conference on Sedimentation and Hydrologic Modeling, April 19-23, 2015, Peppermill Hotel, Reno, Nevada (pp. 595–605). https://acwi.gov/sos/pubs/3rdJFIC/Contents/4A-Sibley.pdf

Topping, D. J., Melis, T. S., Rubin, D. M., and Wright, S. A., 2004, High-resolution monitoring of suspended-sediment concentration and grain size in the Colorado River in Grand Canyon using a laser-acoustic system, in Hu, C.,and Tan, Y, eds., Proceedings of the Ninth International Symposium on River Sedimentation, October 18-21, 2004, Yichang, China: People's Republic of China, Tsinghua University Press, p. 2507-2514.

Topping, D. J., Wright, S. A., Melis, T. S., and Rubin, D. M., 2006, High-resolution monitoring of suspended-sediment concentration and grain size in the Colorado River using laser-diffraction instruments and a three-frequency acoustic system: CD-ROM Proceedings of the 8th Federal Inter-Agency Sedimentation Conference, Reno, Nevada, April 2-6, 2006, ISBN 0-9779007-1-1.

Topping, D. J., Wright, S. A., Melis, T. S., and Rubin, D. M., 2007, High-resolution measurements of suspended sediment concentration and grain size in the Colorado River in Grand Canyon using a multi-frequency acoustic system: Proceedings of the Tenth International Symposium on River Sedimentation, August 1-4, 2007, Moscow, Russia, v. 3, p. 330-339. ISBN 978-5-89575-124-4, 978-5-89575-127-5.

Topping, D. J., and Wright, S. A., 2016, Long-term continuous acoustical suspended-sediment measurements in rivers - Theory, application, bias, and error, U.S. Geological Survey Professional Paper 1823, 98 p. http://dx.doi.org/10.3133/pp1823

Topping, D. J., Wright, S. A., Griffiths, R. E., and Dean, D. J., 2016, Long-term continuous acoustical suspended-sediment measurements in rivers – Theory, evaluation, and results from 14 stations on five rivers, in Constantinescu, G., Garcia, M., and Hanes, D., eds., River Flow 2016, CD-ROM Proceedings of the International Conference on Fluvial Hydraulics, St. Louis, Missouri, USA, July 11-14, 2016, ISBN 978-1-138-2913-2 for set of Book and CD-ROM, ISBN 978-1-315-64447-9 for eBook PDF, p. 1510-1518 on CD-ROM.

Topping, D. J., Mueller, E. R., Schmidt, J. C., Griffiths, R. E., Dean, D. J., and Grams, P. E., 2018, Long-term evolution of sand transport through a river network: Relative influences of a dam versus natural changes in grain size from sand waves, Journal of Geophysical Research: Earth Surface, 123, 1879–1909. https://doi.org/10.1029/2017JF004534.

Topping, D. J., Grams, P. E., Griffiths, R. E., Dean, D. J., Wright, S. A., and Unema, J. A., 2021, Self-limitation of sand storage in a bedrock-canyon river arising from the interaction of flow and grain size: Journal of Geophysical Research: Earth Surface, v. 126, e2020JF005565. https://doi.org/10.1029/2020JF005565

U.S. Department of the Interior, 2016a, Glen Canyon Dam Long-term Experimental and Management Plan Environmental Impact Statement: Salt Lake City, Utah, Bureau of Reclamation, Upper Colorado Region, Lakewood, Colorado, National Park Service, Intermountain Region. http://ltempeis.anl.gov

U.S. Department of the Interior, 2016b, Record of Decision for the Glen Canyon Dam Long-term Experimental and Management Plan Environmental Impact Statement: Washington, D.C., Office of the Secretary of the Interior, Salt Lake City, Utah, Bureau of Reclamation, Upper Colorado Region, Lakewood, Colorado, National Park Service, Intermountain Region (15 pp. plus appendices). http://ltempeis.anl.gov/documents/docs/LTEMP_ROD.pdf

Walling, D.E., 1977, Assessing the accuracy of suspended sediment rating curves for a small basin: Water Resources Research, v. 13, n. 3, p. 531-538, doi:10.1029/WR013i003p00531.

Wright, S. A., Topping, D. J., and Williams, C. A., 2010, Discriminating silt-and-clay from suspended-sand in rivers using side-looking acoustic profilers: Proceedings of the 2nd Joint Federal Interagency Conference, Las Vegas, Nevada, June 27-July 1, 2010.

Name of Servicing Agency:	U.S. Geological Survey										
Project Name:	85f										

		YEAR 1		**YEAR 2**		**YEAR 3**		**YEAR 4**		**YEAR 5**	**TOTAL**
Enter the BEGINNING dates for each year ------>		**10/1/2021**		**10/1/2022**		**10/2/2023**		**10/1/2024**		**10/1/2025**	
		Through		Through		Through		Through		Through	
Enter the ENDING dates for each year ------->		**9/30/2022**		**10/1/2023**		**9/30/2024**		**9/30/2025**		**9/30/2026**	
DIRECT LABOR AND FRINGE BENEFIT COSTS:		**YEAR 1**		**YEAR 2**		**YEAR 3**		**YEAR 4**		**YEAR 5**	**TOTAL**
Direct Labor - Hourly		$ 16,971.00		$ 17,310.42		$ -		$ -		$ -	$ 34,281.42
Fringe Benefits - Hourly		$ 6,534.76		$ 6,665.46		$ -		$ -		$ -	$ 13,200.22
Subtotal of Direct Labor & Fringe Benefits:		**$ 23,505.76**		**$ 23,975.88**		**$ -**		**$ -**		**$ -**	**$ 47,481.64**
OTHER DIRECT COSTS:		**YEAR 1**		**YEAR 2**		**YEAR 3**		**YEAR 4**		**YEAR 5**	**TOTAL**
Materials and Supplies		$ -		$ -		$ -		$ -		$ -	$ -
Travel Costs		$ 3,445.50		$ 3,445.50		$ -		$ -		$ -	$ 6,891.00
Equipment		$ -		$ -		$ -		$ -		$ -	$ -
Contractors											$ -
Subtotal of Other Direct Costs:		**$ 3,445.50**		**$ 3,445.50**		**$ -**		**$ -**		**$ -**	**$ 6,891.00**
INDIRECT/OVERHEAD COSTS:		**YEAR 1**		**YEAR 2**		**YEAR 3**		**YEAR 4**		**YEAR 5**	**TOTAL**
Subtotal of Labor and Other Direct Costs:		**$ 26,951.26**		**$ 27,421.38**		**$ -**		**$ -**		**$ -**	
Total dollars exempt from indirect/overhead base:											
<Enter Description of Indirect/OH Cost #1>	29.00%	$ 7,815.87	35.00%	$ 9,597.48	35.00%	$ -	35.00%	$ -	35.00%	$ -	$ 17,413.35
Total dollars exempt from indirect/overhead base:		$ -		$ -		$ -		$ -		$ -	
<Enter Description of Indirect/OH Cost #2>		$ -	0.00%	$ -	0.00%	$ -	0.00%	$ -	0.00%	$ -	$ -
Subtotal of Indirect/Overhead Costs:		**$ 7,815.87**		**$ 9,597.48**		**$ -**		**$ -**		**$ -**	**$ 17,413.35**
		YEAR 1		**YEAR 2**		**YEAR 3**		**YEAR 4**		**YEAR 5**	**TOTAL**
GRAND TOTAL:		**$ 34,767.13**		**$ 37,018.86**		**$ -**		**$ -**		**$ -**	**$ 71,785.99**

SUMMARY OF DIRECT LABOR & FRINGE BENEFITS

Enter Escalation Rates ------->	Yr 2 Escalation Rate	2.00%

								YEAR 1					YEAR 2				
								10/1/2021		Through	9/30/2022		10/1/2022		Through	9/30/2023	
	Task # or Description	Federal Employee Name	Position Title	GS/WG Grade	GS/WG Step	OPM Pay Location	Current Hourly Rate	# of Hours	Hourly Rate	Salary Cost	Fringe Rate	Fringe Cost	# of Hours	Hourly Rate	Salary Cost	Fringe Rate	Fringe Cost
5	Field and interpretive work	David Topping	Research Hydrologist	15	3	Rest of US	$ 65.46	80.0	$ 65.46	$ 5,236.80	42.50%	$ 2,225.64	80.0	$ 66.77	$ 5,341.54	42.50%	$ 2,270.15
6	Field and interpretive work	Ron Griffiths	Hydrologist	12	8	Rest of US	$ 45.79	180.0	$ 45.79	$ 8,242.20	38.30%	$ 3,156.76	180.0	$ 46.71	$ 8,407.04	38.30%	$ 3,219.90
7	Lab work	Casey Longstret	Hydrologic Technician	5	1	Rest of US	$ 17.46	200.0	$ 17.46	$ 3,492.00	33.00%	$ 1,152.36	200.0	$ 17.81	$ 3,561.84	33.00%	$ 1,175.41
8							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
9							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
10							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
11							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
12							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
13							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
14							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
15							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
16							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
17							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
18							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
19							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
20							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
21							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
22							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
23							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
24							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
25							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
26							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
27							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
28							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
29							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
30							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
31							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
								460.00		$ 16,971.00		$ 6,534.76	460.00		$ 17,310.42		$ 6,665.46

SUMMARY OF DIRECT LABOR & FRINGE BENEFITS

Yr 3 Escalation Rate	2.00%	Yr 4 Escalation Rate	2.00%

								YEAR 3					YEAR 4				
										Through					Through		
	Task # or Description	Federal Employee Name	Position Title	GS/WG Grade	GS/WG Step	OPM Pay Location	Current Hourly Rate	# of Hours	Hourly Rate	Salary Cost	Fringe Rate	Fringe Cost	# of Hours	Hourly Rate	Salary Cost	Fringe Rate	Fringe Cost
5	Field and interpretive work	David Topping	Research Hydrologist	15	3	Rest of US	$ 65.46	-	$ 68.10	$ -	0.00%	$ -	-	$ 69.47	$ -	0.00%	$ -
6	Field and interpretive work	Ron Griffiths	Hydrologist	12	8	Rest of US	$ 45.79	-	$ 47.64	$ -	0.00%	$ -	-	$ 48.59	$ -	0.00%	$ -
7	Lab work	Casey Longstret	Hydrologic Technician	5	1	Rest of US	$ 17.46	-	$ 18.17	$ -	0.00%	$ -	-	$ 18.53	$ -	0.00%	$ -
8							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
9							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
10							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
11							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
12							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
13							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
14							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
15							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
16							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
17							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
18							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
19							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
20							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
21							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
22							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
23							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
24							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
25							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
26							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
27							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
28							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
29							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
30							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
31							$ -	-	$ -	$ -	0.00%	$ -	-	$ -	$ -	0.00%	$ -
								-		$ -		$ -	-		$ -		$ -

SUMMARY OF DIRECT LABOR & FRINGE BENEFITS

Yr 5 Escalation Rate	2.00%

	Task # or Description	Federal Employee Name	Position Title	GS/WG Grade	GS/WG Step	OPM Pay Location	Current Hourly Rate	YEAR 5 Through # of Hours	Hourly Rate	Salary Cost	Fringe Rate	Fringe Cost	Total Salary Cost	Total Fringe Cost	Total Labor Cost
5	Field and interpretive work	David Topping	Research Hydrologist	15	3	Rest of US	$ 65.46	-	$ 70.86	$ -	0.00%	$ -	$ 10,578.34	$ 4,495.79	**$ 15,074.13**
6	Field and interpretive work	Ron Griffiths	Hydrologist	12	8	Rest of US	$ 45.79	-	$ 49.56	$ -	0.00%	$ -	$ 16,649.24	$ 6,376.66	**$ 23,025.90**
7	Lab work	Casey Longstret	Hydrologic Technician	5	1	Rest of US	$ 17.46	-	$ 18.90	$ -	0.00%	$ -	$ 7,053.84	$ 2,327.77	**$ 9,381.61**
8							$ -	-	$ -	$ -	0.00%	$ -	$ -	$ -	**$ -**
9							$ -	-	$ -	$ -	0.00%	$ -	$ -	$ -	**$ -**
10							$ -	-	$ -	$ -	0.00%	$ -	$ -	$ -	**$ -**
11							$ -	-	$ -	$ -	0.00%	$ -	$ -	$ -	**$ -**
12							$ -	-	$ -	$ -	0.00%	$ -	$ -	$ -	**$ -**
13							$ -	-	$ -	$ -	0.00%	$ -	$ -	$ -	**$ -**
14							$ -	-	$ -	$ -	0.00%	$ -	$ -	$ -	**$ -**
15							$ -	-	$ -	$ -	0.00%	$ -	$ -	$ -	**$ -**
16							$ -	-	$ -	$ -	0.00%	$ -	$ -	$ -	**$ -**
17							$ -	-	$ -	$ -	0.00%	$ -	$ -	$ -	**$ -**
18							$ -	-	$ -	$ -	0.00%	$ -	$ -	$ -	**$ -**
19							$ -	-	$ -	$ -	0.00%	$ -	$ -	$ -	**$ -**
20							$ -	-	$ -	$ -	0.00%	$ -	$ -	$ -	**$ -**
21							$ -	-	$ -	$ -	0.00%	$ -	$ -	$ -	**$ -**
22							$ -	-	$ -	$ -	0.00%	$ -	$ -	$ -	**$ -**
23							$ -	-	$ -	$ -	0.00%	$ -	$ -	$ -	**$ -**
24							$ -	-	$ -	$ -	0.00%	$ -	$ -	$ -	**$ -**
25							$ -	-	$ -	$ -	0.00%	$ -	$ -	$ -	**$ -**
26							$ -	-	$ -	$ -	0.00%	$ -	$ -	$ -	**$ -**
27							$ -	-	$ -	$ -	0.00%	$ -	$ -	$ -	**$ -**
28							$ -	-	$ -	$ -	0.00%	$ -	$ -	$ -	**$ -**
29							$ -	-	$ -	$ -	0.00%	$ -	$ -	$ -	**$ -**
30							$ -	-	$ -	$ -	0.00%	$ -	$ -	$ -	**$ -**
31							$ -	-	$ -	$ -	0.00%	$ -	$ -	$ -	**$ -**
								-		**$ -**		**$ -**	**$ 34,281.42**	**$ 13,200.22**	**$ 47,481.64**

SUMMARY OF TRAVEL COSTS

Cost Element	Year 1	Year 2	Year 3	Year 4	Year 5	TOTAL
Trip #	1	1	1	1	1	
From-To	Flagstaff to Ouray	Albuquerque to Navajo Dam				
Reason	Field work	Field Work				
# of Days (include travel days)	5	5				
Airfare						
Lodging (Per Night)	$ 26.00	$ 26.00				
MI&E Per Day	$ 55.00	$ 55.00				
Auto Rental Per Day						
Total Per Trip	$ 377.50	$ 377.50	$ -	$ -	$ -	
No. of persons	2	2				
SUBTOTAL =	$ 755.00	$ 755.00	$ -	$ -	$ -	$ 1,510.00

Cost Element	Year 1	Year 2	Year 3	Year 4	Year 5	TOTAL
Trip #	2	2	2	2	2	
From-To	Flagstaff to Ouray					
Reason	Field work					
# of Days (include travel days)	5	5				
Airfare						
Lodging (Per Night)	$ 26.00	$ 26.00				
MI&E Per Day	$ 55.00	$ 55.00				
Auto Rental Per Day						
Total Per Trip	$ 377.50	$ 377.50	$ -	$ -	$ -	
No. of persons	2	2				
SUBTOTAL =	$ 755.00	$ 755.00	$ -	$ -	$ -	$ 1,510.00

Cost Element	Year 1	Year 2	Year 3	Year 4	Year 5	TOTAL
Trip #	3	3	3	3	3	
From-To	Flagstaff to Ouray	Flagstaff to Ouray				
Reason	Field work	Field work				
# of Days (include travel days)	5	5				
Airfare						
Lodging (Per Night)	$ 26.00	$ 26.00				
MI&E Per Day	$ 55.00	$ 55.00				
Auto Rental Per Day						
Total Per Trip	$ 377.50	$ 377.50	$ -	$ -	$ -	
No. of persons	2	2				
SUBTOTAL =	$ 755.00	$ 755.00	$ -	$ -	$ -	$ 1,510.00

SUMMARY OF TRAVEL COSTS

Cost Element	Year 1	Year 2	Year 3	Year 4	Year 5	TOTAL
Trip #	4	4	4	4	4	
From-To	Flagstaff to Ouray	Flagstaff to Ouray				
Reason	Field work	Field work				
# of Days (include travel days)	5	5				
Airfare						
Lodging (Per Night)	$ 26.00	$ 26.00				
MI&E Per Day	$ 55.00	$ 55.00				
Auto Rental Per Day						
Total Per Trip	$ 377.50	$ 377.50	$ -	$ -	$ -	
No. of persons	2	2				
SUBTOTAL =	$ 755.00	$ 755.00	$ -	$ -	$ -	$ 1,510.00

Cost Element	Year 1	Year 2	Year 3	Year 4	Year 5	TOTAL
Trip #	5	5	4	4	4	
From-To	Flagstaff to Researcher's meeting	lagstaff to Researcher's meeting				
Reason	Talk at researcher's meeting	Talk at researcher's meeting				
# of Days (include travel days)	3	3				
Airfare						
Lodging (Per Night)	$ 96.00	$ 96.00				
MI&E Per Day	$ 55.00	$ 55.00				
Auto Rental Per Day						
Total Per Trip	$ 425.50	$ 425.50	$ -	$ -	$ -	
No. of persons	1	1				
SUBTOTAL =	$ 425.50	$ 425.50	$ -	$ -	$ -	$ 851.00

	Year 1	Year 2	Year 3	Year 4	Year 5	TOTAL
TOTAL COST BY PERIOD =	$ 3,445.50	$ 3,445.50	$ -	$ -	$ -	$ 6,891.00

SUMMARY OF CONTRACTOR COSTS

	Contractor:	Contractor Website:	Purpose:	Competitive Award?	Year 1	Year 2	Year 3	Year 4	Year 5	TOTAL
1	DNA Analytics	www.dnaanalytics.com	Perform Fish DNA analysis for project	Yes	$ 5,000.00	$ 5,100.00	$ 5,200.00	$ 5,300.00	$ 5,400.00	**$ 26,000.00**
2					$ -	$ -	$ -	$ -	$ -	**$ -**
3					$ -	$ -	$ -	$ -	$ -	**$ -**
4					$ -	$ -	$ -	$ -	$ -	**$ -**
5					$ -	$ -	$ -	$ -	$ -	**$ -**
				TOTAL =	**$ 5,000.00**	**$ 5,100.00**	**$ 5,200.00**	**$ 5,300.00**	**$ 5,400.00**	**$ 26,000.00**