PAP-767

Muddy Creek Demonstration Stream Restoration Research Project

Spring 1997

by

Dr. Rodney J. Wittler

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CRDA-96-1

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INTRODUCTION

This report summarizes progress on the part of the Reclamation Water Resources Research Laboratory (WRRL) during the period April 1, 1997 - June 30, 1997. The Principal Investigator is Dr. Rodney J. Wittler. This report includes details on the consolidation of all field data, progress on the three-dimensional CAD drawing/database for the project, and a list of publications or reports issued by Reclamation.

Background

This progress report concerns the efforts of a partnership of Federal and local government agencies and a local citizen task force to solve the water quality problems associated with the incision of Muddy Creek near Great Falls, Montana. The United States Bureau of Reclamation (Reclamation) and Greenfield Irrigation District (GID) are collaborating to reduce return flow to Muddy Creek. Reclamation, Cascade County Conservation District (CCCD), and the Muddy Creek Task Force (MCTF), are collaborating to stabilize the gradient and plan form of the stream. Funding for the original agreement came from a grant by the State of Montana to the Cascade County Conservation District. Mr. Alan Rollo is the Muddy Creek Task Force Coordinator. Funding for the amendment comes partially from a State of Montana grant ($10,000) and a grant by the National Fish and Wildlife Foundation ($41,000) to the Cascade County Conservation District. Funding is part of the Cooperative Research & Development Agreement (CRDA) 96-1 and its amendments between Reclamation and the CCCD.

There are eleven grade control structures named 1-A through 1-F, 2-A through 2-C, 2-E & 2-F. Figure 1 shows selected structure sites along Muddy Creek. The selection includes a sill constructed by the US Army Corps of Engineers. The sill, constructed in February, 1994, was designed for zero drop. Incision in Muddy Creek below the sill has led to a substantial drop across the sill at the present time. The total drop measured across the grade control structures, including the Corps sill, at a flow between 45 ft^3/s and 63 ft^3/s is 15.16 feet as of October, 1996. The total design drop for the 11 structures was 17 feet. Not including the Corps sill, the total drop is 15.16-1.19 or 13.97 feet. Therefore, we have achieved 13.97/17 or 82% of the design head, at the flow rate of roughly 45 ft^3/s. Including the Corps sill increases the measured drop to 87% of the design drop.

There are 160 barbs installed on Muddy Creek between Gordon and Vaughn, roughly 8 river miles. Figure 1 shows selected structure sites along Muddy Creek. Task force plans include installation of an equal number of barbs in this reach during the Fall of 1997. There are 33 barbs installed above Gordon, primarily in conjunction with the cutoff revetments in this reach. The Task Force plans include installation of 100-200 barbs in this reach. There are seven revetments and four cutoff revetments installed on Muddy Creek. Figure 1 shows these sites.

The Reclamation WRRL designed a low-cost culvert crossing for Muddy Creek in October 1996 and supervised construction in December 1996. The crossing design demonstrates dual functionality as a grade control structure and crossing. The crossing is in the vicinity of buildings owned by the Wohlgemuth family. Figure 1 shows the site.

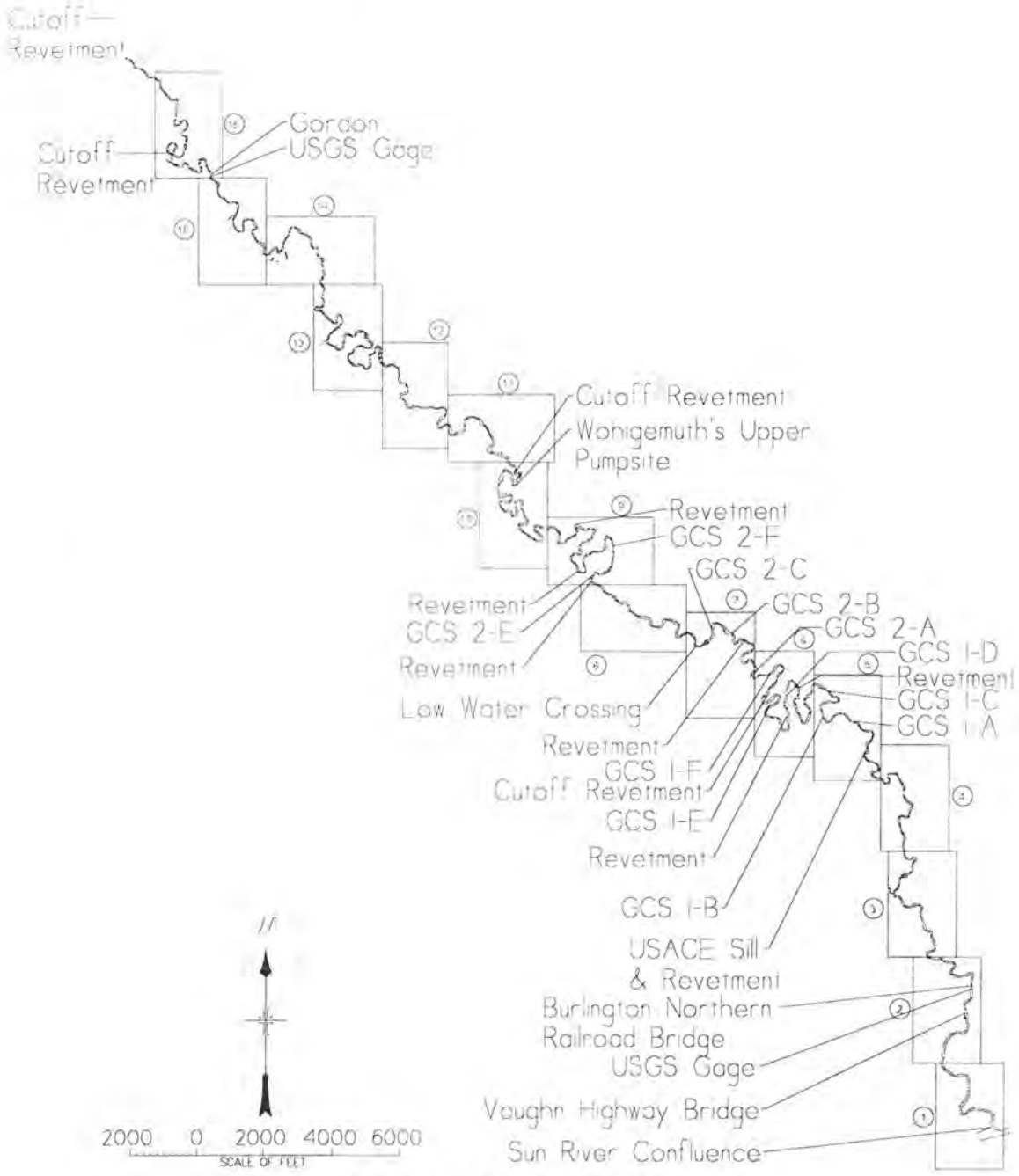

Figure 1. Selected sites along Muddy Creek.

CONSTRUCTION UPDATE

The Task Force depends upon Greenfield Irrigation District in-kind construction services for the project tasks. In January, 1997, the District Manager resigned. Since that time a new manager has been hired. Also, Pishkun dam, a district facility, has developed a severe dam safety problem. Last year, 1996, Willow Creek dam, another district facility, also developed a dam safety problem. The district construction capability has been absorbed by these emergency dam safety problems. Regular district maintenance has fallen behind schedule.

These circumstances have forced the Task Force to delay construction activities on Muddy Creek until Fall, 1997. At that time barb construction will resume and maintenance and repair of existing structures will get underway. All rock materials for the additional structural construction has been delivered. Several sites have been identified in advance. The Task Force anticipates that Greenfield will be able to assist with construction beginning sometime around September, 1997.

TASK A2 - PUBLICATIONS & REPORTS

In May the Task Force and Reclamation presented five papers at the conference "Management of Landscapes Disturbed by Channel Incision, *Stabilization, Rehabilitation, Restoration,* " May 20-22, 1997, Oxford, Mississippi. Reclamation and the Muddy Creek Task Force hosted a session at the conference titled "Western Incised Channel Restoration: Engineering, Biology, and Cultural Resources." The titles, authors, and abstracts from the papers are listed below. Attendance at this conference was funded by Reclamation, not this project.

Case Study: Muddy Creek, Montana

R.J. Wittler, S.D. Keeney, A.W. Rollo, C.C. Watson

ABSTRACT

The Muddy Creek Task Force under the auspices of the Cascade County Conservation District began a Stream Restoration Project on Muddy Creek in 1993. The Task Force is using the latest stream restoration and watershed planning technology to enhance water quality, fisheries, and wildlife habitat in the Muddy Creek watershed. Reclamation, the Natural Resources Conservation Service, Greenfield Irrigation District, and the Muddy Creek Task Force, are collaborating on the project. This report summarizes progress to date while illustrating the successful implementation of some advanced restoration technology.

Cultural Resources Considerations for Stream Restoration Projects

R.J. Wittler, M. Andrews, E.I. Friedman

ABSTRACT

Cultural resources are remnants of previous cultures. Traditional methods of archaeology are useful for discovering and investigating cultural resources. Stream restoration projects on public lands or by state or federal officials must by law consider the consequences of disturbing cultural resources during restoration activities. This paper discusses the management of cultural resources applied to stream restoration projects. Two case studies illustrate cultural resources considerations for restoration projects.

Field Data Plan for Muddy Creek

R.J. Wittler, D.R. Eby, D.L. Burgett, A.W. Rollo

ABSTRACT

This paper describes the evolution of the field data plan for the Muddy Creek Stream Restoration project. The paper includes descriptions of the various types of data collected over the course of the three year

project. An overall view of the project at the beginning is the characteristic of a good field data plan. The overall view should include a thorough search for all previous aerial photography and topography. A search for photographs by local citizens, newspapers, and agencies is very valuable for establishing the condition of the stream and watershed before, during, and after disturbance. Of great use is a high-resolution aerial survey of the project reach at the smallest affordable contour interval. Cross-sectional data, both current and historical, is very valuable from an analysis standpoint. Hydraulic analysis requires cross-sectional data along the reach.

Building Banks on Muddy Creek With Barbs

R.J. Wittler, S.D. Keeney, D.R. Eby, D.L. LaGrone

ABSTRACT

Barbs are jetties that extend from the bank and angle down into the channel, and upstream into the thalweg. Barbs vary in size depending upon channel size, shape and flow levels. Typical barb construction uses rock whose size primarily depends on stream velocity. Barbs are an effective alternative for bank stabilization problems. Barbs build stream banks and create riparian areas by trapping bedload and suspended sediments. Other names of barbs include jetties, toe dikes, groins, habitat sills, and bendway weirs.

Barbs displace high-velocity flow in the outside of bends away from the bank and create back flow cells at the base of the stream bank. At low flow, eddying between barbs causes sediment deposition. During higher flows, turbulence against vertical or overhanging banks causes bank collapse into areas between barbs. Bank collapse stops once the banks have reached a threshold slope. Low flow eddying maintains sediment between barbs. Sediment accumulation between barbs eventually results in riparian development. Over time the barbs become less visible as sediment accumulates and riparian vegetation develops.

The Muddy Creek Partnership: How to Restore a Stream

A.W. Rollo, D.L. Burgett, R.J. Wittler, S.D. Keeney

ABSTRACT

The Muddy Creek Demonstration Stream Restoration Research Project near Great Falls, Montana began in 1993. The Project is the result of a cooperative effort and partnership between Federal, State, and County agencies, and a local citizen task force. Together this interagency, interdisciplinary group is working to find solutions to the water quality problems originating in Muddy Creek. Muddy Creek is a tributary of the Sun River in the Upper Missouri River Basin. The Creek drains approximately 314 square miles of agricultural land. Muddy Creek borders the downstream edge of the Greenfield Irrigation District. The creek intercepts return and waste flow increasing base flow, causing extensive erosion of the fine grained alluvial soils. The primary erosion mechanism is incision followed by large scale bank slumping in the creeks lower reaches. The sediment transported by Muddy Creek decreases water quality in the Sun and Missouri Rivers.

In 1993, the state of Montana stepped in at the request of concerned citizens to look at ways to resolve the massive erosion problem of Muddy Creek. They were able to bring together a significant number of interested parties that were willing to work together to resolve the water quality problem. At the outset,

the partners knew that they could not restore Muddy Creek overnight. They also knew that large amounts of federal dollars would not be available. Thus they would need new innovative ideas and cost-effective approaches. The partners established a task force as part of a consensus building process. The process allowed for open discussion, and contributes to a feeling of ownership for the outcome of the project. The Muddy Creek Task Force now gives progress reports to a larger group of interested individuals, communities and agencies, concerned with the Muddy Creek sediment issue.

CAD Database

Task A4 - CAD Based Three-dimensional Model of Project Area

Task A4 requires Reclamation to incorporate all surveying data provided by the NRCS into a three-dimensional CAD based model of the project area. The basis of the model is the 1995 topographic survey of the demonstration reach by the Muddy Creek Task Force. The model will include pre-construction cross-sectional surveys, water surface profiles, and the exhaustive cross-sectional survey completed by NRCS in the spring of 1995. The first step in the creation of this model is to transform all project survey data to the State Plane Coordinate System. Table 1 lists the types and years of project surveys.

Table 1. Types and years of surveys.

Year	Type of Survey	Incorporated into CAD?
1993	Water Surface Profile (Phase I Reach)	No
1993-94	Selected Cross Sections (Phase I Reach)	No
1994	Water Surface Profile (Phase I Reach)	No
1995	Aerial Topographic (Mouth to above Gordon)	Yes
1995	Cross Section (Phase I Reach)	Yes
1995	Water Surface Profile (Phase II Reach)	No

Sub-Tasks to Complete CAD Model

As of the third quarter of FY 1997 the following steps are complete towards accomplishing Task A4.

1. Transformation of all survey data to the SPCS.
2. Receipt of the 1995 aerial topography from the contractor in three-dimensional, AutoCAD R13 format.

3. Receipt of the expanded 1995 aerial topography from the contractor. Includes topography not included in the original delivery.

4. Combining Hydraulic modeling data, HEC-2 or HEC-RAS, with aerial topography.

5. Locations of grade control structures

6. Comparison of water surface profiles from 1993 and 1994.

7. Preliminary delineation of MCTF named sub-reaches in Muddy Creek corridor.

The following sub-tasks remain, and also point towards additional field based tasks for supporting construction and restoration activities.

1. Location of cultural resources (CAD)

2. As-builts for GCS

3. All structures added to CAD

4. RAS model for Phase I reach (95 X-section extents) This River Analysis System (RAS) model will supersede the HEC-2 model currently in use by the Task Force.

5. Comparison of 77 or earlier, 90, & 95 topography - This task is underway. The first step is to scan and vectorize the 1977 topography. The TSC Remote Sensing group is performing this step. Then the 1977 and 1995 data will be overlayed onto the same drawing, contrasting the changes in the creek over that period. Analysis includes changes in sinuosity, amount of incision, and volume of erosion.

6. Updated field data plan including:

    a. Water surface profile (Corps sill to above Gordon?)
    b. X-section survey (repeat)
    c. Close the traverse
    d. Selected x-sections above and below Phase I reach

Additional field and analysis activities include:

1. Survey, photograph, and assess the performance of each structure including all barbs and revetments. (September, 1997)

2. Bank stability modeling (Future)

3. Compilation & expansion of conference papers (Part of Final Reports)

4. Barb design guidance (Expand US Army Corps of Engineers guidance)

5. Construction planning (Coordinate with Sun River Watershed Planning Group)

6. Construction activities (Contingent upon Greenfield Irrigation District availability)

7. Report on water quality based upon USGS data analysis - Initial analysis was delivered to the Task Force by the USGS. The Task Force is currently evaluating the data for inclusion in the next progress report. The data is for a very short period of time. Conclusions should be tempered by the statistical significance of this data.

TASK A5 - LOW WATER CROSSING

In February, 1997, during a warm weather period, snowmelt runoff overtopped and severely damaged the low water crossing. The crossing had been in place since December, 1996. Large ice sheets contributed to the damage of the crossing.

The failure of the crossing was due to blockage of the culverts and insufficient anchorage of the armoring on the roadway. The overflow channel on the left abutment was insufficiently excavated to protect the crossing. Once the ice flows blocked the culverts flow overtopped the roadway. The left abutment should have been excavated enough to capture the high flow. Instead flow over the roadway eroded the roadbase and removed the 24 inch riprap armor on top of the culverts.

After review of the damage, the Task Force is contemplating the following remedial measures:

1. Further excavate a high-flow channel on the left abutment of the crossing. Include armoring to protect the downstream groin of the crossing.

2. Construct a concrete cutoff wall incorporating the culvert tubes at the downstream end of the tubes.

3. Replace the riprap armor on top of the tubes buttressed by the cutoff wall.

4. Replace the roadbase material.

These measures will require extension of the permits for the original crossing. Planning and construction of the remedial measures is dependent upon Greenfield Irrigation District.

TASK A6 - SIGHT & INSTALL BARBS

Contingent upon Greenfield Irrigation District, construction of barbs and other structures will begin in September, 1997. Several sites are identified, rock material is in place and ready for construction.