Restoration of Rare or Declining Natural Communities:
Zeedyk Structures for Riparian Areas and Wet Meadows

Conservation Practice 643 - Specification Sheet

Client:		**Date:**	
Location:		**County:**	
Contract #:		**Tract/Field:**	
Planner:		**Acres:**	

Practice Description

Zeedyk structures are low profile, hand-built treatments made of rock or wood intended to restore hydrologic and ecological function of wet meadows and small streams impacted by head-cutting, gully erosion, and channel incision. The structures help to slow and disperse water, dissipate energy, capture sediment, and increase soil moisture thereby promoting mesic and wetland plant species expansion that prevents further degradation and fosters channel recovery. Typical installation requires multiple structures to achieve desired effects within a reach.

Site Conditions/Objectives

Reach ID	Length	Baseline Conditions	Management Objectives	Success Criteria
Old Cabin	*1000 ft*	*2 ft high headcut lowering water table. Wetland vegetation shifting to upland species in meadow.*	*Stop headcut progression. Preserve 5 ac meadow upstream. Raise bed elevation and water table of incised channel downstream.*	*No change to 10% increase in sedge and rush cover immediately upstream of headcut. Sediment capture elevates bed by 1 ft at ORD.*

Treatment Specifications

Reach ID	Structure No.	Structure Type	Dimensions (ft) (L x W x H)	Materials	Site-Specific Notes
Old cabin	*1*	*Zuni bowl*	*8x6x1*	*1.8 cu yds rock*	*Ensure the rock placement at headcut pour-over is flush with sod*
Old cabin	*2*	*One rock dam*	*6x5x1*	*1 cu yds rock*	*Top of dam should match height of inset floodplain upstream*

Materials, equipment, and staging instructions	(Provide detailed information on total materials and equipment required for the project. For example, 5 cu yds of angular rock from onsite will be collected to meet building needs, or reference rock quarry specs – Appendix 5. Hand tools needed include: shovels, picks, rock crib, etc. Also describe any specific details in staging this site for work, such as, number of smaller staging piles and location, access restrictions to delivery vehicles, sensitive areas where disturbance should be avoided, etc.)
Planned installation dates	(Insert planned installation dates and other timing guidance, such as, avoid disturbing vegetation during the primary bird nesting and brood rearing periods and abide by regulatory work window requirements)

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Permits, notifications, and stipulations	(List federal/state/local permits obtained and any notification requirements. Document additional stipulations or conservation measures required to comply with Conference/Biological Opinions/Reports)
Design drawings, plan maps, and additional notes:	See conservation plan map for location of structures. Also refer to attached appendices for standard structure drawings and installation instructions. Site-specific conditions may warrant minor modifications to structure designs to ensure proper function. Seeding not required if surrounding vegetation or seedbank is sufficient for regeneration of desired plants. Should re-vegetation be necessary, refer to appropriate practice specifications (612, 550, or 342).

Operation and Maintenance

At a minimum, structures will be inspected annually after peak runoff events. Typically, structure maintenance and repair is most important following the first runoff event before the structure has the opportunity to fill with sediment and be colonized by vegetation. Rocks or logs that have become dislodged or washed out should be replaced to ensure proper function. Minor adjustments to the original structure may be needed if it appears water is not flowing as desired or is causing unintended erosion. Because multiple structures operate as a complex within a reach, the failure of an individual structure may not be problematic if undesired impacts are not occurring and management objectives are still being achieved in the planned reach. By the third year, maintenance needs should be minimal.

The structures are designed to initiate restoration of natural processes but additional interventions are often necessary to slowly build incised channels back up to desired floodplain levels. As structures fill with sediment and vegetation, it may be desirable to plan a new project with additional structures on top of or near existing structures to further raise the water table and expand riparian and wet meadow areas.

CLIENT'S ACKNOWLEDGEMENT STATEMENT:

The Client acknowledges that:

a. They have received a copy of the specification and understand the contents and requirements.
b. It shall be the responsibility of the client to obtain all necessary permits and/or rights, and to comply with all ordinances and laws pertaining to the application of this practice.

Accepted by:/s/____ Date:____________

CERTIFICATION:

I have completed a review of the information provided by the client or have conducted a site visit and certify this practice has been applied according to NRCS standards and specifications.

Certified by:/s/___________________________ Job title:________________________________ Date:___________

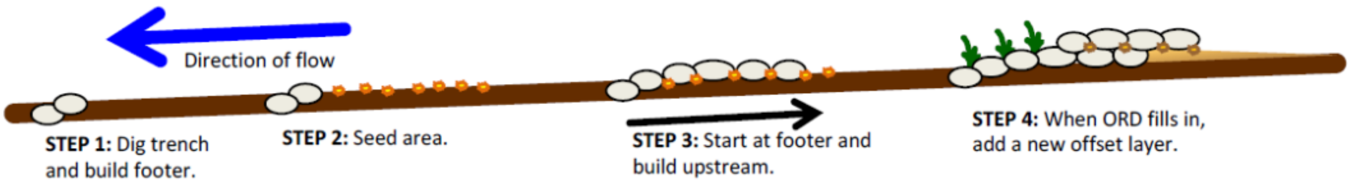
Appendix 1. One Rock Dam. Figure from Sponholtz, C. and A.C. Anderson (2013). Erosion Control Field Guide. Quivira Coalition and Watershed Artisans.

ONE ROCK DAM "ORD"

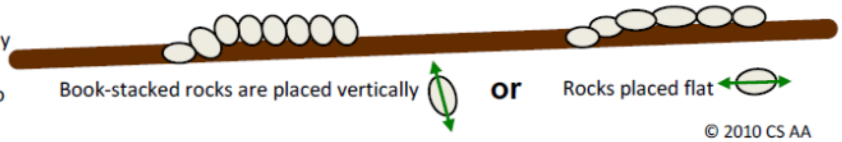
*A low grade control structure built with a single layer of rock on the bed of the channel. ORDs stabilize the bed of the channel by slowing the flow of water, increasing roughness, recruiting vegetation, capturing sediment, and **gradually** raising the bed level over time. ORDs are also passive water 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, as if you were building a horizontal wall on the bed of the channel.
4. Over time, the ORD will fill with sediment. Once completely filled, another offset layer can be added to the ORD to further raise the bed of the channel and capture more sediment. The original ORD becomes the splash apron for the new layer.

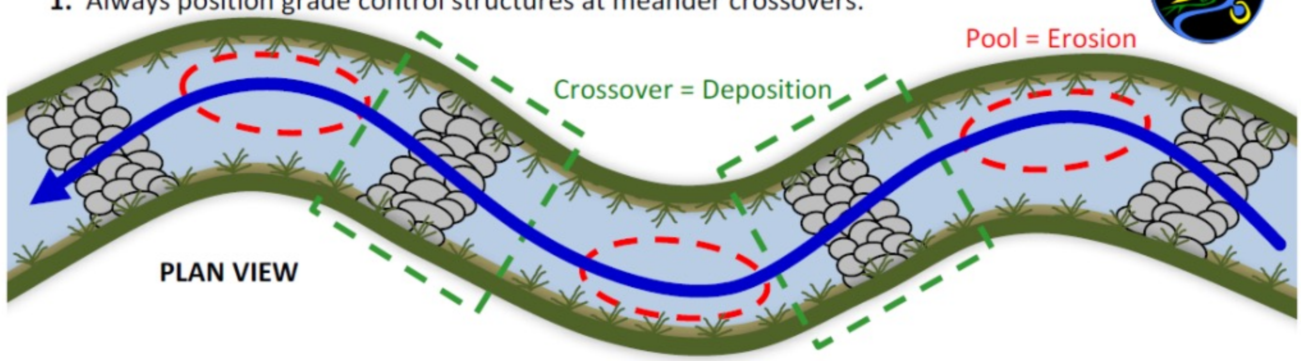


Orientation of Rocks: Placing rocks vertically is called book-stacking. This makes for a very strong structure, especially when using small rocks. It is also a good way to make a slightly taller structure.

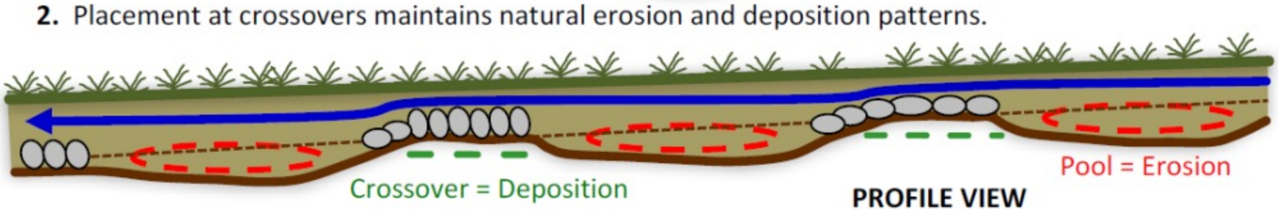


ONE ROCK DAM

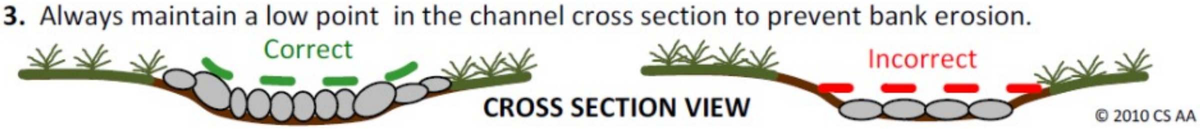
1. Always position grade control structures at meander crossovers.



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



3. Always maintain a low point in the channel cross section to prevent bank erosion.



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Example of a One Rock Dam. Photo from Gunnison Basin Climate Working Group.

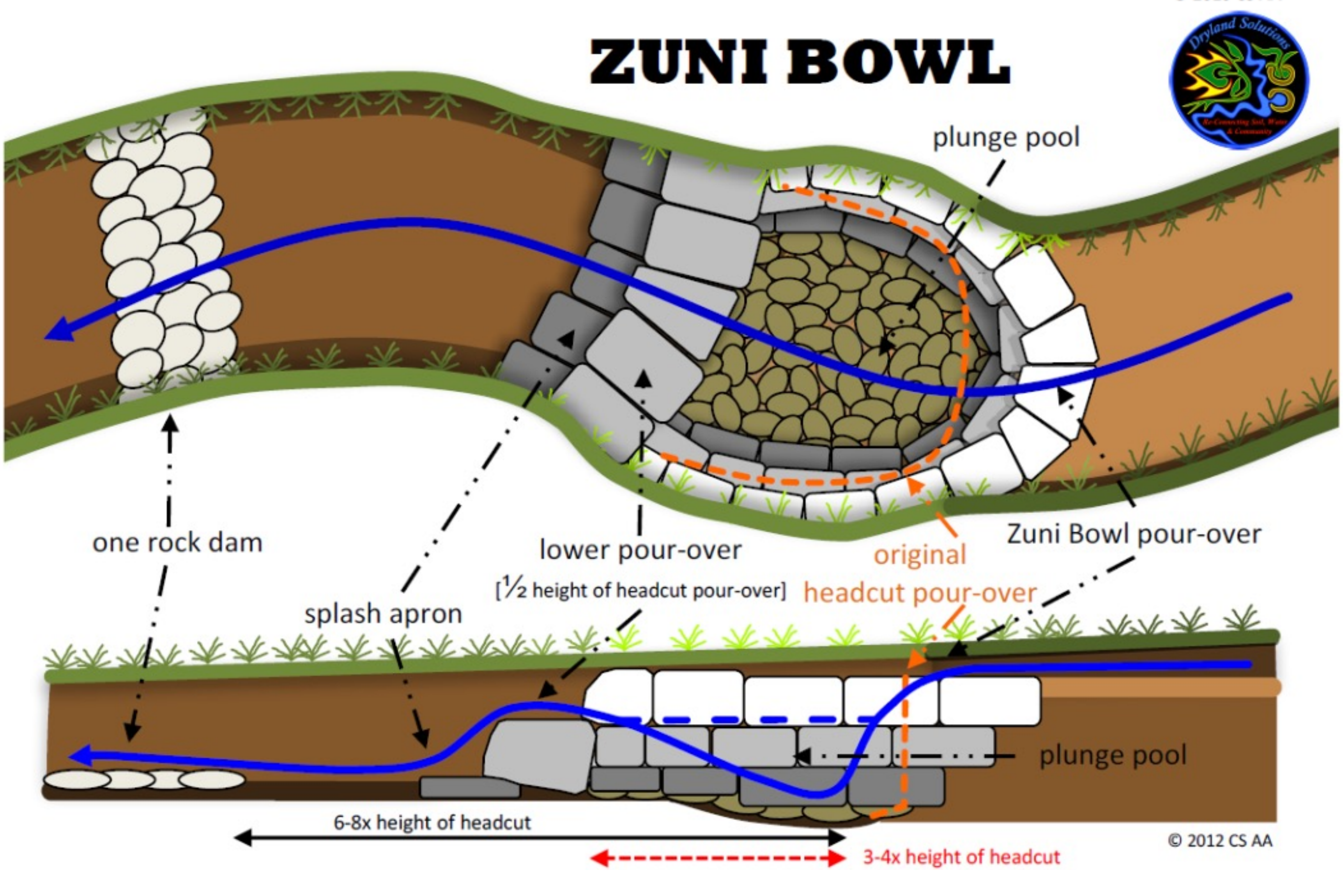
Appendix 2. Zuni Bowl. Figure from Sponholtz, C. and A.C. Anderson (2013). Erosion Control Field Guide. Quivira Coalition and Watershed Artisans.

ZUNI BOWL

An in-channel headcut control structure composed of rock-lined step falls and plunge pools that prevents headcuts from continuing to migrate upstream. Zuni Bowls stabilize actively eroding headcuts by dissipating the energy of falling water at the headcut pour-over and the bed of the channel. The structure converts the single cascade at an eroding headcut into a series of smaller step falls. Zuni Bowls also serve to maintain soil moisture on the face of the headcut, encouraging the establishment of protective vegetation. Original concept developed by the people of Zuni Pueblo and Bill Zeedyk.

Design & Construction

1. Select a headcut for treatment. Shape and layback the face of the headcut to create a uniform surface on which to build.
2. Determine the height of the headcut. Next measure and mark the location downstream from the face of the headcut that is three to four times (3-4x) the height of the headcut. At this location dig a shallow trench 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 Zuni Bowl.
3. Scatter native grass and wildflower seeds in the area where the Zuni Bowl is to be built.
4. Gather the largest rocks available, and place them in a row just upstream from, and in contact with, the splash apron. These rocks should sit at an elevation approximately ½ the total height of the headcut. This will serve as the ***lower pour-over*** of the Zuni Bowl. Use keystones on the pour-over whenever possible.
5. Armor the bottom of the ***plunge pool*** with a single layer of rocks. Place these rocks at a uniform height to create a stable foundation for the rest of the Zuni Bowl. Smaller rocks may be used for this part of the Zuni Bowl.
6. Starting just upstream from the lower pour-over, lay courses of rock around the face of the headcut. This will form the walls of the bowl. Maintain contact with the shaped surface. The structure will have more integrity if built with layers of off-set rocks that form a sloping wall inside of the headcut, as opposed to merely lining the face with rocks. Improve the durability of the structure by avoiding gaps in the rock work. As an extra precaution, you can use biodegradable geotextile fabric to line the face of the headcut prior to laying down rocks.
7. Continue to lay courses of rock on the face of the headcut until you reach the height of the ***original headcut pour-over***. No rocks in the ***Zuni Bowl pour-over*** should protrude above this level to allow water to flow freely over the structure. Use keystones whenever possible.
8. Construct a ***ORD*** downstream from the Zuni Bowl. Place the upstream edge of the ORD approximately six to eight times (6-8x) the height of the headcut away from the Zuni Bowl pour-over.



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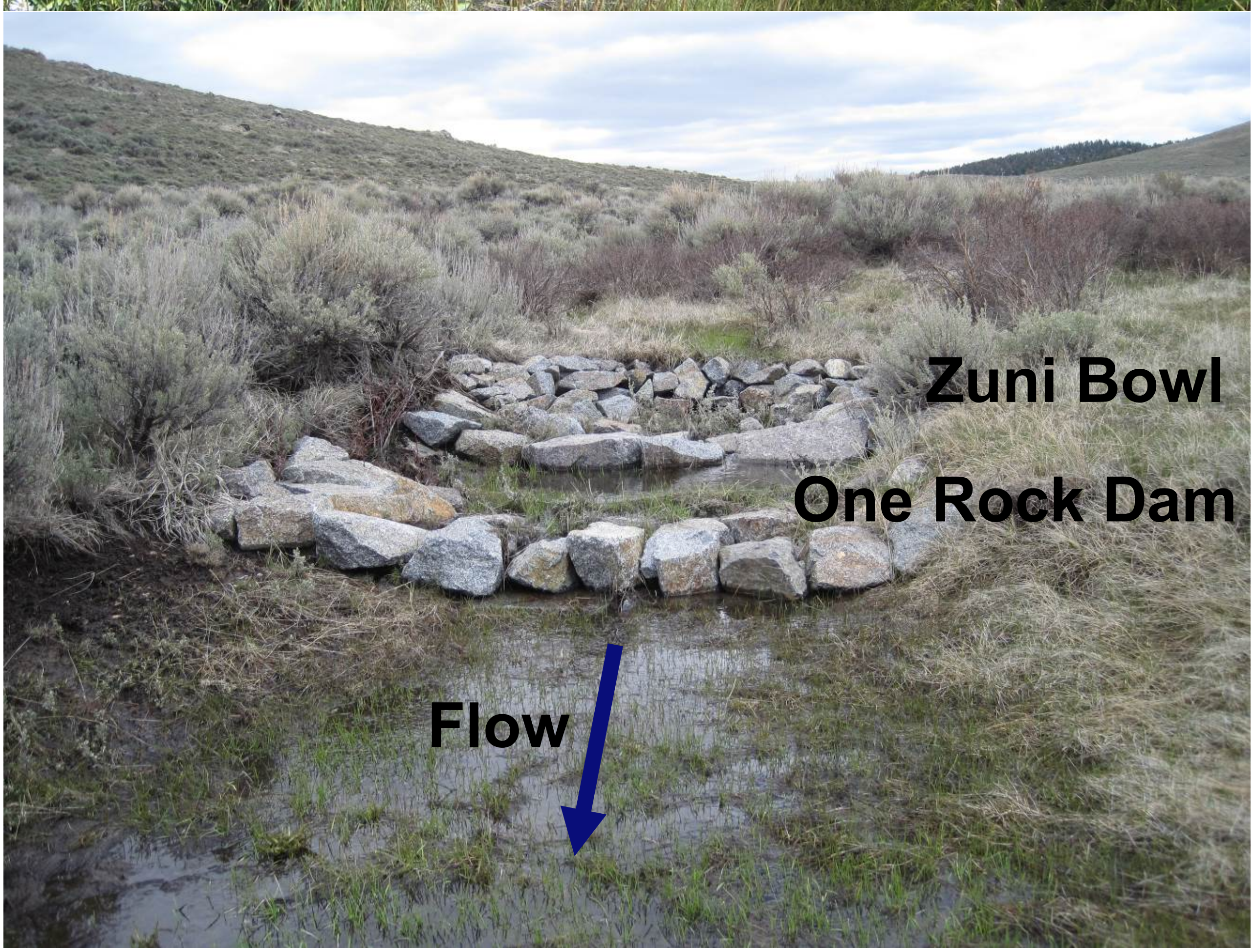
Example of a Zuni Bowl. Photo from Gunnison Basin Climate Working Group.



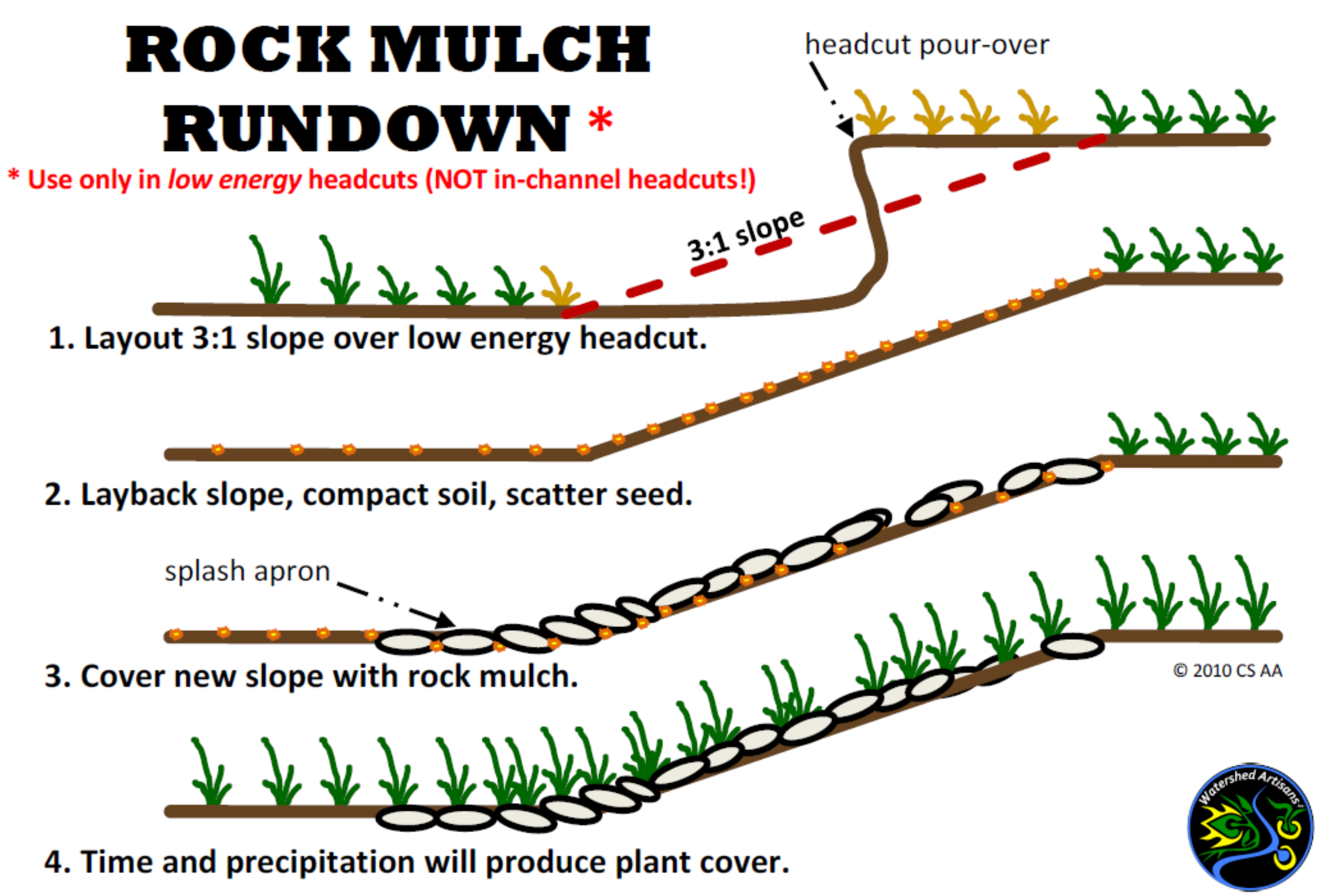
Appendix 3. Rock Rundown. Primarily applicable in low energy headcuts < 2 ft high. Figure from Sponholtz, C. and A.C. Anderson (2013). Erosion Control Field Guide. Quivira Coalition and Watershed Artisans.

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. 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 down rocks.



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Example of a Rock Rundown. Photo from Gunnison Basin Climate Working Group.

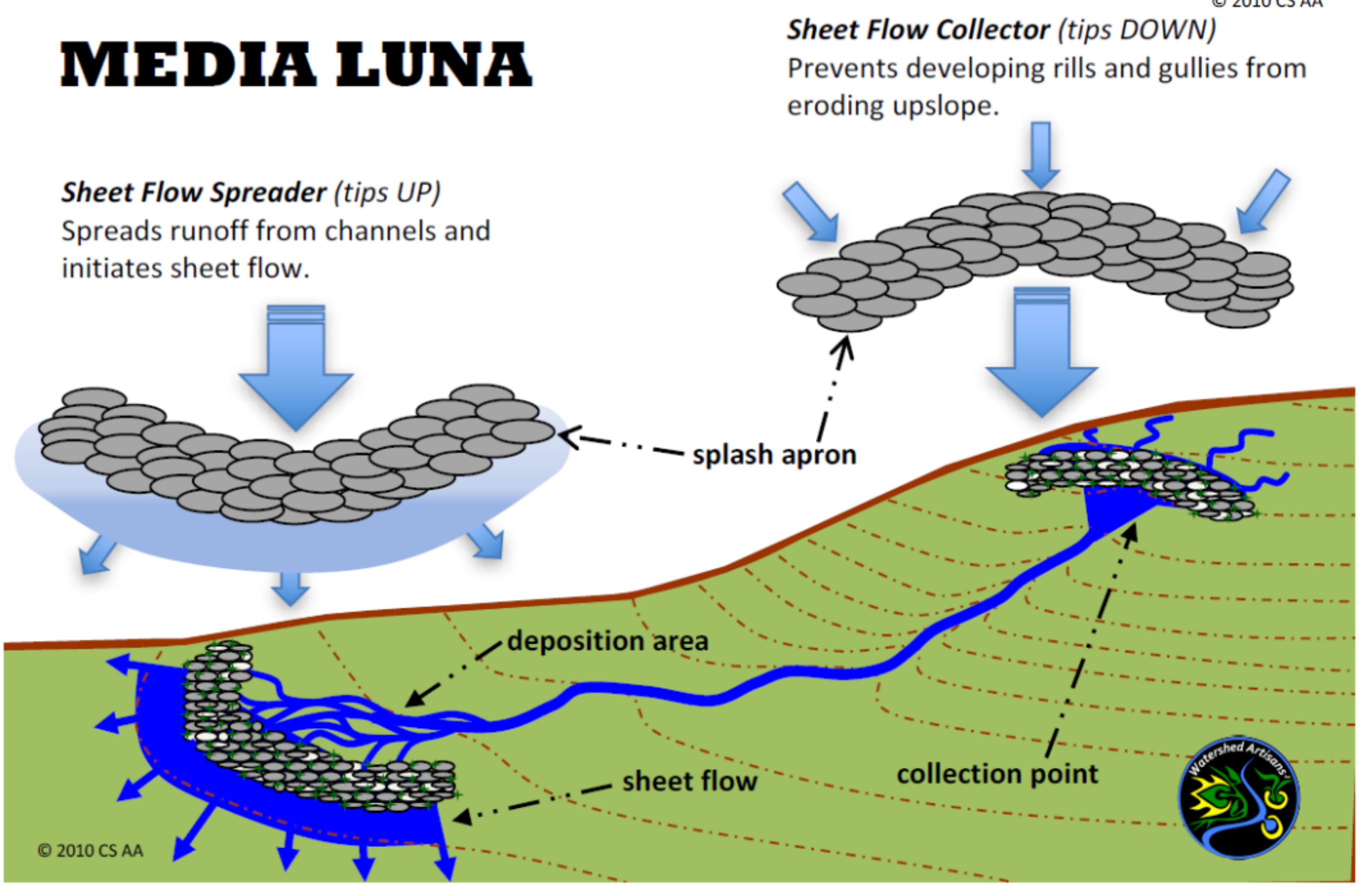
Appendix 4. Media Luna. Figure from Sponholtz, C. and A.C. Anderson (2013). Erosion Control Field Guide. Quivira Coalition and Watershed Artisans.

MEDIA LUNA

There are two types of Media Luna structures – both used to manage sheet flow and prevent erosion. "Sheet flow collectors" (tips DOWN) prevent erosion (small headcuts) at the head of rills and gullies by creating a stable transition from sheet flow to channel flow at the collection point. "Sheet flow spreaders" (tips UP) are used to create a depositional area on relatively flat ground by dispersing erosive channelized flow and reestablishing sheet flow where it once occurred. Original concept developed by Van Clothier.

Design & Construction

1. Identify which type of Media Luna ("tips UP" or "tips DOWN") is appropriate for the treatment site.
2. If the treatment site is at the collection point of a network of rills (< 6 in/15cm deep) or small channels (< 1 ft/30cm deep) then use a ***sheet flow collector*** (tips DOWN). First lay out the down-slope edge of the structure by selecting two points on the banks of the main channel immediately down slope from where the rills enter. Using a leveling tool, lay out a level arc from bank to bank so that the tips point down slope, and the arc spans all of the rills that you aim to treat.
3. If the treatment site is located where runoff from rills or a shallow channel can easily be spread across relatively flat ground, then use a ***sheet flow spreader*** (tips UP). First lay out the down-slope edge of the structure by creating a level arc across the flat area with the tips on a slightly higher contour. The tips should be far enough up slope that they prevent water from running around the ends of the structure.
4. Layout the up-slope edge of both types of Media Lunas by tracing a level arc parallel to the down-slope edge to create a band that is at least 3 ft/1m wide. Media Lunas composed of wider bands of rock mulch offer more protection from erosion, improved infiltration and increased plant recruitment.
5. Scatter native grass and wildflower seeds in the area where the Media Luna is to be built.
6. To construct the ***splash apron***, start by digging a shallow trench from tip to tip along the down-slope edge. Fill the trench with one to two rows of rock, so that no rock protrudes more than 2 in/5cm above ground level.
7. For both types of Media Lunas, continue construction on the down-slope edge (by the splash apron) and work up slope covering the ground with a single layer of rock mulch to form a band at least 3 ft/1m wide. The tops of the rocks need to be level to ensure proper function of the structure.



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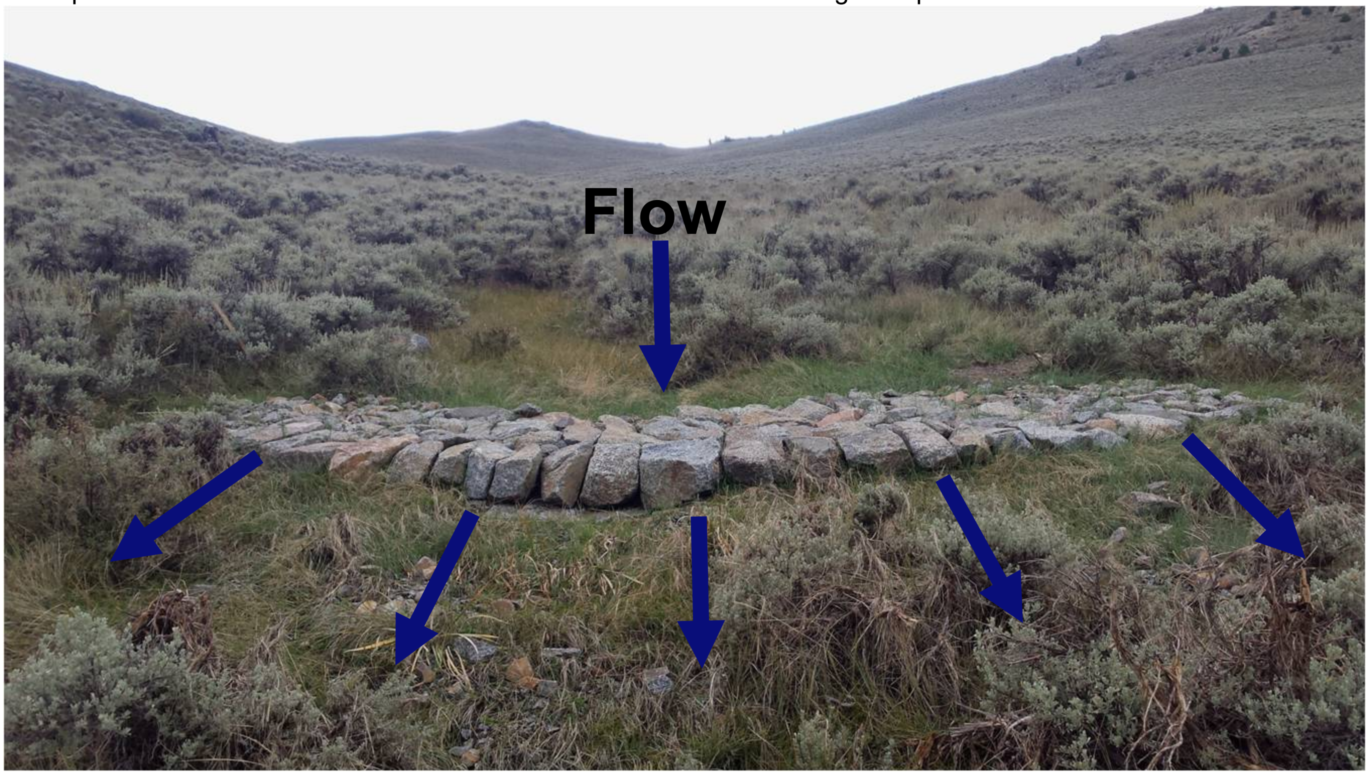
Example of a Media Luna. Photo from Gunnison Basin Climate Working Group.



Appendix 5. Log and Fabric Step Falls (Headcut Control Structure For Moist Soils). This structure is used to control headcuts advancing through wet soil areas such as wet meadows, springs, and seeps. The erosive action can be stopped if a healthy mat of wet soil plants can become established to hold the headwall in place. Text and figures from Zeedyk, W.D. and J. Jansens (2009). An Introduction to Erosion Control. Santa Fe, NM: Quivira Coalition. 3rd edition.

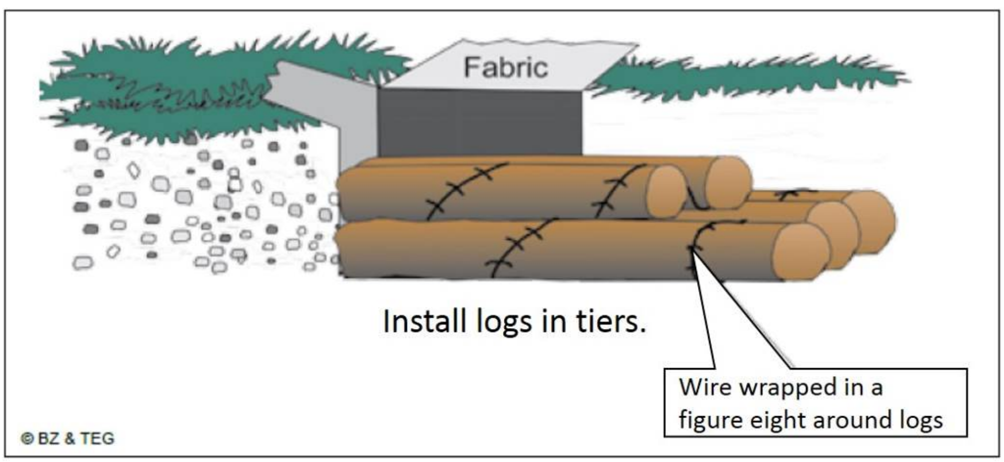
Materials Needed
1. Geotextile Fabric (silt fencing fabric in 3 foot widths works well and is convenient to use).
2. Logs: Logs 6 to 10 inches in diameter and varying lengths from 4 to 8 feet long. (For example, bottom tier, 8 feet long, second tier, 6 feet, third tier, 4 feet.) Logs should be straight, trimmed and green, or seasoned, but not rotten. Any protruding knots, limbs, or knobs make stacking very difficult and should be trimmed.
3. Wire: one roll of smooth fencing wire or barbed wire.
4. Fencing staples: 2 inches long, about 2 lbs.
5. Sod clumps: 6” X 6” X 3”. Dig locally.

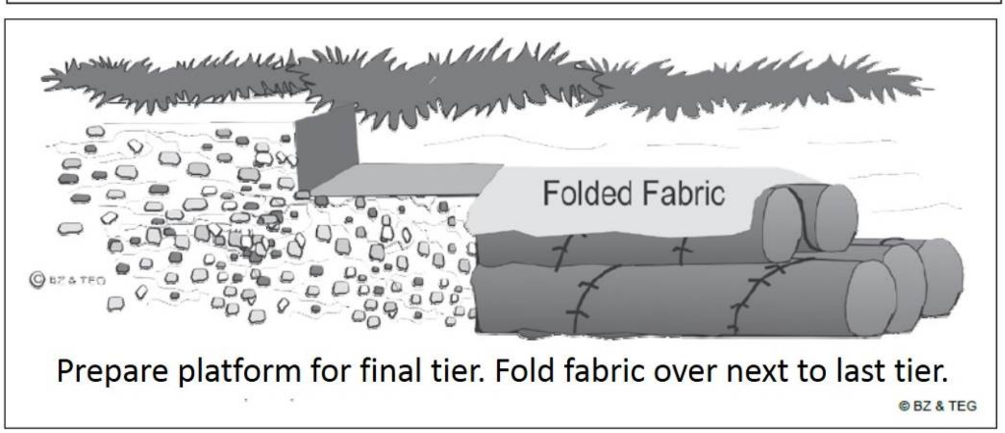
Tools Needed
1. Shovel (for digging)
2. Pick (for squaring sidewalls)
3. Crowbar (for wedging logs together)
4. Axe (for cutting roots, trimming)
5. Utility knife (for cutting fabric)
6. Claw hammer (for driving staples)
7. Fencing pliers (for cutting wire)
8. Wheel barrow (transport logs, tools, materials)
9. Log carrier (optional – for lifting, carrying logs)

Construction Steps:
1. Prepare the site by “squaring up” the headwall, sidewalls, and bottom of the channel. Eliminate the scour pool and any irregularities (rocks, roots, or indentations) in the channel bottom, sidewalls, or headwall. Use a shovel, spade, pick, or crowbar to shape the site. Save and stockpile sod clumps of wet soil grasses and sedges for use in the final step.

2. When preparation is finished, cut and drape geotextile fabric across the headwall, sidewalls, and channel bottom. Three pieces work better than one. The first should start about 2 feet above the lip of the headwall, extend down the headwall, and cover the channel bottom for 6-8 feet (the length of the bottom tier of logs). The second should be draped over one side wall and part way across the channel bottom. The third should be draped over the opposite sidewall in a like manner. Temporarily anchor the fabric in place by weighting the ends with rock or sod clumps. Once logs are placed, the extra flap of material will be folded back over the logs.

3. Install logs in the prepared site using as many tiers as necessary to stack them even with the lip of the headwall. (See Figures below). Logs within each tier should be of the same diameter; between tiers, they can be of different diameters. Logs in the bottom tier should be the longest; the top tier, the shortest. For example, if three tiers are needed, make the bottom tier 8 feet long, the middle tier 6 feet, and the top tier 4 feet long. It is important to wedge logs tightly against the face of the headwall and sidewalls. When all tiers are in place, fold the extra flap of fabric back over the top logs. Using smooth wire and fencing staples, wire each tier of logs together as you go. (Wire tier one logs before installing tier two, etc.) Tamp soil into any open spaces between fabric, headwall, and sidewalls.





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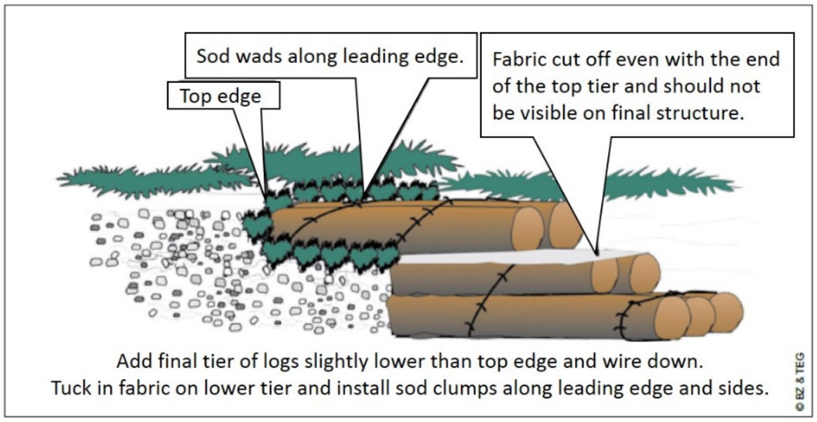
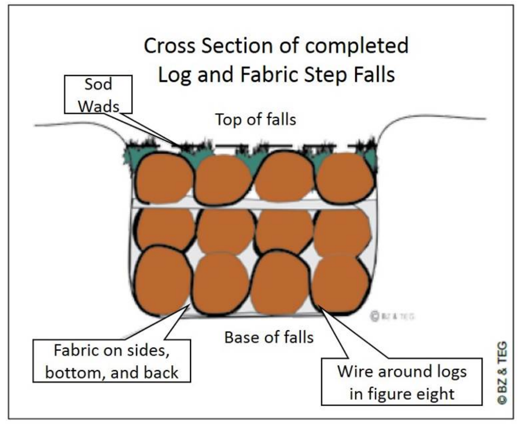
4. Working upstream from the lip of headwall, excavate a smooth platform level with the top tier of installed logs and one log-diameter wider on either side of the channel. The platform should extend at least 4 feet upstream from the lip of the headwall. Line the platform with the fabric extending out over the installed logs by 3-4 feet and upstream for 1-1.5 feet.

5. Using logs of equal diameter, install the final tier by wedging and tamping each log firmly in place (see Figure below). The logs should be long enough to extend about 2 feet downstream from the lip of the headwall. Wire this tier together and to the rest of the structure. Tuck the upstream flap of fabric in place along the leading edge (upstream face) of the logs in the final tier.





6. Transplant live green sod clumps of aquatic grasses, sedges, or rushes to the leading edge and sides of the final tier of logs. Completely fill any cracks or holes between the fabric and channel walls with live sod. **This is a key step.** The success of the log structure depends on your successfully establishing a living mat of wet soil grasses and grass-like plants along the upstream edge and sides of the structure.

7. After installation is complete, return to the site periodically (every 2-3 weeks initially, then less frequently) to fill any developing cracks or holes with fresh sod clumps until a healthy mat of vegetation is successfully established and no new cracks or holes develop.

Example of a Log and Fabric structure before and after installation. Photo from Gunnison Basin Climate Working Group.

Appendix 5. “Recipe” for sourcing rock for Zeedyk structures from quarries when on-site materials are insufficient. From Liz With, Shawn Conner, and Brooke Vasquez, Gunnison Basin, Colorado (2017).

Specification: The rip-rap rock mix for restoration structures shall be angular granitic rock between 6-18 inches (in length) with the following composition:

- 70-80% between 6-12 inches
- 10% should be 12-18 inches
- A small percentage (5-10%) should consist of gravel and rock fragments

Description: The recipe will slightly depend on the quarry the rock is being pulled from and the proportion of the size of the rock being blasted. You may need to adjust the ratios a little to get the rock right for your local situation.

70% of the material should be screened through a 6" grizzly (rock sorter with only vertical bars - see photo to right). This will allow mostly stuff less than 6" through. Then take the over-burden that was already screened off (so you minimize the amount of small stuff being added) and put it over a 1' grizzly for the remaining 30%. This will ensure that rock much larger than 1' will be removed. Since the grizzly only has vertical bars, there will be slightly larger material that is able to fit through on a smaller axis, but the majority of the materials delivered should be moveable by hand without the need for heavy machinery. It does mean sorting the material twice, which the quarry may charge an extra fee for, but it makes it worth it because all the rock delivered is usable and without much waste. This means that you are able to reduce hauling costs which, in most situations, is much more expensive than material costs.

Other considerations: The pits need to be weed free and as little dirt as possible should be hauled with the rock. If you are working on a steeper area or one with more water, you may want to reduce the amount of small rock and increase the large stuff to deal with the increased velocities. If you have a quarry that you know your producers will be working with regularly, it is more than worth it to take a trip out to that quarry and look at the material available and talk with the operator about what the project needs. Since these are natural materials, people have to deal with a lot of variability—it’s not like buying pipe. There is an increased need to ensure that the materials acquired are actually appropriate to completing the task at hand.

Before sorting

After sorting