



HERMIT'S PEAK WATERSHED ALLIANCE

Wolf Creek Stream and Riparian Restoration – New Mexico's Front Range Wetland Complex Protection and Restoration Project I

Final Report

Submitted to NM Land Conservancy
by Hermit's Peak Watershed Alliance

July 12, 2021

Project Name

Wolf Creek Stream and Riparian Restoration. In partial fulfillment of a National Wetlands Conservation Act (NAWCA) grant titled - New Mexico's Front Range Wetland Complex Protection and Restoration Project I.

NM Land Conservancy

Various Stewardship Coordinators over the life of the project
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Background

As part of the New Mexico's Front Range Wetland Complex Protection and Restoration Project managed by the NM Land Conservancy, Hermit's Peak Watershed Alliance (HPWA) was tasked with performing stream and riparian restoration on Wolf Creek as it flows through the Fort Union Ranch near Watrous, New Mexico (see Map 1). Wolf Creek is part of the lower Mora River Watershed; its confluence with Mora River is near Valmora, New Mexico.

Instream restoration work on Wolf Creek began in 2017 with two grants. One from the NM Environment Department section 319(h) of the Clean Water Act titled *On-the-Ground Improvement Projects for the Mora River - Upper Canadian Plateau Phase 1A* and one from the Playa Lakes Joint Venture (PLJV). Two miles of the stream was treated with 39 structures (a copy of the NMED and PLJV project reports are available upon request). This NAWCA funded project continues that work downstream, adding 1.2 miles of restored stream with 24 structures (see Figure 1).

This NAWCA funded project complements other work by HPWA in the lower Mora Watershed. A Watershed Based Plan for the Mora River – Upper Canadian Plateau (WBP) was completed in 2016 and followed by the first phase of implementation from September 2017 to June 2020. The second phase of implementation of this WBP is underway, beginning in September 2020 and ending in June 2023. Because the area covered by the Watershed Based Plan for the lower Mora River was so large, 477 square miles, more detailed treatment of the Wolf Creek Watershed was called for. An effort to develop a more specific Watershed Based Plan for Wolf Creek is also underway, scheduled for completion in December 2022. All these efforts help to ensure that comprehensive, long-term watershed restoration in the Wolf Creek and the greater watershed will continue.



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Wolf Creek Stream and Riparian Restoration NAWCA Grant



-  2019 NAWCA Project
-  2017 Playa Lakes Joint Venture Project
-  Fort Union Ranch Boundary
-  Fort Union Monument



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Map 1. Wolf Creek Stream and Riparian Restoration Project as part of the New Mexico's Front Range Wetland Complex Protection and Restoration Project I funded by a National Wetlands Conservation Act (NAWCA) grant.



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Figure 1. Picture of a 2017 restored reach of Wolf Creek, with ORD structures, part of the PLJV project.

NAWCA Project Term

February 1, 2019 to June 30, 2021

Project Budget

\$36,704.19

[\$20,000 (original budget), \$16,704.19 (additional funds – Dec. 17, 2020)]



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Project Partners

HPWA lead the project assisting with the design, completing the US Army Corps of Engineers 404 permit, organizing, and leading the construction, and managing all finances and reporting. This project, however, could not have been accomplished without the help and cooperation of a number of partners.

The New Mexico Land Conservancy was the principal NAWCA grant recipient and HPWA was a subgrantee responsible for the stream and riparian restoration exclusively.

Fort Union Ranch, as landowner, was the key partner as owners of the land, contributor of significant labor and resources, and the entity responsible for the long-term maintenance.

As subcontractors, Bill Zeedyk was hired to lead the project design and oversee construction. Steve Townsend was hired as the archaeologist to do the cultural survey needed for the US ACE 404 permit.

Volunteers from the Albuquerque Wildlife Federation, New Mexico Highlands University, and numerous HPWA volunteers contributed substantial labor to build the 24 structures and plant riparian vegetation.

Project Area

Wolf Creek is in the lower Mora River Watershed located in Mora County. The project area is about 9 miles northeast of the village of Watrous, New Mexico and near the Rio Mora National Wildlife Refuge. Fort Union Ranch, owned by the Union Land and Cattle Company, comprises most of the length of Wolf Creek. The confluence of Wolf Creek and Mora River occurs near Valmora, New Mexico. The entire length of Wolf Creek is 24.5 miles, and the Wolf Creek Watershed is 77,530 acres (121 sq. mi.) in size. This NAWCA project reach begins at the bridge over Wolf Creek to the Fort Union National Monument and extends downstream to near the diversion of Wolf Creek to Wheeler Lake, a length of 1.2 miles.

Project Goals and Design

In keeping with the goals of the New Mexico's Front Range Wetland Complex Protection and Restoration Project, our goals were to restore freshwater and saline emergent and riverine wetlands in and along Wolf Creek to ensure their future viability for waterfowl and water birds in the southern shortgrass prairies of northeastern New Mexico and to brace them to face



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climate change. Also, as part of HPWA's watershed-wide goals, we aimed to improve the persistence and water flow in Wolf Creek to address its flow impairment and the nutrient impairment of the Mora River (an impairment that is correlated to flow conditions). These two goals were synergistic since both involve improving water retention, both above and below ground, in Wolf Creek, a stream that was historically perennial but because of stream channel and floodplain degradation became ephemeral in nature. To improve the diversity and utility of the area by wildlife, another goal was to enhance woody riparian vegetation in the riparian area.

The project was fortunate to use the design and project oversight services of the Southwest's master wetland restoration expert, Bill Zeedyk, of Zeedyk Ecological Consulting. Mr. Zeedyk worked with HPWA staff and staff of Fort Union Ranch to design the types and locations of structures to improve flow conditions and water bird habitat in Wolf Creek.

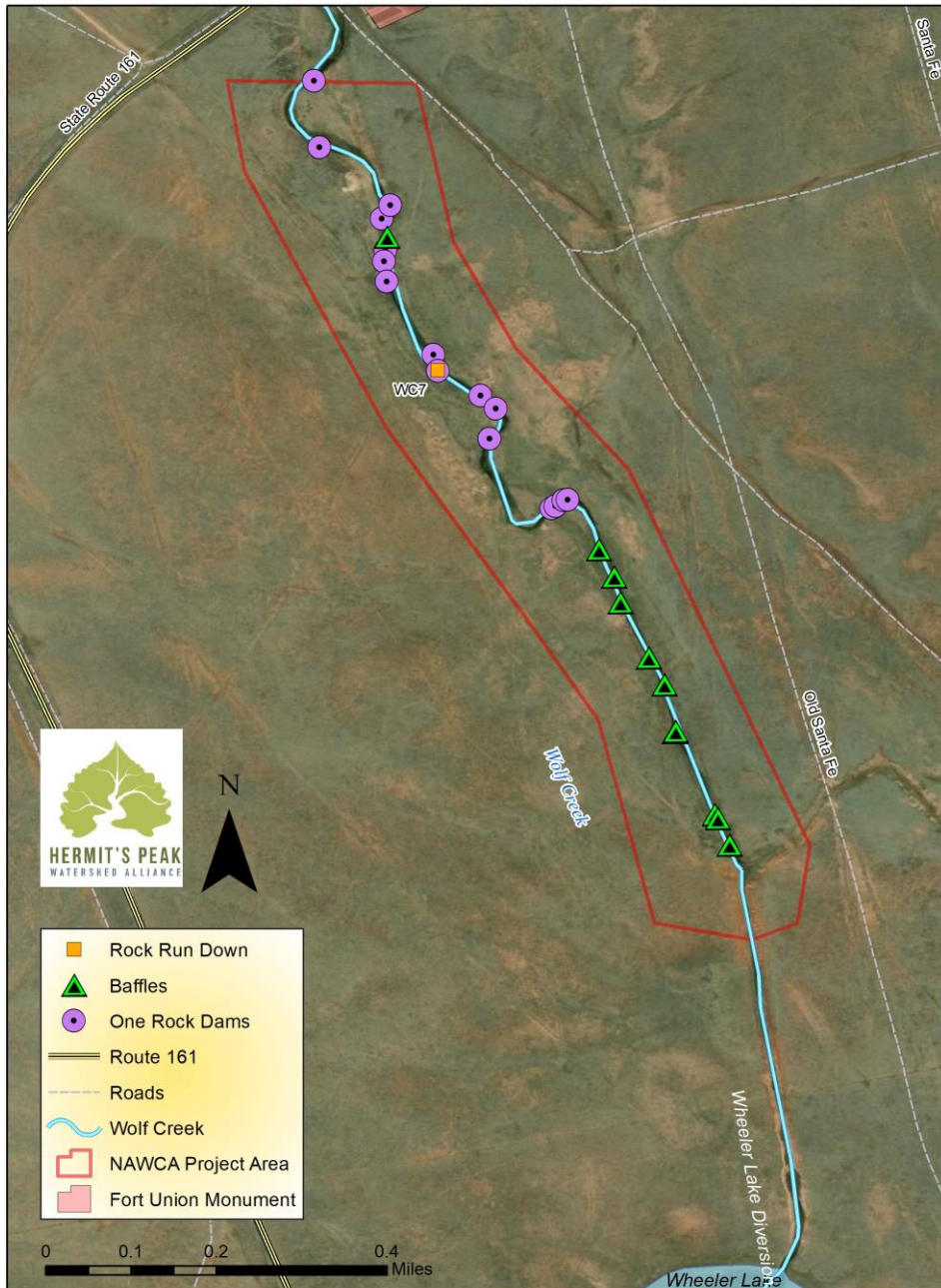
Twenty four structures were designed and built including 15 one-rock dams, 9 juniper pole baffles, and a mix of earthen dams and rock-run downs (see Map 2). Each structure was specifically placed and designed to increase the wetted area (both above and below ground), improve instream diversity, add instream obstacles to slow flow, and support wetland vegetation.

A historically straightened Wolf Creek had structures installed to induce meandering and increase the sinuosity and the stream length. By adding stream length, the structures then reduce the gradient of the stream and make it less prone to accelerated rates of erosion and further downcutting. Wolf Creek is a severely entrenched stream system and so addressing the issue with an induced meandering approach was essential to help restore stream health. The structures also add in-stream channel roughness which reduces stream velocities and promotes establishment of more wetland riparian vegetation.



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Wolf Creek Restoration NAWCA Field Map





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Figure 2. ORD structure and the wetland riparian vegetation surrounding the structure on Wolf Creek.



Figure 3. Aerial view of the ORD structure taken by a drone.



Figure 4. Bill Zeedyk directing the construction of an ORD structure.

Structures were built with various sizes of rock collected across Fort Union Ranch by ranch staff and with wood juniper poles harvested in forest thinning projects on the ranch.



Figure 5. Bill Zeedyk directing the construction of a juniper pole baffle on Wolf Creek.

Locally appropriate, native woody riparian vegetation were to be planted in clumps in strategic locations. Locations were generally on top of depositional features such as sand bars where subsurface water was most likely to reach the roots of all planted woody plants. Planting in clumps made it practical to fence plantings to protect them from herbivory and damage by elk, pronghorn, beaver, cattle, and horses.

US Army Corps of Engineers 404 Permit

A required section 404 Clean Water Act Permit was prepared by Amina Sena of HPWA with the Cultural Resources Study done by Townsend Archaeological. The permit was approved by the U.S. Army Corps of Engineers (ACE) on March 11, 2020. See Appendix 1 for the verification letter from ACE (Nationwide Permit Verification – Action No. SPA-2020-00072, NAWCA Wolf Creek Riparian and Wetland Restoration Project). The first of five annual reports required for this permit will be submitted before December 2021, after one full growing season post construction. Permit monitoring consists of photo points at selected structures and is being done by HPWA staff.



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Project Construction

Structure construction and riparian planting was accomplished with the following four events plus extra work by Fort Union and HPWA staff. Photos of the project are in Appendix 2.

1. The first was a training effort conducted by Bill Zeedyk and given to HPWA and Fort Union Ranch staff. Seven structures were built, including 3 ORDs and 5 juniper pole baffles.
2. A work weekend with Albuquerque Wildlife Federation, HPWA staff, and volunteers was held September 18-20, 2020. Forty-one volunteers participated working 298 hours during which we built 8 ORD structures were built. The match for this event was claimed under our Wolf Creek Watershed Based Plan project.
3. A day of work by NMHU football team and various HPWA staff and volunteers, held on October 10, 2020, when 14 volunteers participated for a total of 70 hours of work building 8 structures were built, 4 ORDs and 4 Baffles. The match for this event was claimed under our Wolf Creek Watershed Based Plan project.
4. A day of work by HPWA staff and volunteers to plant and cage woody riparian vegetation occurred on March 20, 2021. Eleven cages were built to protect the 356 shrubs and 40 trees that were planted, and 12 volunteers did the work. The volunteer work for this project was totaled at 96 hours. Fort Union staff finished up the planting and caging on their own.

Woody riparian vegetation was planted in clumps in strategic locations and wire cages were built around the clumps to protect the saplings and seedlings from herbivory by native ungulates, beaver, and livestock. Cottonwood poles were planted by digging approximately 4-5' deep holes with an auger attached to a bobcat provided by Fort Union Ranch. Shrub seedlings and potted plants were planted with a steel pole with a point on one end and driven into the ground with a fence post pounder, planting dibbles, or shovels.

Plants were obtained from the Santa Ana Nursery (<http://www.santaana.org/nursery.htm>) and the New Mexico Forestry Division Conservation Seedling Program (<http://www.emnrd.state.nm.us/SFD/treepublic/ConservationSeedlings.html>). The supply of available species from NM Forestry were extremely limited at the time of purchase. The table below lists plants that were obtained and planted.



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Wire cages were built with 12.5 gauge welded wire 6' tall with a 2x4" mesh obtained by Blain's Farm and Fleet. Cages were constructed approximately 3 feet away from trees and shrubs and were held by about 4 or more 8' t-posts and the wire was secured to the ground with 18" pieces of 3/8" rebar with a hook bent on one end.

All work events were coordinated and facilitated by HPWA and Fort Union Ranch staff. Ranch staff did considerable work to gather rock and juniper poles, shape baffle poles from raw juniper and they participated in all work events.

Source	Species	Number	Type of Container
NM Forestry			
	Chokecherry	98	1" tubes
	Gooding's Black Willow	98	1" tubes
Santa Ana Pueblo			
	Rio Grande Cottonwood	40	12-15' poles
	Peachleaf Willow	100	whips
	NM Olive	20	1 gallon containers
	False Indigo Bush	20	1 gallon containers
	Three-leaf Sumac	20	1 gallon containers

Project Analysis

This NAWCA project, coupled with the previous Playa Lakes Joint Venture project, and the NMED funded Wolf Creek Watershed Based Plan, Lower Mora WBP, and plan implementation grants, will help to comprehensively restore the length of Wolf Creek to meet its full potential given the current infrastructure, landownership, and climate conditions. A coordinated approach to restoring the functionality of Wolf Creek has been made possible by the willingness of the primary landowner, Fort Union Ranch, and the resources they have made available to this work.

The restoration vision, knowledge, design, and mastery contributed by Bill Zeedyk, who has been involved in all the work in Wolf Creek, has been key to its success. Bill saw the ecological potential of this damaged creek to provide wildlife habitat and improve all watershed functions of this arid landscape. Because of the hand-built nature of all structures (a hallmark of Bill Zeedyk) built in Wolf Creek thus far, and because of contributions from Bill,



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Fort Union Ranch and many volunteers, considerable restoration has been accomplished for a relatively low budget.

The restoration success has been evident already (as shown in photographs in this report and in Appendix 2) but will most assuredly continue to improve as riparian vegetation matures. This restoration also offers an excellent model of the improvement to stream health, wildlife habitat, and watershed function that is possible with vision, thoughtful design, good oversight, a coordinated approach, a shared landowner vision, and adequate funding.

Use of Funds (Budget)

The original budget for this Wolf Creek Stream and Riparian Restoration project was \$20,000. Several factors increased the actual costs of planned work and there was a desire to add riparian planting and caging to revegetate the riparian area more thoroughly. NMLC was able to increase the granted amount by \$16,704.19. This enabled us to defray additional costs and accomplish planting 396 plants and enclosing them in protective cages.

Factors affecting the increase in costs beyond what was originally estimated included the following. Considerably more HPWA staff time was required to assist Bill Zeedyk with the project design. Designs were finished early in the project but because of COVID-19 we had to post-pone construction dates with volunteers till September 2020 (it was originally planned for the spring of 2020). Extra trips were required to remark structures that lost markings over the summer. The work to refine the design and prepare the 404 permit application was more than anticipated. Considerably more staff time was required to build structures, train volunteers and coordinate events. COVID was certainly a contributor to greater staff time since events were arranged then cancelled a few times. The number of trips back and forth to the project site were more numerous than expected.

Pre- Covid this project could have been completed in one large AWF event. With Covid came precautionary measures like group size restrictions than increased the number of times required to create smaller volunteer opportunities to get the work done. HPWA branched out and sought new volunteer opportunities with NM Highlands University and the local athletic department. The work was completed by seeking out these extra volunteer opportunities to make up for the capacity management of group sizes issue that was part of the COVID -19 safety protocol. This required more oversight from HPWA staff as these volunteer groups were also not as trained in these restoration measures as volunteer groups like AWF. That



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training was a wonderful opportunity to share this knowledge of resource restoration with our local community and partners like NM Highlands University.

Also, the original budget was perhaps overly ambitious, especially with the goal of accomplishing all needed restoration in the 1.2 mile stretch of Wolf Creek. With the available funds, we were able to build all needed structures and carry out a reasonable amount of riparian planting that was appropriate in this reach. At this time, no additional work is needed here until maintenance is required.

Below is an accounting of budget and actual expenses for this project.



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NAWCA Expense Accounting							
Description	Original Budget	Difference between Budget and Actual	Actual Costs	Invoice #4	Invoice #3	Invoice #2	Invoice #1
Design – Bill Zeedyk	\$6,000.00	\$(1,277.46)	\$7,277.46			\$3,638.48	\$3,638.98
HPWA Design support		\$(2,350.00)	\$2,350.00				\$2,350.00
Archaeology - Steve T	\$3,000.00	\$132.93	\$2,867.07				\$2,867.07
404 Permit	\$3,000.00	\$(650.00)	\$3,650.00				\$3,650.00
HPWA Coord.	\$3,000.00	\$(11,425.00)	\$14,425.00	\$4,475.00	\$6,775.00	\$3,175.00	
Construction supervision - Bill Zeedyk	\$5,000.00	\$3,068.72	\$1,931.28	\$908.67	\$1,022.61		
Supplies		\$(3,484.02)	\$3,484.02	\$3,009.83	\$298.03		\$176.16
Travel - HPWA		\$(726.84)	\$726.84	\$219.24	\$309.96		\$190.08
Original budget TOTAL	\$20,000.00						
Dec. 17 contract addition per Milu Velardi email	\$16,704.19	\$16,704.19					
TOTAL	\$36,704.19	\$0.08	\$36,704.11	\$8,612.74	\$8,405.60	\$6,813.48	\$12,872.29



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Match Offered

The total match budgeted for this project was \$9,200, made up of labor, equipment, travel, and supplies provided by HPWA and Fort Union Ranch (FUR). The actual match offered was \$50,345.28, which was more than the budgeted match by \$41,145.28. See the below table for accounting of match offered throughout this project.

Much of the increased match was offered by Fort Union Ranch who contributed significantly more match than was originally estimated. This match was in the form rocks for all the structures, the labor and equipment to collect them, and labor to build structures and do planting and caging, as well as equipment for planting. HPWA also provided considerable match beyond the budget in the form of volunteer labor, travel, and supplies.

Much of the match offered by Albuquerque Wildlife Federation, NM Highlands University, and HPWA volunteers who all worked hard to build restoration structures was claimed under the Wolf Creek Watershed Based Plan since match requirements for this project were met and far exceeded. For information, that match claimed by volunteers for the structure construction totaled \$14,309 (\$9,200 for labor and \$5,109 for travel).

NAWCA MATCH ACCOUNTING			
BUDGET CATEGORY	CUMULATIVE MATCH	MATCH BUDGET	MATCH IN EXCESS OF BUDGET
Personnel – HPWA and Volunteers	10,810.00	3,500.00	7,310.00
Equipment and supplies - HPWA	750.00	400.00	350.00
Travel - HPWA	1,059.48	300.00	759.48
Travel - Volunteers	145.80	0	145.80
subtotal HPWA	12,765.28	4,200.00	8,565.28
Personnel - FUR	19,360.00	0	19,360.00
Equipment - FUR	6,100.00	1,000.00	5,100.00
Rock - FUR	10,520.00	4,000.00	6,520.00
subtotal - FUR	35,980.00	5,000.00	30,980.00
Contractual - Bill Zeedyk	1,600.00	0	1,600.00
subtotal - Zeedyk	1,600.00		1,600.00
TOTAL	\$50,345.28	\$9,200.00	\$41,145.28



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Appendix 1: NWP 27 Verification Letter – this continues to Page 29



DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, ALBUQUERQUE DISTRICT
U.S. ARMY CORPS OF ENGINEERS REGULATORY DIVISION
4101 JEFFERSON PLZ NE, ALBUQUERQUE, NM 87109

March 11, 2020

Regulatory Division

SUBJECT: Nationwide Permit (NWP) Verification – Action No. SPA-2020-00072,
NAWCA Wolf Creek Riparian and Wetland Restoration Project

Joshua Miner
Union Land and Grazing Company
PO Box 111
North Andover, MA 01845

Dear Mr. Miner:

This letter responds to your February 14, 2020, pre-construction notification (PCN) for the proposed Wolf Creek Riparian and Wetland Restoration Project located at approximately latitude 35.889399, longitude -105.012388, in Mora County, New Mexico. The work, as described in your PCN, will consist of installation of baffles, rock run downs, and one rock dams within Wolf Creek.

Specifically, and as shown in the attached Figure 3-5, appendix 3, and as described in the attached tables 1-3, this verification authorizes the permanent discharge of approximately 410 CY of fill material into approximately 3.8 acres of intermittent channel, specifically Wolf Creek which is a tributary of the Mora River, for the purpose of environmental restoration and erosion control associated with the Wolf Creek Riparian and Wetland Restoration Project.

We have assigned Action No. SPA-2020-00072 to this project. Please reference this number in all future correspondence concerning the project.

Based on the information provided, we have determined that the project is authorized by NWP 27, Aquatic Habitat Restoration, Establishment, and Enhancement Activities. A summary of this permit and the New Mexico Regional Conditions are available on our website at www.spa.usace.army.mil/reg/nwp. Clean Water Act (CWA), Section 401, requires applicants of federal permits to obtain certification of compliance, or waiver thereof, with applicable water quality standards from the appropriate certifying authority. Please refer to our website at <http://www.spa.usace.army.mil/Missions/Regulatory-Program-and-Permits/Water-Quality-Certification/> and the attached spreadsheet for information regarding CWA Section 401 water quality certification (WQC). The permittee must ensure that the work complies with the terms and conditions of the NWP, including New Mexico Regional



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Conditions and conditions of the applicable WQC. Furthermore, you must comply with the non-discretionary Special Conditions listed below:

1. The permittee shall submit annual restoration site monitoring reports to the Corps Albuquerque District Office by December 31st of each year, beginning in the calendar year in which the project is completed, for a minimum of 3 years or until the Corps has determined that the restoration performance standards and success criteria have been met. Preparation of monitoring reports may be combined with a Corps site inspection. The restoration monitoring reports shall at a minimum include the following:
 - a. Photographs (minimum 5) from fixed photographic monitoring points with a location reference map and indicating camera orientation.
 - b. Fish and wildlife observations at the mitigation site.
 - c. Summary statement regarding the perceived success of the mitigation project and any potential problem areas. Suggestions and a timetable for corrections should be included if it is anticipated that project goals may not be met.
 - d. Discussion of any unusual events that might have impacted or may impact the structures, stream, or wetland, such as upstream landslides, unusually large snowpack, large-scale erosion event, drought, and etc.
 - e. Discussion of any recent corrective or maintenance activities conducted since the previous report submission, including date and type, and specific recommendations for any additional corrective or remedial actions.
 - f. Date(s) of field inspection(s).
2. Pursuant to Part 11 of Appendix C of 33 CFR 325, if buried cultural deposits are encountered during construction, work should cease immediately and the permittee shall contact the Corps and avoid further impacts to the area until a determination of significance can be made. If necessary, consultation will take place with the State Historic Preservation Officer (SHPO) and with American Indian Tribes that have cultural concerns in the area to determine the best course of action.
3. Prior to initiating construction within Waters of the U.S., the Permittee shall clearly mark the limits of on-site cultural resources specifically LA 195234, LA 195235, and LA 195238 with flagging or similar means to ensure mechanized equipment does



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not enter areas of cultural significance, as described in the applicants cultural resource report entitled "A Cultural Resource Inventory for US Army Corps of Engineers 404-Permitting of Riparian Restoration Work along Wolf Creek, Mora County, New Mexico-NAWCA 2019"

Our review of this project also addressed its effects on threatened and endangered species and historic properties in accordance with general conditions 18 and 20. Based on the information provided, we have determined that this project will not affect any federally listed threatened or endangered species or any historic properties. However, please note that the permittee is responsible for meeting the requirements of general condition 18 on endangered species and general condition 20 on historic properties.

This letter does not constitute approval of the project design features, nor does it imply that the construction is adequate for its intended purpose. This permit does not authorize any injury to property or invasion of rights or any infringement of federal, state or local laws or regulations. The permittee and/or any contractors acting on behalf of the permittee must possess the authority and any other approvals required by law, including property rights, in order to undertake the proposed work.

This permit verification is valid until March 18, 2022 (33 CFR 330.6), unless the NWP is modified, suspended, revoked or reissued prior to that date. Continued confirmation that an activity complies with the terms and conditions, and any changes to the NWP, is the responsibility of the permittee. Activities that have commenced, or are under contract to commence, in reliance on a NWP will remain authorized provided the activity is completed within 12 months of the date of the NWP's expiration, modification, or revocation.

Within 30 days of project completion, the permittee must fill out the enclosed Certification of Compliance form and return it to our office. The landowner must allow Corps representatives to inspect the authorized activity at any time deemed necessary to ensure that it is being, or has been, accomplished in accordance with the terms and conditions of the NWP.

If you have any questions, please contact me at (505) 342-3280 or by e-mail at Stephen.R.Roethle@usace.army.mil. At your convenience, please complete a



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Customer Service Survey on-line available at
http://corpsmapu.usace.army.mil/cm_apex/f?p=136:4:0.

Sincerely,
ROETHLE.STEP
HEN.ROBERT.1
281156949

Digitally signed by
ROETHLE.STEPHEN.ROBE
RT.1281156949
Date: 2020.03.11 08:08:50
-06'00'

Stephen Roethle
Project Manager
NM/TX Branch

Enclosure(s)



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Certification of Compliance with Department of the Army Nationwide Permit

Action Number: SPA-2020-00072

Name of Permittee: Joshua Miner, Union Land and Grazing Company

Nationwide Permit: NWP 27 Aquatic Habitat Restoration, Establishment, and Enhancement Activities

Upon completion of the activity authorized by this permit and any mitigation required by the permit, sign this certification and return it to the following address:

Stephen Roethle
Albuquerque District, U.S. Army Corps of Engineers
U.S. Army Corps of Engineers Regulatory Division
4101 Jefferson Plz NE, Albuquerque, NM 87109

Please note that your permitted activity is subject to a compliance inspection by an U.S. Army Corps of Engineers representative. If you fail to comply with this permit, you are subject to permit suspension, modification, or revocation.

Please enclose photographs showing the completed project (if available).

I hereby certify that the work authorized by the above referenced permit has been completed in accordance with the terms and conditions of the said permit, and required mitigation was completed in accordance with the permit conditions.

Date Work Started _____

Date Work Completed _____

Signature of Permittee

Date



Appendix 2: Field Maps with rock stabilizing structures

**Wolf Creek Restoration
NAWCA Field Map**

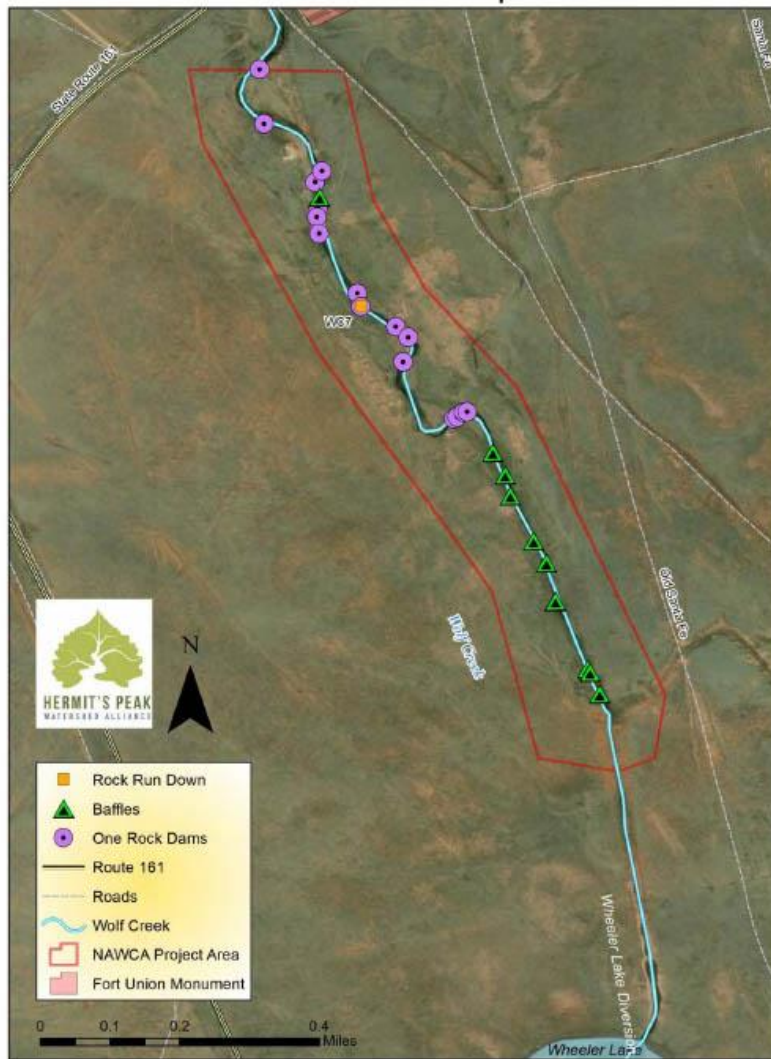


Figure 3. NAWCA Erosion Control Structure field map overview



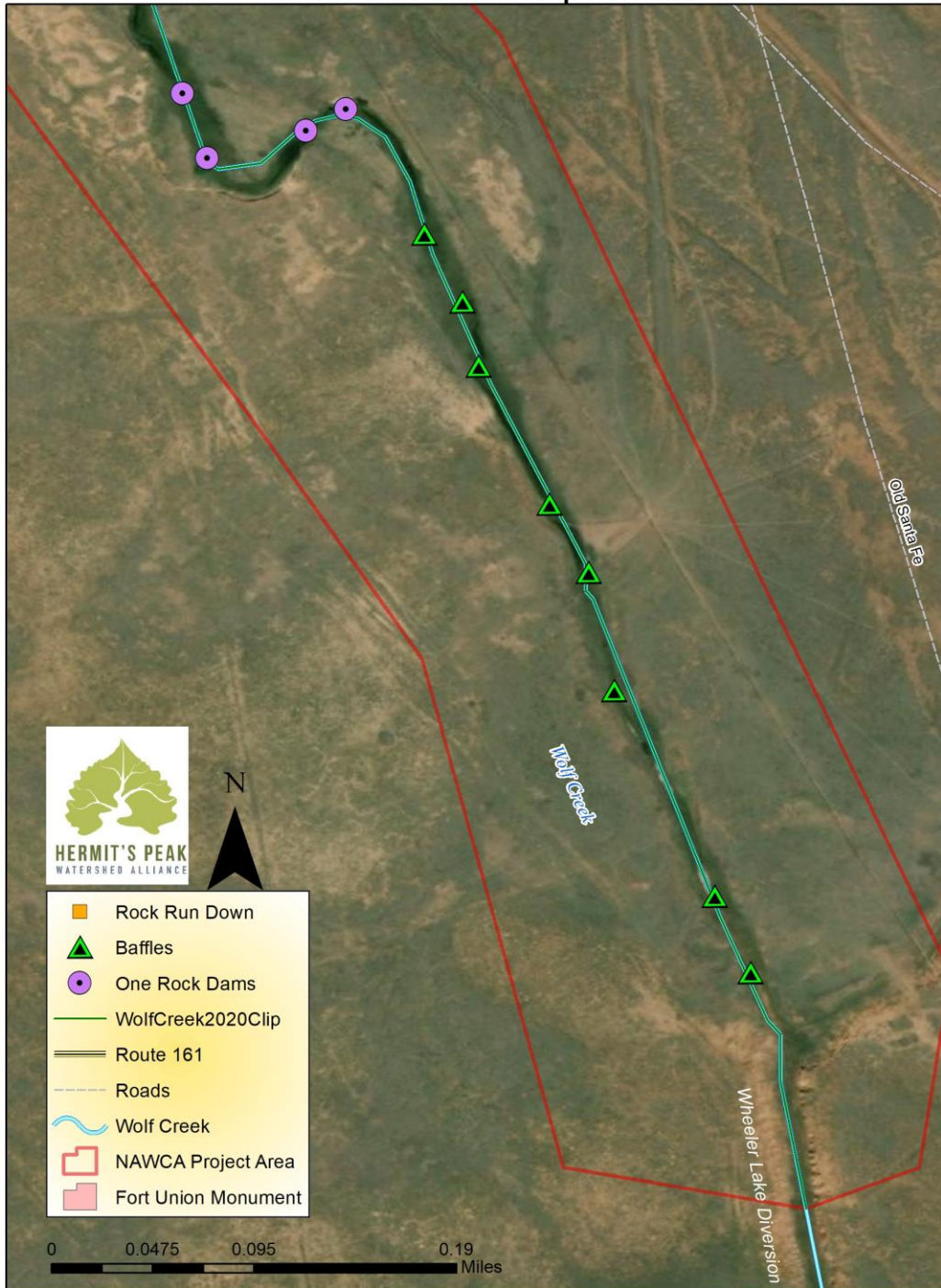
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Wolf Creek Restoration NAWCA Field Map North





Wolf Creek Restoration NAWCA Field Map South





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Appendix 3: Erosion Control Structure Diagrams

Information from the Erosion Control Field Guide publication created by Craig Sponholtz & Avery C. Anderson in cooperation with the Quivira coalition and Dryland Solutions Inc. in 2010.

One Rock Dam (ORD)

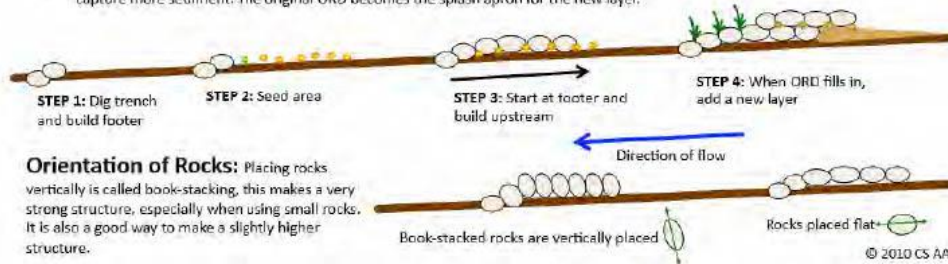
ONE ROCK DAM "ORD"



A low grade control structure built with a single layer of rock on the bed of the channel. ORDs stabilize the bed of the channel by slowing the flow of water, increasing roughness, recruiting vegetation, capturing sediment, and gradually raising the bed level over time. ORDs are also passive water harvesting structures. The single layer of rock is an effective rock mulch that increases soil moisture, infiltration, and plant growth. Original concept developed by Bill Zeedyk.

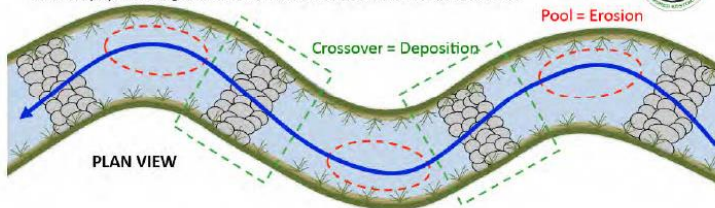
Design & Construction

1. Select area to build the ORD; dig a shallow footer trench and fill with one or two rows of rock, so that no rock protrudes more than 2 in/5cm above the bed of the channel. This will serve as the splash apron for the ORD.
2. Scatter native grass and wildflower seeds in the area where the ORD is to be built.
3. Start building at the footer and continue upstream, laying down one layer of rock horizontally, as if you were building a rock wall.
4. Once the ORD is completely filled with sediment, another layer can be added to further raise the bed of the channel and capture more sediment. The original ORD becomes the splash apron for the new layer.

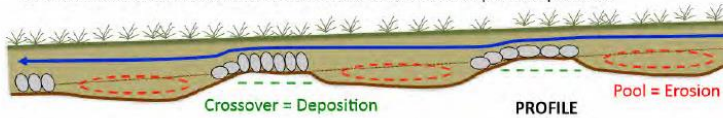


ONE ROCK DAM

1. Always position grade control structures at meander crossovers.



2. Placement at crossovers maintains natural erosion and deposition patterns.



3. Always maintain channel cross section to protect banks.





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Rock Mulch Rundown (RMR)

ROCK MULCH RUNDOWN



A headcut control structure where the face of the headcut has been laid back to a stable angle of repose (minimum of a 3:1 slope), and then covered with a single layer of rock mulch. The mulch serves to slow runoff, increase soil moisture, recruit vegetation, and ultimately prevent the headcut from migrating further up slope. Rock Mulch Rundowns are ONLY to be used on low energy headcuts, like those found in upland rills and gullies with small catchment areas, and where sheetflow collects and enters a channel. Original concept by Craig Sponholtz.

Design & Construction

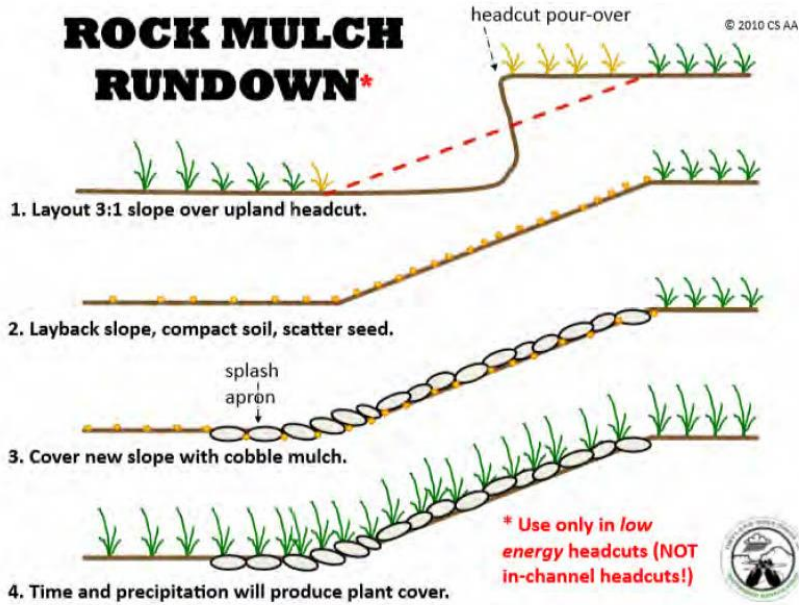
1. Select a low energy headcut for treatment.
2. Determine the extent of the 3:1 slope. Take care to balance the cutting required to achieve a 3:1 slope vs. the potential disturbance to existing vegetation.
3. Layback the headcut by cutting away soil from the top of the face, and then use the cut material to fill the base of the headcut. Where possible, the Rundown should be the entire width of the channel below the headcut, or when no channel exists, the width of the headcut itself. Narrow headcuts may need to be widened to accommodate the rock work. Adjacent headcuts, separated by uneroded fingers of earth, but leading to the same channel, can be combined into a single Rundown structure. Knock down the uneroded earth between the headcuts, and use it as fill.
4. Compact the fill.
5. Scatter native grass and wildflower seed and rake the surface of the Rundown.
6. Dig a shallow trench on the down slope side of the Rundown and fill with one to two rows of rock, so that no rock protrudes more than 2 in/5cm above the bed of the channel. This will serve as the **splash apron** for the Rundown.
7. Cover the entire surface of the Rundown with a single layer of rock mulch. The center of the Rundown should be the lowest point in the structure so that water will not run around the edges.
8. Continue to lay rock on the surface of the Rundown until you reach the height of the **headcut pour-over**. No rocks should protrude above this level to allow water to flow freely over the structure. It is very important to avoid gaps in the rock work because gaps cause weak points in the structure. Fill gaps with small gravel if needed. To improve durability, you can use a biodegradable geotextile mesh to line the surface of the Rundown prior to laying rocks.

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ROCK MULCH RUNDOWN*





Appendix 8: Erosion Control Structure Locations in Table Format

Table 1. Erosion Control Structure locations in UTM Nad83

Row Labels	X Value	Y Value
NAWCA10ORD	35.889399	105.012388
NAWCA11ORD	35.88944	105.012319
NAWCA12ORD	35.889537	105.012186
NAWCA13ORD	35.889545	105.012116
NAWCA14ORD	35.88334	105.00918
NAWCA1Baffle	35.894	105.015172
NAWCA1ORD	35.896651	105.016416
NAWCA1RRD	35.89174	105.01431
NAWCA2AORD	35.89548	105.01633
NAWCA2Baffle	35.888699	105.011584
NAWCA2ORD	35.895524	105.016324
NAWCA3AORD	35.894312	105.015267
NAWCA3Baffle	35.888238	105.011326
NAWCA3ORD	35.894538	105.015119
NAWCA4Baffle	35.887804	105.011214
NAWCA4ORD	35.893773	105.015203
NAWCA5Baffle	35.886868	105.010734
NAWCA5ORD	35.893591	105.015226
NAWCA6AORD	35.893244	105.015183
NAWCA6Baffle	35.886406	105.010469
NAWCA6ORD	35.892008	105.014389
NAWCA7AORD	35.891312	105.01359
NAWCA7Baffle	35.885604	105.010295
NAWCA7ORD	35.891733	105.014318
NAWCA8Baffle	35.884208	105.009613
NAWCA8ORD	35.891093	105.013335
NAWCA9Baffle	35.88369	105.009369
NAWCA9ORD	35.890583	105.013437

Appendix 9: Wetland types and total acres in project area

Sum of All Wetland Acres = 7 Acres within project boundary
<i>Freshwater Emergent Wetland</i>
<i>Freshwater Pond</i>
<i>Freshwater Forested/Shrub Wetland</i>
<i>Riverine Wetland</i>



Appendix 10: Fill Material Dimensions for Each Structure

Fill material in the form of hand-carry-able rocks must be placed within the OHWM in order to construct the one-rock dams and rock run-downs. Baffles may be constructed from either poles or boulders. For permit purposes, all baffles were assumed to be created from boulders, and this material was calculated as fill and included in fill values calculated below.

Table 2. Dimensions of Impact for NAWCA Wolf Creek Project

Row Labels	X Value	Y Value	Width Value	Length Value	Height Value
NAWCA10ORD	35.889399	105.012388	8	12	1.5
NAWCA11ORD	35.88944	105.012319	8	12	2
NAWCA12ORD	35.889537	105.012186	8	12	2
NAWCA13ORD	35.889545	105.012116	8	12	2
NAWCA14ORD	35.88334	105.00918	8	12	1.5
NAWCA1Baffle	35.894	105.015172	30	10	3
NAWCA1ORD	35.896651	105.016416	8	22	1.5
NAWCA1RRD	35.89174	105.01431	6	3	1
NAWCA2AORD	35.89548	105.01633	8	22	1.5
NAWCA2Baffle	35.888699	105.011584	20	10	2
NAWCA2ORD	35.895524	105.016324	8	12	1.5
NAWCA3AORD	35.894312	105.015267	8	25	1.5
NAWCA3Baffle	35.888238	105.011326	30	10	3
NAWCA3ORD	35.894538	105.015119	8	26	1.5
NAWCA4Baffle	35.887804	105.011214	30	15	2
NAWCA4ORD	35.893773	105.015203	8	12	1.5
NAWCA5Baffle	35.886868	105.010734	20	10	2
NAWCA5ORD	35.893591	105.015226	8	16	1.5
NAWCA6AORD	35.893244	105.015183	8	14	1
NAWCA6Baffle	35.886406	105.010469	30	15	2
NAWCA6ORD	35.892008	105.014389	8	14	1
NAWCA7AORD	35.891312	105.01359	8	18	1
NAWCA7Baffle	35.885604	105.010295	40	20	2
NAWCA7ORD	35.891733	105.014318	6	3	1
NAWCA8Baffle	35.884208	105.009613	30	15	2
NAWCA8ORD	35.891093	105.013335	8	20	1
NAWCA9Baffle	35.88369	105.009369	30	15	2
NAWCA9ORD	35.890583	105.013437	8	18	1.5
Grand Total			408	405	47



Appendix 11: Fill Material in Cubic Yards for Erosion Control Structures

Quantities in cubic yards of fill and/or excavation material:

Row Labels	X Value	Y Value	Sum of Structure Area in cu. Yds
NAWCA10ORD	35.889399	105.012388	5.33
NAWCA11ORD	35.88944	105.012319	7.11
NAWCA12ORD	35.889537	105.012186	7.11
NAWCA13ORD	35.889545	105.012116	7.11
NAWCA14ORD	35.88334	105.00918	5.33
NAWCA1Baffle	35.894	105.015172	33.33
NAWCA1ORD	35.896651	105.016416	9.78
NAWCA1RRD	35.89174	105.01431	0.67
NAWCA2AORD	35.89548	105.01633	9.78
NAWCA2Baffle	35.888699	105.011584	14.81
NAWCA2ORD	35.895524	105.016324	5.33
NAWCA3AORD	35.894312	105.015267	11.11
NAWCA3Baffle	35.888238	105.011326	33.33
NAWCA3ORD	35.894538	105.015119	11.56
NAWCA4Baffle	35.887804	105.011214	33.33
NAWCA4ORD	35.893773	105.015203	5.33
NAWCA5Baffle	35.886868	105.010734	14.81
NAWCA5ORD	35.893591	105.015226	7.11
NAWCA6AORD	35.893244	105.015183	4.15
NAWCA6Baffle	35.886406	105.010469	33.33
NAWCA6ORD	35.892008	105.014389	4.15
NAWCA7AORD	35.891312	105.01359	5.33
NAWCA7Baffle	35.885604	105.010295	59.26
NAWCA7ORD	35.891733	105.014318	0.67
NAWCA8Baffle	35.884208	105.009613	33.33
NAWCA8ORD	35.891093	105.013335	5.93
NAWCA9Baffle	35.88369	105.009369	33.33
NAWCA9ORD	35.890583	105.013437	8.00
Grand Total			409.78



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Appendix 2. Project Photos



Figure 6. Bill Zeedyk and Amina Sena on the first constructed ORD, as part of an early training workshop.



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Figure 7. Construction of Juniper wood pole Baffle, built to induce meandering of bankfull flood flows.



Figure 8. Bill Zeedyk directing the height of the baffle pole as well as the spacing and angle of the structure.



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Figure 9. One Rock Dam structure built across the width of the bankfull channel on Wolf Creek.



Figure 10. ORD structure from the cross section view, to show the height and width of the ORD.



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Figure 11. ORD after three months of riparian wetland vegetation growth.



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Figure 12. Baffle structure to induce bankfull flows to erode the meandering bank and increase length.



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Figure 13. Site for a baffle to be constructed, prior to project implementation.



Figure 8. Constructed baffle, post project implementation.



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Figure 9. AWF volunteers constructing ORD structures across the bankfull width of the active channel.



Figure 10. AWF volunteers constructing ORD structures one rock high across the active channel.



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Figure 17. AWF volunteers wearing COVID safety masks but still getting hard work done.



Figure 11. Rich Pratt, from HPWA, working to restore the riparian vegetation of Wolf Creek.



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Figure 12. Amina Sena, member of HPWA, digging the cottonwood poles deep enough to hit the groundwater supplies of nearby Wolf Creek.



Figure 20. Volunteers from New Mexico Highlands University, helping construct small exclosure fences to promote successful regeneration of plated woody and herbaceous riparian species.



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Figure 21. Constructed inlet to Wheeler Lake that diverts all Wolf Creek flows in this straight channel.



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Figure 22. Wheeler Lake full of water in the background of the constructed inlet channel.



Figure 23. Bill Zeedyk assessing for future restoration treatments surrounding Wheeler Lake and the inlet and outlet channel that currently diverts all of Wolf Creek.