Caring for Good Trails

A Field Guide for Trail Maintenance Volunteers in the Southwestern U.S.

Jan-Willem Jansens

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OTHER TECHNICAL FIELD GUIDES

This Technical Field Guide is presented to you by the Santa Fe Conservation Trust, based on an earlier version produced by Earth Works Institute. This is the fifth in a series of Technical Field Guides produced by Earth Works Institute between 2001 and 2011. Previous guides are *An Introduction to Induced Meandering*, *An Introduction to Erosion Control*, *Rangeland Health and Planned Grazing Field Guide*, and *Consumer Guide to Advanced Wastewater Treatment Systems in New Mexico*.

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Santa Fe Conservation Trust is a New Mexico nonprofit corporation dedicated to preserving the spirit of place among the communities of northern New Mexico by protecting open spaces and critical wildlife habitat, by creating trails, and by protecting the traditional landscapes of our diverse cultures.

Photographs in this document were provided by Earth Works Institute and Cynthia Lovely. If you reproduce a photo, please credit Santa Fe Conservation Trust and the photographer listed for that photo.

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INTRODUCTION

This technical field guide is designed for volunteer trail stewards in the Southwestern United States. The practices described here are the result of many years of work on watershed restoration and open space management in Northern New Mexico. The purpose of the document is to:

1. Enhance public interest in high-quality, sustainable trails that provide a great outdoor experience
2. Raise awareness of the characteristics of good trails, and
3. Offer guidelines for best practices for trail repair and maintenance.

This guide will be useful for workshops and field events that are intended to increase the public's knowledge of trails and reduce trail maintenance by making trails more sustainable. For this guide to be useful, we assume that trail managers have evaluated trail purpose, use, and management, and will lead and communicate trail repair and maintenance work accordingly.

We caution readers that this technical field guide does not provide guidelines for trail design. Proper trail design and installation require technical considerations that this document does not provide. Please consult the reference list in the back of this guide for in-depth literature on trail design and maintenance.

ENJOYABLE, HIGH-QUALITY TRAILS

This guide describes essential maintenance considerations for ***unimproved, single-track, backcountry trails for middle-elevation rangeland areas in the southwestern U.S.*** These backcountry trails are typically 12 to 18 inches wide and have often grown from traditional use or have been built for recreational purposes. The recommendations offered in this document apply in particular to trails in piñon/juniper-grassland ecosystems. Trails in mountain areas, forest lands, and wetlands, as well as trails specifically designed for use by mountain bikers or horseback riders, require additional considerations beyond those addressed in this publication.

The purpose of most single-track, backcountry trails is to allow hikers to enjoy the outdoors in this beautiful part of the world. The design, layout, and quality of the trail are important for people's outdoor experience, as well as for the level of trail maintenance that will keep it functional and enjoyable. No official trail building and maintenance standards exist for this region. However, over the last

few decades many trail and outdoor enthusiasts have accumulated trail building and maintenance experience, which has led to a sense of agreement about general principles and techniques that may guide us in creating and maintaining enjoyable, high-quality trails in the Southwest.

Trails bring people closer to nature. In addition, they may instill in people the desire to protect the environment and seek ways to play a role in hands-on care and protection of the splendid backcountry of the Southwest. We hope this publication appeals to an emerging group of experienced volunteers, young "green collar" workers, and members of outdoor conservation groups who support communities in their goals of having enjoyable outdoor experiences.

Figure 1. A well-designed and maintained trail, which has a gentle slope and is able to shed water. (Photo: Cynthia Lovely)

TRAIL DESIGN AND MAINTENANCE PRINCIPLES

When maintaining or repairing backcountry trails it is important to take into account how the trail was designed and laid out in the terrain. Often, trail locations are not ideal and trail easements are not designed exclusively for trail quality. A review of some key trail design principles may help us anticipate the need for recurring repair and maintenance when a trail deviates from these principles.

- Avoid building trails in or immediately adjacent to areas that are
    - Highly erodible, have steep slopes, and/or are susceptible to avalanches or landslides
    - Susceptible to periodic wind erosion
    - In floodplains, riparian areas, arroyos/ephemeral streams, or wetlands
    - Susceptible to heavy snow accumulation
    - Sensitive for wildlife conservation
    - Archaeological sites and/or culturally and historically sensitive sites
    - Hazardous (for example, areas that are highly prone to wildfire, abandoned or operating mines, and logging sites)
- Enhance public safety by designing and maintaining trails to
    - Optimize sight lines at trail intersections, sharp curves, and visual terrain obstructions (rocks, branches, logs, etc.)
    - Minimize crossing roads and driveways
- Enhance trail enjoyment by
    - Following the natural flow of the landscape
    - Guiding the trail along remarkable terrain features, natural passageways, edges, and view points
- Minimize the need for trail maintenance (i.e., optimize trail sustainability) by
    - Heeding the recommendations listed above, as they will encourage people to stay on the trail without creating shortcuts and alternative trails
    - Keeping trail width to a minimum (18 inches or less)

- Keeping trails outsloped to promote optimal shedding of stormwater runoff and snowmelt
- Following a rolling contour profile and with a trail grade less than 15%
- Maintaining a full bench trail that is well compacted on the entire tread and backslope (see Figure 1)
- Passing trees or rocks on the uphill side, so that the tree roots or rock serve as a solid footer and visual anchor to the trail tread

Avoidance areas are susceptible to negative effects from trail use and may cause harmful effects to trail quality and enjoyment. In many cases it would be expensive and impractical to perform ongoing maintenance to reduce the impact on trails in these conditions. When there are cultural/historical sites, wetland sites, or wildlife sighting opportunities, it may be desirable for the trail user to walk through or near these areas. However, land managers may prefer to protect these sites from the effects of trail use. Trails should be routed through or adjacent to such special areas only when the landowner agrees and when there is an opportunity to inform trail users of the special features of these areas.

Educating the public about these special areas can be a great way to teach people to prevent trail use from damaging sensitive sites while improving trail safety and enjoyment. Pruning and thinning vegetation can enhance views of peaks, trees, rock formations, and scenic views while keeping trails open and accessible, which will also benefit trail safety and enjoyment.

In many cases, the most appropriate, long-term fixes may involve the closure and rerouting of problematic trails. Additionally, land managers or landowners may consider certain terrain management options, such as temporary use restrictions for trails or land use changes to adjoining areas.

In addition, public education on "Leave No Trace Principles" and "Trail Etiquette" will build a sense of community while changing user behavior, which will enhance people's safety and enjoyment of trails while reducing trail repair and maintenance needs. A summary of Leave No Trace Principles is included on the back of this document.

COMMON TRAIL PROBLEMS

We can learn much from reviewing common trail problems that require ongoing repair and maintenance. The following photos show some of the consequences of ignorance and poor maintenance regarding drainage, maintaining sight lines, and so on.

Figure 2. A poorly placed trail located in a natural depression, which has turned the trail into a drainage channel and formed a gully. (Photo: Earth Works Institute)

Figure 3. An example of poor brushing. It would have been better to remove this tree entirely. (Photo: Earth Works Institute)

Figure 4. Vegetation restricts sight lines along this trail. Vegetation removal can create adequate visibility, remove dead wood, and open a trail corridor with adequate width. (Photo: Cynthia Lovely)

Figure 5. Trails through wet terrain typically lead to a braided trail system with significant impact on the land. (Photo: Cynthia Lovely)

Figure 6. A berm of dirt or rock prevents water from running off the trail. Instead, water will run down the trail, eroding the tread and creating a U-shaped trail profile that increases tread erosion. (Photo: Cynthia Lovely)

Figure 7. Trails that are not outsloped in drainage areas will allow water to accumulate. Outsloping and removing berms will minimize puddles. (Photo: Cynthia Lovely)

MAINTAINING A SAFE AND SCENIC TRAIL

What can we do when repairing and maintaining trails to enhance their quality and people's trail experience? The most important maintenance techniques for high-quality backcountry trails include:

1. Brushing and grubbing: maintaining the trail corridor
2. Tread maintenance
    - Outslope restoration
    - Full bench tread construction
    - Slough and berm removal
    - Backslope adjustment
3. Drainage features and erosion control
4. Closure and obliteration of undesirable trails
5. Naturalization of the work area

1. Brushing and Grubbing: Maintaining the Trail Corridor

The first thing you should do when building or maintaining a trail is to clear the "trail corridor," the space through which the trail will pass. This area includes the trail tread and the area above and below the trail that is affected by trail construction. Maintaining the trail corridor includes:

- "Brushing" – Removing fallen trees, branches, shrubs, cacti, yuccas, and other bushy or spiny vegetation, and
- "Grubbing" – Removing boulders, rocks, and piles of dirt

Brushing and grubbing may need to take place annually. Brushing and grubbing make it possible to walk or ride on the tread, to gain access along the tread for other maintenance work, and to maintain clear lines of sight along the trail.

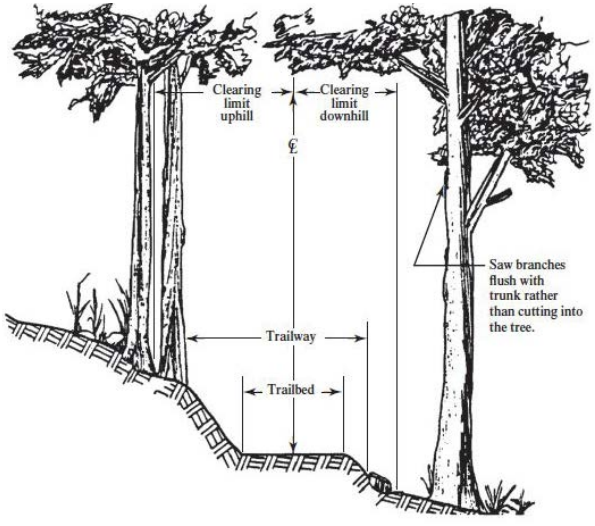

Illustration 1. The appropriate brushing area of a trail. (Source: US Forest Service)

The types of use, desired trail experience, anticipated frequency of maintenance, required sight lines, and terrain conditions determine the height and width of the trail corridor. In the Southwest, where plant growth is slow, clearing dimensions are not as great as in other parts of the country. Local land managers will be able to provide you with trail objectives and standards for trail corridor dimensions as well as for the kinds and sizes of vegetation that you should leave in place.

Brushing, Grubbing, and the User's Trail Experience

The way in which you brush and grub contributes greatly to the user's enjoyment of the the trail. Leaving certain characteristic rocks, trees, shrubs, cacti, and yuccas may in fact lead the trail tread to curve around them in a more natural way than if they were removed. These rocks and plants then become visual anchors for the tread alignment. Leaving a rock or a tree immediately below the downhill side of the trail will help stabilize the tread. The choice to keep certain plants in place may also help accentuate turns, deliberately hide nearby trails or objects, manage the speed of users, and improve the ambiance of the trail's surroundings. Conversely, removing vegetation may create certain desirable sight lines, views, and openings that create a diverse experience of the trail environment. Removing vegetation on one side of the trail may accentuate an edge effect in the landscape, while trimming vegetation selectively on both sides may create a gateway, both of which may highly improve the trail experience at certain special locations.

It is important to maintain a natural look within the brushed area. Brushing and grubbing should be minimal to achieve the desired effect of making the trail passable. You should avoid straight lines of clearing. If you cut trees and bushes immediately along the trail, you should cut them flush at ground level. You can blend in freshly cut stumps with the terrain if you cover them with duff (needles, moss, and decaying plant matter).

Keep the following tips in mind when brushing and grubbing:

- You can leave rocks and limbed trees on the lower edge of the trail to prevent hikers from walking the outer edge of the tread and to keep the tread in place.
- Brushing the uphill side is more important than the lower side of the trail! On steep slopes, you should cut back logs, branches, and other protruding vegetation material to allow people to walk the higher side of the trail as long as possible and avoid "trail creep," the gradual migration of the tread downhill onto fill material and steeper ground. Cutting a little higher and wider may keep the trail clear a bit longer and reduce the need to return for brushing work in the next year or two.
- Cut limbs flush with the stem, just outside the bark collar – the spot where a branch joins the tree. When trimming large tree branches, always make a small undercut first before cutting from the top to avoid peeling off a protective strip of bark when the branch falls.
- When dealing with fallen or leaning trees, consult or hire an experienced logger or technician. You will need training and experience to use chain saws, and to deal with these kinds of situations in a safe manner. If the log is stable, limb the log as best as you can or limb it when it is down on the ground to allow it to decay faster.

You should use brushed and grubbed material for erosion control or dispose of the material downhill, away from the trail corridor. The uses of cleared brush for erosion control may include:

- Contour layering of logs and thick branches on steep sections of slope downhill from the trail (but not across gullies or drainage paths!) to slow stormwater runoff
- Placing branches lengthwise in rills and small gullies with the butt end uphill to slow the flow in the gullies and encourage the smaller branches to impale themselves in the wet, soft gully bottom, which stabilizes the branch and accumulates debris and sediment over time
- Covering open, exposed soil with small branches that are trampled down in a way that they do not stick upward more than one foot. This will create a microclimate underneath the brush that will encourage grass regeneration and infiltration of precipitation.

2. Tread Maintenance

The trail tread is the travel surface of the trail: where shoes, tires, and hooves meet the path. Trail construction and maintenance requires creating (or recreating) a solid, sustainable tread. If you follow the principles mentioned above, such as locating trails on contour, making the trail gently roll with the terrain (so-called "rolling contour" trails), building on solid ground, and outsloping the tread, then it is easier to create a solid, sustainable tread.

Figure 8. This is an example of a well-brushed trail with good visibility, an interesting "gateway" passage through vegetation, and an outsloped trail tread for optimal drainage. (Photo: Earth Works Institute)

Outslope Restoration

An outsloped tread is lower on the outside (downhill) side of the trail than on the inside (uphill or bank side). Outsloping allows water to flow naturally across the trail. You should outslope the tread by at least 5%. Loss of outslope is probably the most common trail maintenance problem. **Restoring outslope is often the most important maintenance technique that you will perform if budgets (time or labor) are limited.** Maintaining or restoring outslope includes removing "slough" and "berms" (see below) and sometimes adjusting the backslope. It may also include the removal of roots and rocks, constructing drainage features, restoring the tread up the hill, or minor rerouting of the tread upslope above trees.

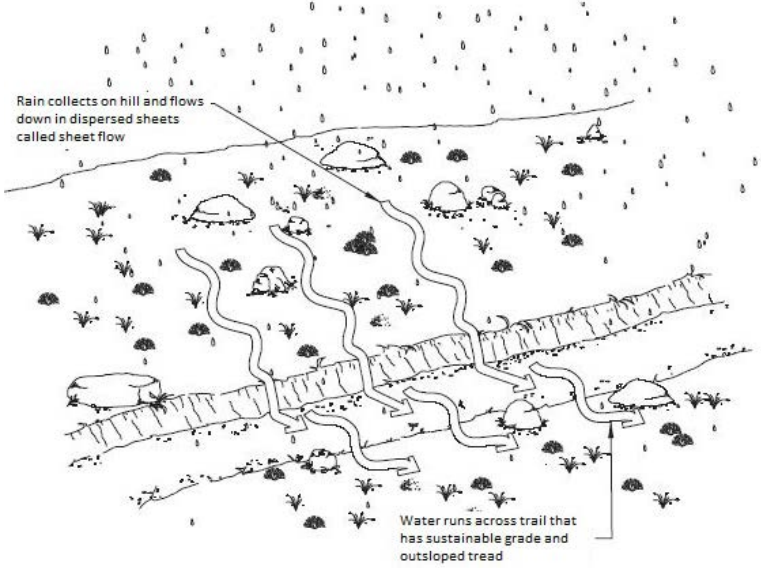

Illustration 2. An outsloped tread has the capacity to move sheet flow across a trail without collecting water. (Source: US Forest Service)

Full Bench Tread Construction

In order to place the trail on more stable ground, it is often preferable to construct trails with a "full bench." You can construct a full bench trail by cutting the full width of the tread into the hillside. Cast the excavated material as far as possible downhill or cart it off for use in drainage structures or fill for retaining walls along the trail. Full bench construction requires more excavation and leaves a larger backslope than partial bench construction, but the tread will be more durable and will require less maintenance.

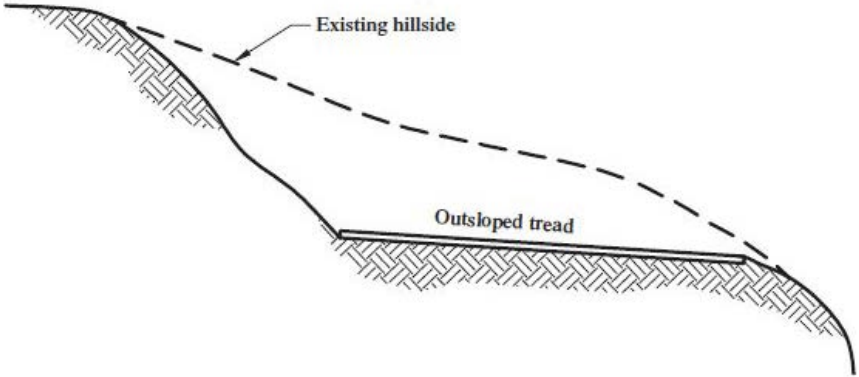

Illustration 3. When constructing a trail, be sure to grub it so that the tread is outsloped. (Source: US Forest Service)

Slough and Berm Removal

Over time, most trails tend to get hollowed out as a result of compaction, soil displacement to the sides, and soil erosion due to water flow down the tread. Slough (pronounced "sluff") is debris such as soil, rock, and silt on the inside of the tread; berm is debris built up on the outside of the tread. The accumulation of these causes the tread to have a U-shaped profile, which narrows the walkway. A berm forms a barrier that prevents water from flowing off of the trail because the tread is no longer effectively outsloped.

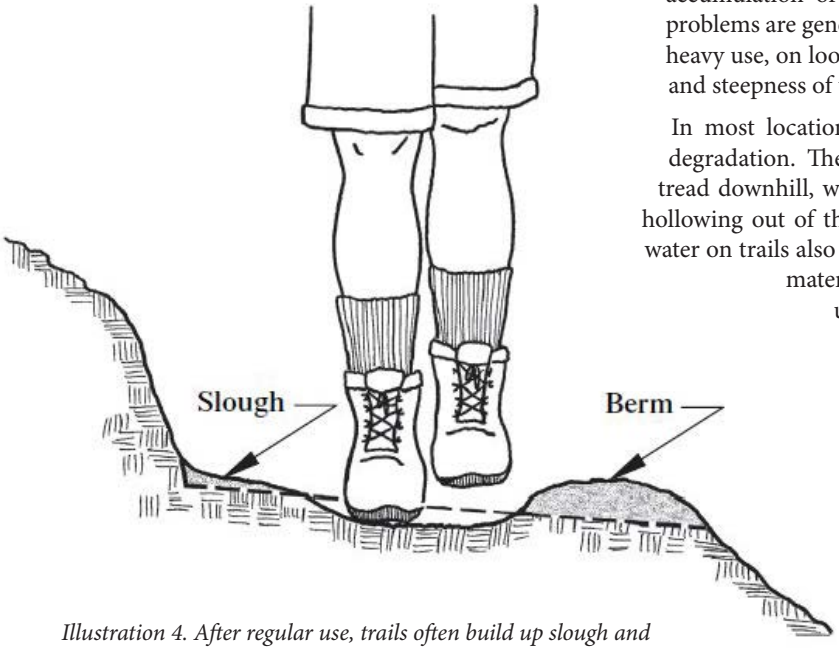

Illustration 4. After regular use, trails often build up slough and berm, which can lead to erosion problems and puddles. (Source: US Forest Service)

Both slough and berm can become overgrown with vegetation. The accumulation of slough can lead to tread creep. Slough and berm problems are generally more pronounced in steep terrain, on trails with heavy use, on loose or unconsolidated soils, and with increasing length and steepness of the slope above the tread.

In most locations, water flow is the most important cause of trail degradation. The effects of water include runoff following the trail tread downhill, which causes soil erosion on the trail and leads to the hollowing out of the tread and to trail surface irregularities. Too much water on trails also causes mud pools, erosion, and displacement of tread material to the sides (slough and berm). As a result, trail users tend to walk around these disturbed areas and create a widened tread, tread creep (downhill), or new side trails. This leads to more exposed soil surface and unimproved treads that may be on even more problematic ground, leading to more erosion.

You should loosen compacted slough with a mattock or Pulaski. After that, remove soil and rock with a shovel or McLeod. Then, broadcast the removed material downslope or use it elsewhere on the trail for the construction of drainage features. Finally, groom and compact the tread thoroughly, and naturalize the trail sides so the adjustments blend into the landscape.

While removing slough, it is best not to disturb the backslope. However, if the backslope is unstable, you may want to adjust it to reduce the movement of debris downhill and the renewed accumulation of slough.

You remove berms in a similar way as slough. Finally, you must reshape the tread to recreate a 5% outslope, and then compact and naturalize the tread and excavated berm area. Make sure that the tread does not cover any fill material on the outside of the slope. This material is often too loose to support a solid tread. If the tread is too narrow, readjust the backslope by widening the trail on the inside, cutting more into the slope (see below) or rerouting the trail above rocks or trees that form barriers for tread width on the inside.

Backslope Adjustments

The backslope is the excavated, exposed area above the tread surface. The backslope should match the "angle of repose" of the parent material (i.e., the angle at which the parent material is naturally stable under the influence of gravity; for example, this may be 1:1, meaning one foot vertical rise over one foot horizontal run). When the backslope of the trail is too steep (i.e., exceeding the angle of repose), rock or soil material will naturally slide or roll down and accumulate as slough on the trail. Trail users tend to avoid the slough and walk the outside of the trail, which leads to tread creep. In turn, this will lead to poor and potentially hazardous trail conditions.

You must make sure to lay the backslope to the angle of repose until it is unlikely that material will slide down onto the trail tread. In areas where this is not possible, you should relocate the trail, build a retention wall, or cut the trail bench so far into the slope that it reaches a stable rock face. In any case, you must compact the constructed backslope (ideally with application of some water) with the use of a tamper or the flat backside of a McLeod. Make sure to also compact the point of transition between the backslope and the natural hill slope (called the "critical point") to prevent erosion from starting at this point and washing soil material down onto the slope. In some cases, revegetating or piling brush on the critical point may help stabilize steep areas.

It may be best to relocate a trail when it is impossible to create a full bench because the hill slope is too steep, there are too many obstacles, or there are pooling and erosion problems. Relocating a trail may ultimately be less work than frequently maintaining a poorly placed trail. A relocation or reroute of the trail is a short section of newly constructed trail, accompanied with the closure, obliteration, and terrain reclamation of the failing trail section (see below). A new, relocated trail section should follow the general trail-building principles described above.

Figure 9. Grubbing a new trail tread for a relocated section of trail. (Photo: Earth Works Institute)

3. Drainage Features and Erosion Control

Water on trails is the primary cause of trail degradation over time. **Keeping trails dry means keeping trails accessible and reducing the need for maintenance.** In areas where it is difficult or impossible to create an outsloped, rolling contour trail (and even along trails that are well designed), it is often necessary to install and maintain drainage features along the trail because a combination of compaction, soil displacement, and erosion will trap water on the tread.

In this section we will explain some of the most useful drainage features for backcountry trails in the Southwest. The conceptual basis behind all of them is the construction of a "grade reversal" – a short distance where the tread goes down and up again – to allow water to flow off the trail in the constructed depression across the tread to the lower part of the trail. In locations with severe drainage

problems it is best to relocate the trail over a short distance in order to build a grade reversal over 10–15 feet that "rolls" with the terrain. All these drainage features work effectively only if the trail has lower ground next to it where water can drain away.

Removing roots parallel to the trail tread will help keep the tread outsloped and prevent water from being trapped between roots and the backslope, which will lead to the creation of a rut that carries water downhill on the tread.

Knicks are outsloped depressions along the trail. You construct knicks in the trail by shaving down a semicircle 10 feet in diameter that is outsloped about 15% in the center in order to drain water to the lower part of the tread and further downslope. A knick should be smooth and subtle, so that most trail users won't notice its presence. Knicks are typically built on gentle sections of trail where water tends to puddle due to compaction, displacement of tread material, and lack of slope. Knicks also work well on well-draining, noncohesive soils, such as sand, pumice, and decomposed granite.

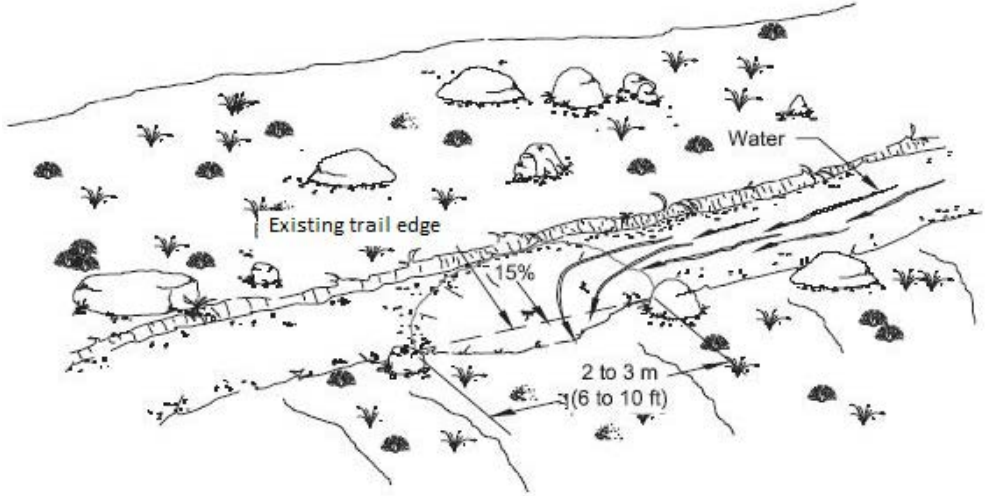

Illustration 5. A knick helps drain the trail tread at locations where water tends to puddle on the trail. (Source: US Forest Service)

Rolling grade dips are structures that you can use on sections of a trail that are steeper than areas where you would create knicks, but not on trails steeper than 12%. Rolling grade dips consist of a knick in the tread immediately followed downgrade by a long, gentle dirt ramp. Water running down the tread will not be able to flow over the rise of the ramp and will run down the center of the knick and off the trail. The diameter of the knick should be longer than the length of a bicycle (6–10 feet), while the length of the ramp should measure about 10–20 feet. The total length of the rolling grade dip depends on the steepness of the trail: the steeper the trail, the longer the ramp and knick. When creating a dip, it is important to avoid an overly steep ramp. Therefore, be sure the total grade of the tread, including the grade increase on the ramp, does not exceed 15%.

Figure 10. A well placed rolling grade dip (foreground) with a drainage path stabilized by rock. The blue arrows show the direction of water flow. (Photo: Earth Works Institute)

Proper placement of a rolling grade dip in a natural roll of the terrain will save time and effort in trail construction and maintenance. When building a rolling grade dip, you excavate the knick area and use the excavated soil to create the mound of the ramp. The ramp must be outsloped at 5% like the normal tread. The knick is outsloped 15% to facilitate rapid drainage and reduce the rapid accumulation of debris in the depression. You should construct rolling grade dips on straight, midslope trail sections and not in turns or at the top of a grade. You should not construct rolling grade dips where they might send sediment-laden water into streams.

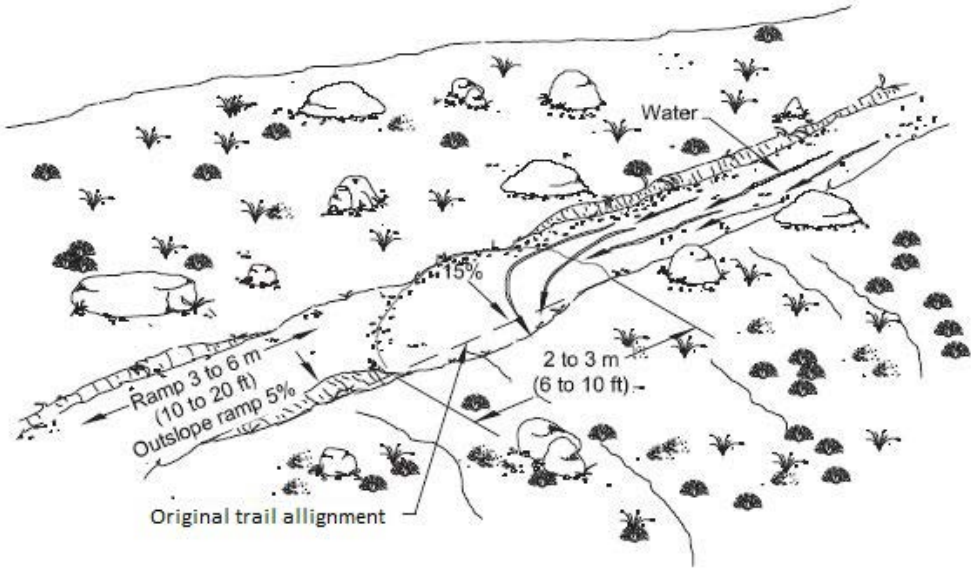

Illustration 6. A dip is similar to a knick but is more appropriate in areas with a steeper grade. (Source: US Forest Service)

Rolling grade dips require minimal maintenance such as removal of sediment and debris from the bottom of the knick every year or so. You can use this material to build up the ramp if necessary, or you can cast it aside down the slope.

Waterbars are simple drainage structures with an abrupt and short grade reversal in the form of a line of rocks or one or more logs that stick up above the tread and turn water off the trail. When possible, use local, native rock material. You should install waterbars at a 45-degree angle with the tread direction (pointing down the slope) and maintain the 5% outslope grade of the tread to shed water most effectively. You must key (or dig) the rocks or logs into the backslope of the trail and be sure they extend all the way across the trail to the outflow opening on the downhill side of the tread. The outflow opening must be wide and deep enough to allow water to flow away easily. When the soil is loose and erodible and the downhill slope is steep, it is necessary to armor the outflow with rock to prevent headcut erosion in the outflow.

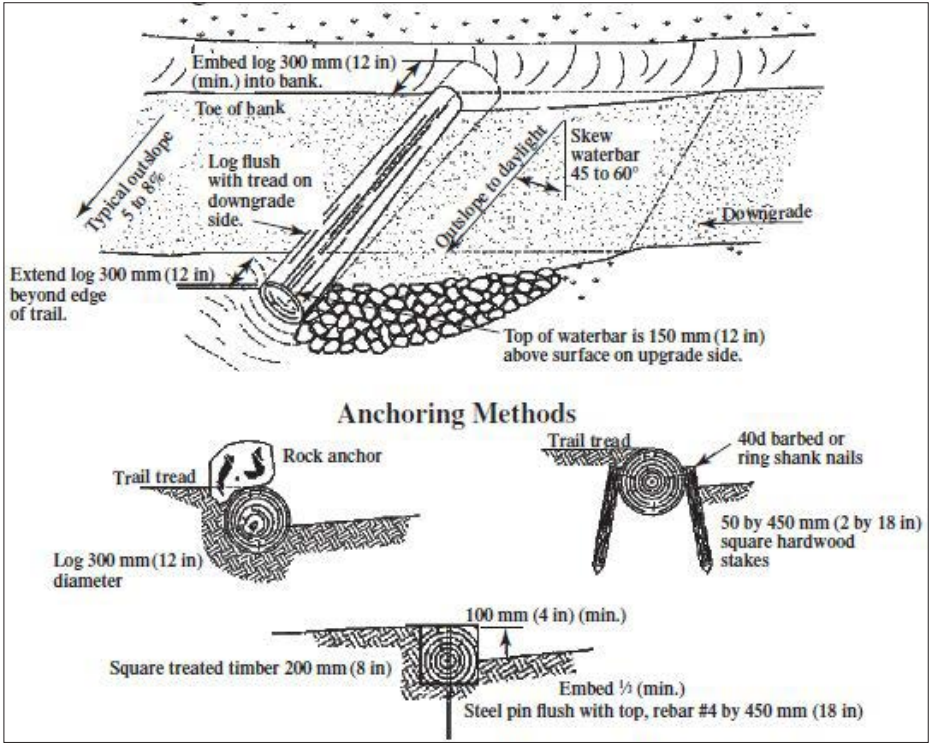

Illustration 7. A schematic showing proper log waterbar installation. (Source: US Forest Service)

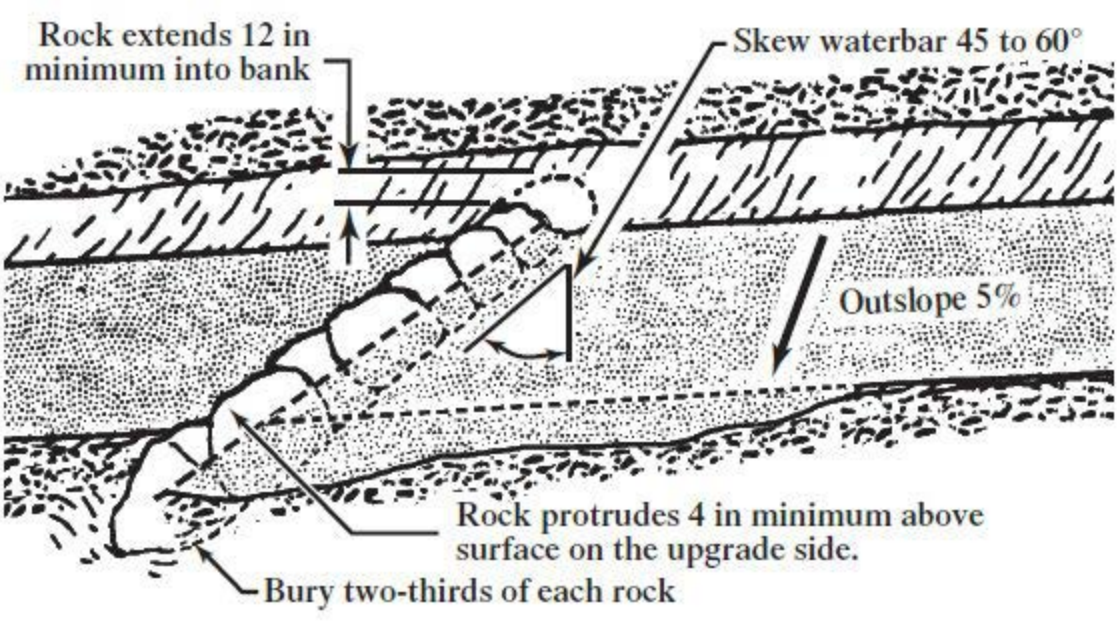

Illustration 8. A schematic showing proper rock waterbar installation. (Source: US Forest Service)

Figure 11. A well-built, effective waterbar. (Photo: Earth Works Institute)

Figure 12. The same waterbar as previous page, showing outflow protection. (Photo: Earth Works Institute)

Note that waterbars are less effective drainage structures than knicks and rolling grade dips. Heavy water flows tend to overtop waterbars, which you can only prevent by installing more of them at short distances. Outflows tend to clog up, leading to pooling of water and sediment above the waterbar. Alternatively, unprotected outflows may scour, leading to headcut erosion and a rut traveling up into the tread above the waterbar.

Figure 13. A failing waterbar. (Photo: Earth Works Institute)

In some cases, people use waterbars in a misguided attempt to fix trails that are too steep and poorly designed. Waterbars work best on slopes of less than 15%, on remote trails that don't see much maintenance and no bike use, and where use by horses and other pack animals tends to hollow out the tread. In such circumstances, properly installed waterbars serve to maintain the tread grade and interrupt the degradation caused by compaction, displacement of tread material, and erosion. In order to prevent horses from dislodging log waterbars, anchor the logs with rebar or replace them with rock.

Trail users dislike waterbars because they act as sudden bumps in the trail, which makes hiking and biking less enjoyable. As a result, trail users tend to go around waterbars, which further deteriorates the trail as a result of widening and trail creep. In addition, waterbars require frequent maintenance because they tend to silt up quickly.

Figure 14. A poorly functioning waterbar with puddling. (Photo: Earth Works Institute)

Figure 15. The placement of this waterbar causes trail users to walk around, widening the trail. (Photo: Earth Works Institute)

On steep trails (over 15%) and/or on extremely eroded and hollowed-out trails, the only solution to trail repair is to alternate waterbars with **risers** (a.k.a. check steps), using the same rock and log materials as in waterbars, to create steps that go straight across the trail. On hollowed-out trails, the tread should allow water to cascade down and then be guided off the trail by the next waterbar. On outsloped

trails, the riser should follow the same outslope angle as the tread. Risers that allow for a cascading water flow should be straight and smooth across the top to spread the water optimally across the width of the trail and minimize the scouring force of cascading water along one line on the tread. You must compact the tread well or embed it with a rock or log sill just below the riser to prevent erosion and undermining. You should be sure that the riser is entirely flush with the trail tread profile in order to prevent scour at the uphill side of the riser.

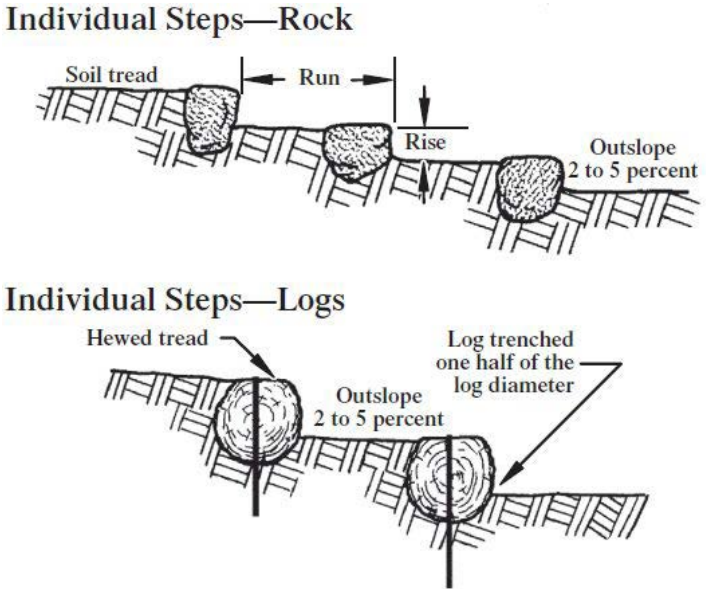

Illustration 9. Check steps for use in particularly steep areas. (Source: US Forest Service)

Figure 16. A rock step in a switchback helps scale the steeper grade at this location. (Photo: Earth Works Institute)

Figure 17. A log waterbar. (Photo: Earth Works Institute)

4. Closure and Obliteration of Undesirable Trails

Along poorly maintained trails and where the tread is seriously eroded, trail users tend to leave the trail and create alternate tracks that form a braided trail system. These social trails, cutoffs, detours, and parallel tracks widen the trail profile and expose more terrain to the erosive forces of shoes, tires, hooves, water, and wind. Such braided trail systems quickly lose their charm as trail users experience the cumulative effects of degradation.

Therefore, land managers and trail stewards should consider closing and obliterating undesirable trails. Public outreach and education must accompany trail closure and obliteration. The closure will be more effective if trail users understand how and why a trail is being closed. Group meetings may be useful to get feedback and spread the word. Finally, signs can help encourage people to use the newly built trail sections while promoting trail enjoyment and acknowledging the community effort that went into improving the trail experience. The bottom line is that the new trail must improve the overall trail experience in order to provide an incentive to users to use the new trail and not return to the closed and obliterated one.

The technical steps of the trail closure process include:

- Subtly blocking access to the trail by placing rocks, branches, or a log across the tread in a non-geometrical pattern that visually blends into the texture of the terrain
- Installing drainage features (see previous section), if necessary, on the transition point between the old and new trail as well as on the abandoned trail section to prevent water from flowing on the closed trail
- Disguising any visible parts of the closed tread by raking slough and fill dirt material from downslope onto the tread, covering it with leaves, duff, twigs, stone material, and other naturally available groundcover
- Planting or transplanting locally occurring tree and shrub seedlings and/or sowing local grasses and forbs in patches on and around the obliterated tread to close the old trail corridor and blend it into the surrounding landscape

- Naturalizing the transition: avoid grading and planting in lines and geometrical shapes, as this will continue to outline the shape of the former trail alignment. The tread alignment transition from the old trail to the new one must be natural and smooth, both visually and in the roll of the tread.

- Monitoring and touching up in following years to ensure that the closure is effective, blends into the terrain, and does not continue to erode.

5. Naturalization of the Work Area

At the completion of all trail restoration and maintenance work described above, it is essential to leave no lasting visible trace of recent work on the trail. The trail surroundings must appear as natural and undisturbed as they would look under healthy ecological circumstances. The finishing touches of naturalization of the work area include:

- Scattering the removed vegetation or dead plant material in a natural pattern downslope, preferably out of sight from the trail

- Reusing scraped and stashed topsoil in drainage structures or scattering it downslope

- Grading the surrounding terrain back to the natural terrain grade so that it does not show any signs of scraping or dirt piles. After grading, you should cover the area with local mulch material such as leaves, duff, twigs, branches, rock, and natural stone material so that it matches the landscape and prevents soil erosion

- Packing out materials, such as stakes, flagging tape or pins, bottles, cans, and any other objects foreign to the landscape

- Raking away tracks from boots, wheelbarrows, and hooves and covering the soil with local mulch

- Blending in the trail corridor so that the final product matches the landscape's visual structure and pattern

SAFETY PRECAUTIONS

Trail maintenance supervisors must encourage and enforce safe work habits and work conditions on the job for trail maintenance volunteers, practitioners, and passers-by. Safety rules for supervisors include:

- Review safety habits every day before work begins.
- Provide training, and if possible certification, for crew members.
- Remind workers that work safety, quality, and team spirit go before all else. Workers should pace themselves according to their own physical abilities, help each other, and work mindfully as part of a team.
- Remind workers to wear protective gear and sturdy, long-sleeved clothing.
- Provide adequate supplies of water and food, and remind workers to take adequate breaks. Working beyond one's energy level can lead to accidents, injuries, exhaustion, dehydration, and sickness.
- Remind workers to carry tools in ways that will not cause injury to themselves or others while walking, working, and resting. Place tools away from active walk or work zones so that they cannot injure someone who accidentally steps on them. Workers should always know where other people are in relation to themselves while carrying or working with tools.
- Keep tools well maintained. Sharpen any tools that must be sharp to function properly. Dull tools don't get the job done, require more energy to operate, and will slip more readily, increasing the risk of work-related injuries.
- Remind workers to always maintain a safe distance from others, and interrupt their work and make themselves visible and heard when people are passing the work zone on the trail. (Workers should be especially careful to make their presence known to approaching equestrians, as horses might be startled by unexpected noises or sights on the trail.)
- Provide adequate signage, flagging, and user information to alert trail users that work is in progress ahead on the trail.
- Provide adequate and safe storage and staging areas for supplies, tools, rock, equipment, etc. Install fencing when necessary.
- Establish rules for safe evacuation routes and evacuation behavior in case of fire, lightning, flooding, an avalanche, etc., and inform crew members of such precautions.

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http://www.fs.fed.us/database/acad/dev/trails/trails.htm

Publications on Trail Planning, Design, Construction and Maintenance (Professional Trailbuilders Association)
http://www.trailbuilders.org/resources/books1.html

National Trails Training Partnership: Resources, Trail Design and Construction (American Trails)
http://www.americantrails.org/resources/trailbuilding/index.html

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LEAVE-NO-TRACE PRINCIPLES

- Plan ahead and prepare.
- Travel and camp on durable surfaces.
- Dispose of waste properly: dispose of waste water and human waste 200 feet away from water, trails, and campsites in holes 6 to 8 inches deep.
- Pack it in – pack it out.
- Leave what you find.
- Minimize campfire impacts.
- Respect wildlife.
- Be considerate of other visitors.

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