CLASSROOM GUIDE FOR

# TRAIL BUILDING in the OZARKS.

**A manual for working with volunteers to build quality non-motorized, multi-use, natural surface single-track trails.**

*Prepared by*
The Ozark Trail Association
406 W. High St., Potosi MO 63664
**ozarktrail.com**

## Acknowledgements

The information contained in this guide draws upon information in documents listed in the references section. Information published by the Outdoor Stewardship Institute has been a primary reference from among these sources.

## Warning and Disclaimer

The trail building and maintenance described here are inherently dangerous, high-risk activities. The authors and editors and the Ozark Trail Association (OTA) make no representations or warranties whatsoever, and shall not have any liability to any person or entity whomsoever with respect to injury, death, loss, or damage caused or alleged to be caused directly or indirectly by the instructions contained here.

## Credits

This guide was created through support provided by a grant from the Recreational Trails Program of the U.S. Department of Transportation. It was also made possible through the efforts of Ozark Trail Association volunteers. Special thanks to:

- Josh Penningon – Writing
- Matt Atnip – Writing and editing
- Kathy Atnip – Editing and layout
- Hatham Al-Shabibi – Diagrams

## Purpose

This manual was created to accompany the Crew Leader training program developed by the Ozark Trail Association (OTA). It serves as an aid to volunteer Crew Leaders working with other volunteers to build and maintain single-track natural surface trails in the Ozarks region of Missouri. This manual is designed to serve as a baseline for trail construction and maintenance and as an introduction to leading small groups of volunteers on natural surface trail construction and maintenance events.

An online version of this manual, with the most recent updates, is available on the OTA web site at ozarktrail.com.

Local, state and federal land management agencies, local groups and organizations working with natural surface trails will benefit from having standardized training materials. These can provide common points of reference when discussing trail construction and maintenance, safety, tool use, and Crew Leadership.

Most of the miles of Ozark Trail constructed since 2002 have been built by OTA volunteers: nearly 50 miles as of this printing. The OTA has hosted trail building and maintenance events with thousands of volunteers for more than ten years, following a motto of "Be Safe. Have Fun. Build Trail." This approach has proven to be successful both in the construction and maintenance of the Ozark Trail and in growing a volunteer support base that is willing and capable to assist in the responsibility of caring for trails throughout the Ozarks. This document assumes the following priorities, in order of importance, for every volunteer trail work event:

1. Volunteer safety.
2. Volunteer and Crew Leader enjoyment.
3. Construction of quality trail to meet appropriate guidelines.

This manual is by no means a complete reference or guide to trail work. It incorporates the experience and priorities of the Ozark Trail Association. Only basic trail construction and maintenance techniques are included. You can find more advanced techniques such as construction and maintenance of drainage structures, drainage crossings, turnpikes and rock steps in other manuals listed in the reference section.

Note: while the use of chainsaws is very common in trail maintenance, volunteers must be certified by the U.S. Forest Service to operate them on most of the Ozark Trail. Safe and appropriate use of chainsaws is discussed in volunteer sawyer certification and safety programs offered by land management agencies.

## Introduction

The Ozarks region throughout central and southern Missouri is characterized by lofty hills, deep valleys, and clear rivers and streams. Visitors to the Ozarks have the opportunity to see a range of natural wonders, including billion year-old rocks along the St. Francois Mountains, biologically diverse rugged and scenic hillsides, and clear flowing springs and streams. The forests of the Ozark region are living testimonials to nature's ability to heal. The area was largely deforested in the 1800s to provide lumber for railroads and to support an increasing population of European settlers. The forest composition has changed, with more oak, less pine, more understory species and less open savannah as the forests have grown again.

Rocky Falls, near the Current River section of the Ozark Trail

Today the rugged beauty of the Ozarks offers a wide variety of recreational opportunities. Natural surface multi-use trails provide access to the natural and cultural resources abundant in the Ozark region and help instill an ethic for their conservation. The demand for opportunities to enjoy these resources via trails is continually increasing. In some cases, trails that have been around for a long time are beginning to show quite a bit of wear.

This guide will assist in leading volunteer efforts to construct and maintain natural surface trails in the Ozarks and can also be used to address building trails elsewhere in Missouri and in other states. A trail that is designed, constructed, and maintained properly with an emphasis on sustainability will reduce the amount of required maintenance. It's a key factor in ensuring that the visitor has an enjoyable outdoor experience.

**One of the greatest feelings is what we call "the walk-out." When these folks came out today, the hillside they are working on now looked like the hillside down below. But this afternoon, when they walk out, and not only see what they did themselves but what collectively this group did, they are going to walk on a quarter-mile of trail and get tingles up the back of their necks. It's a great rewarding feeling; it's a way of volunteering and knowing that you did something that will last decades.**

John Roth, late OTA Founder

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# LEADING VOLUNTEER CREWS 1

## What is a Crew Leader?

In simplest terms, a leader is someone who has the capacity to guide, organize and motivate people to achieve a common goal. A Crew Leader is responsible for applying this skill set to constructing and maintaining recreational trails while building lasting volunteer relationships.

There are many different styles of leadership with no single style being better than the others. Volunteers building trail will be a diverse group, as will be the goals and objectives of the crew. It is the Crew Leader's responsibility to ensure volunteers have a safe and quality experience. A person in this role not only serves as a teacher of safety, leadership and trail construction and maintenance, but also as an ambassador for the trail. It is essential that a Crew Leader promote a positive volunteer experience. This encourages volunteers to come back time and time again, feel a sense of pride and stewardship, and essentially take ownership of the trail.

Among the many tasks of a Crew Leader, these are critical: lead, teach, listen, direct activities, provide knowledge of the trail and trail building skills, and emphasize a safe and fun experience. This is not an easy role, but the effective leadership of Crew Leaders is among the top reasons why people form a lasting connection with the trail, bring their families and children to events, and help sustain the trail organization and trail throughout the years.

## The "Leadership" of Crew Leading

Every Crew Leader must draw on his or her personal strengths and skills to enable volunteers to have a safe, enjoyable and productive experience. Effective leadership is comprised of identifiable elements. Attention to these can enhance Crew Leadership skills and the quality of the Crew Leadership experience itself. Key components of effective leadership are listed below, followed by tips for implementing these principles on the trail.

- Good communication.
- Setting reasonable expectations and goals.
- Promoting consistency.
- Maintaining balance among priorities.
- Role modeling.
- Teaching.
- Problem solving.
- Constructive criticism.
- Praising.
- Handling serious rule violations.

**The best type of leadership is the style that works best for each individual. This style is based on tapping into the leader's personality, learning preferences, passions, strengths and experiences. There are many unique situations that confront you as a leader. Choosing the right style to lead in the group in any given situation is the true art of leadership.**

National Outdoor Leadership School

## Good communication

The opening greeting can create a climate for communication. The way a Crew Leader speaks to crew members sets the stage for the rest of their interaction. Let volunteers know how important they are. Establish eye contact and maintain an open body posture to keep an open dialogue. Stand with arms in an open position—not folded across the chest—and remove sunglasses. If the sun is visible, position crew members so they are not facing it whenever possible.

Setting the stage for good interaction

Listen to what crew members say. Paraphrasing or repeating what someone says back to them is a good way for the listener to make sure he or she understands what is said and to assure the speaker that he or she is being heard. Be a good listener, and empathize with the volunteer. If the volunteer feels good about constructing trail but is not using the preferred technique—such as lining the trail with logs—explain the sustainability components behind the technique. Avoid criticizing the work, immediately removing it or requiring the volunteer to do it the "right way."

Use standardized trail terminology when conducting demonstrations and when answering questions. Explain the terms and establish a common trail language. This will enhance the Crew Leader's credibility and make the volunteers feel part of a trail building community as they converse using this new trail language.

## Setting reasonable expectations and goals

Take time before the event to analyze what needs to be done. Set realistic goals, but give it some heft. People want to know that what they are working to achieve is important. Try to accommodate the personal goals of crew members whenever possible. These may come out during the opening talk, especially if people are encouraged to express them. Clearly state the amount of work to be done for the day and the work standards that should be followed. These are the goals and expectations for the crew as a whole.


State goals and expectations up front, before starting work.

Lastly, be organized and portray a professional appearance. This is accomplished through being prepared with maps to show crew members where they are going. Make sure that tools, safety equipment and other supplies positioned and ready. Have the route to the work site in mind to avoid wasted time getting there. An unorganized approach can lead to less security for crew members and can have a negative effect on your credibility as a leader.

Always wear the required safety equipment that volunteers are expected to wear and when provided, wear Crew Leader apparel for easy identification.

### Promoting consistency

Crews will maintain their commitment if the instructions from Crew Leaders are consistent. This applies to a single event as well as across events for volunteers who return. This is one benefit of adopting written standards within and among trail building organizations. While there may be more than one way to accomplish a task, the volunteer experience will be enhanced if all Crew Leaders abide by one reasonable way as the norm.

### Maintaining balance among priorities

In trail building, maintaining balance means building 100 feet of good, sustainable trail rather than 300 feet of poor trail, or 10 feet of beyond-perfect trail. Avoid excess with the work, with the time, with the crew and with yourself. Promote well-built trail but don't go overboard. Safety is always paramount. If you do not know the answer to a question, DO NOT make one up. This will reflect on the credibility of you as a leader and on your organization. If needed, refer questions to the Crew Manager for the event.

Build 100 feet of good trail instead of 300 feet of poor trail or 10 feet of beyond-perfect trail.

### Role modeling

The phrase "Do as I say, not as I do" may work for some parenting roles, but not as a Crew Leader. Crew members that are new to trail work may learn more by observing what their Crew Leader does than what he or she says. This extends to all aspects of crew behavior, not just work habits. If the Crew Leader doesn't take water breaks, crew members are likely not to take them. It is not easy to model hour after hour, but it becomes easier and more natural with experience.

### Teaching

How people first do a job largely determines how they will do it in the future. When a Crew Leader takes the time to train a crew at the beginning of the day, it pays off by the end of the day. Show enthusiasm for quality trail work. To a beginner, there is a lot to learn in building

sustainable trail. It's not possible for someone to absorb everything in a five-minute demonstration. New volunteers learn by doing, but try to monitor their work closely. Correcting work while in progress will be more productive than correcting someone who has just completed work doing it the "wrong way."

Volunteers have made the commitment to give their time and will travel great distances to work outings. They want to "do it right" and if coached through the process, will gladly rework areas to make them meet the set standard. Remember to discuss why a change is needed in terms of water control and sustainability. Helping volunteers to understand the "why" will increase their understanding, build commitment and reduce missteps in the future.

Crew members should come to understand the principles of sustainable trail construction and safe and effective use of tools. For each phase of trail work on a particular section:

1. Define the task. Explain tasks and goals using standard trail terminology.
2. Demonstrate the skills required to complete the task.
3. Monitor and coach as crew members begin the work.
4. Self-evaluation and group critiques help bind the team and promote the exchange of ideas.

Teaching can also be overdone. Some volunteers may not share the typical Crew Leader's enthusiasm for learning and quality work. If someone persists in using a tool in an inefficient though not unsafe way, it is probably best not to persist in attempting to correct the situation. Some will arrive at a project with well-established but poor trail work habits. Sometimes it is better to review a completed task, suggest how "you might have done it" and let it go rather than asking people to redo some work.

**This is why I believe in building the Ozark Trail. Our kids are going to be our future. When we bring them to these events, we're putting ownership of this trail on them.**

Kathie Brennan, OTA Crew Leader

## Problem solving

Crew Leaders should walk their crews through the work section and discuss the work to be done. Though Crew Leaders may have construction notes, staking, and flagging to guide their work, this does not obviate the need for crew members to understand the reasons for the plan and how it will be implemented. If this leads to serious questions about the original specifications, contact the Crew Manager.

As work proceeds new localized problems may develop. Involve the crew in finding a solution following these steps:

1. Define the problem – distinguish facts from assumptions.
2. Generate alternatives – identify but don't evaluate.
3. Select from alternatives – this requires balancing the pluses and minuses.
4. Implement– devise and put into play an action plan of manageable steps.
5. Learn from mistakes.

## Constructive criticism

Be specific and own your feelings when giving feedback. For example, use "I feel" versus "you should." You can never be wrong in your feelings. Ensure proper timing when giving feedback. Praise in Public, Criticize in Private. And lastly, avoid praising and criticizing in the same sentence: "You guys did a fantastic job, but we will have to come back to fix some of those holes in the tread." Regardless of the crew's performance, give positive praise and thank them for their time and effort. Near the middle of the work outing, allow for a short time period for your crew to discuss the work they did and hear from other crew members.

## Praising

Always remember that people are giving of their free time to do manual labor, often traveling and walking great distances to get to the event and worksite. It is easy to get so focused on catching or correcting errors that good efforts are overlooked. Always praise every crew member and as often as it is reasonably justifiable, while avoiding fake praise. Understanding a crew will help in knowing how much praise to give. Over praising veteran trail builders may come off as annoying, whereas some may feel intimidated or harassed. Ensure fairness in praise when working with diverse crew members.

During the final review of a completed section of work, Crew Leaders should note situations that may need to be monitored or that may require additional work, brag a lot and praise the crew for the fine work they have done. But be specific. Point out particular features of the completed work for praise. Avoid generalities, such as "you are a great trail builder," that can come across as condescending.

Focus on praising volunteers with specifics.

## Handling serious rule violations

The two main types of critical problems Crew Leaders must manage are serious violations of technical and safety standards and behavior that is disruptive to the crew. If serious safety violations are seen that endanger the volunteer or those around them, do not hesitate to stop them immediately. Apologize if necessary for a seemingly harsh interruption but that is preferable to someone getting hurt. In most instances, the volunteer is not intentionally doing something dangerous. Respectfully explain how what they were doing could cause an injury. This may need to be done privately to avoid embarrassing the crew member.

Disruptive behavior is not simply obnoxious and annoying but behavior that is clearly undermining the quality of the experience for other crew members. Such problems rarely occur, but

when they do, take the involved individual or individuals aside and explain your concerns. If this does not resolve the matter, repeat the discussion and make it clear that, as Crew Leader, you have the authority to ask a volunteer to leave your crew. If anyone leaves under these circumstances, by their own choice or at the direction of the Crew Leader, ask them to speak with the Event Leader and the representative of the land manager before leaving the project area. They may be able to satisfactorily assign them to another crew or task. Remember that the land steward has legal authority over what takes place on the trail site. Rely on this authority in difficult situations.

Physically or verbally aggressive behavior and sexual harassment must be dealt with swiftly and firmly. There should be no tolerance of such behavior. Any serious crew incidents and any time someone is dismissed from or walks off a crew should be documented in writing to the sponsoring or host agency. It may be appropriate to identify a witness, with his or her permission.

## Common Errors of Crew Leaders

Crew Leaders make mistakes and most volunteers are not very critical. It is up to Crew Leaders and Event Leaders to take whatever action is needed to maintain a high standard of performance. Here are some of the most commonly observed Crew Leader errors:

- Working more than leading. Failing to work at all is an equally poor practice.
- Not taking the time at the beginning of the day to orient, involve and train. On the other hand, dragging out the open orientation longer than necessary runs the risk of losing the initial energy of volunteers. Strike a balance.
- Not encouraging and implementing self-critiques throughout the day.
- Correcting actions of volunteers from other crews. Always go through the Crew Leader of the other crews rather than the volunteers.
- Losing track of crew members who are not sufficiently prepared to work without close supervision. Not staying together as a crew/not having accountability for crew.
- Allowing crew members to leap ahead of other crews before the crew's section is complete.
- Over-managing and not involving people in problem solving.
- Failing to praise good work and thank crews at project's end.

# SAFETY

2

Safety is the first and most important job of a Crew Leader.

Always set a good example. Be vigilant, but courteous about enforcing safety. Trail building involves physical work with sharp tools on uneven terrain. Crew Leaders have a responsibility to teach proper safety skills and maintain a safe working environment.

"Safety begins with you," and all volunteers have a responsibility for personal safety. Before crews move to the trail, leaders should check crew members for proper footwear, gloves, clothing, water and food. After the initial welcome and project explanation, discuss safety.

> **The risk of physical injury or illness is always present in outdoor volunteer work. Avoiding injury is the highest priority. Though project-related injuries and illnesses are extremely rare, their consequences are potentially severe.**
>
> Volunteers for Outdoor Arizona
> Crewleader Manual

## Clothing and Gear

Clothing, other personal gear and safety equipment are important. Trail work often takes people into rough country and protective clothing and footwear are part of the list of essentials.

A well-prepared young volunteer

### Clothing

Long sleeved shirts for best protection from insects, sun and scrapes.

Long pants for more leg protection than shorts.

Work gloves to prevent blisters.

Foul-weather gear included in daypack for any change in conditions.

### Footwear

Cut-resistant or leather nonskid boots for best support and ankle protection (required when using cutting, chopping, or digging tools).

Steel-toed boots for working with rock (preferred).

Avoid sneakers or tennis shoes (they do not offer enough support and protection). Rubber boots are optional and rarely needed in the Ozarks. Gaiters to cover lower leg are also optional to offer protection from insects and debris.

### Safety gear

Hard hat - When swinging tools, working under the canopy of trees, or when there is any chance of being hit on the head, a hardhat is required and offers important protection.

Eye protection for cutting or rock work.

Hearing protection when working near power equipment of 85 dB or louder.

Dust masks for some rock work, dusty conditions or tool sharpening.

### Other gear in a trail builder's pack

Drinking water (critical).

Snacks.

Insect repellent to help avoid tick-borne disease and discomfort.

Sunscreen.

Lip moisturizer.

Sunglasses.

Any medications required.

Sample of volunteer's supplies for trail building

## Potential Hazards

It is important for the Crew Leader to be familiar with the hazards of the worksite. These include weather conditions, biting insects, contact with poison ivy or other irritating plants and potential encounters with venomous snakes and spiders.

A little preparation can go a long way. It is possible that volunteers may be unfamiliar with these hazards and a few minutes in your safety talk can make a big difference to their comfort and safety. If you encounter a venomous snake while building or maintaining trail, simply leave it alone, mark the section to let others know of its presence, inform the Crew Manager or Event Leader and move to another area to work for the day.

Every crew should have a First Aid kit that is carried by the Crew Leader or Assistant Crew Leader. At least one person needs to be certified to give First Aid and preferably certified to perform CPR (cardiopulmonary resuscitation). The OTA Crew Leader training program includes a certification in Red Cross First Aid and CPR. Land management agencies may also require a Job Hazard Analysis (JHA) that includes:

- An itinerary (planned route of travel, destination, estimated time of departure/arrival).
- The names of the workers on the crew.
- Specific work hazards and abatement actions.
- An emergency evacuation plan.

First Aid, emergency procedures, and evacuation routes will be different with every event. Before the event, the Event Leader will work with the land managing agency to determine evacuation routes and local hospitals.

## Safety Briefing

Hold a safety briefing before work begins and whenever conditions change significantly, using the following guidelines:

- Check crew for footwear, clothing, gloves, food and water.
- Ask about specific health concerns a volunteer may have and offer to speak to them individually after the talk.
- Check for people with medical training such as paramedics, those trained in Emergency Medical Services (EMS), or certified in Basic First Aid, CPR, etc., among the volunteers.

Safety briefing near the worksite

- Demonstrate safe working distances – well outside the distance of a fully extended tool in all directions.
- Cover Walk-in/Walk-out procedures and safe tool carrying.
- When passing other workers on the trail call, "Coming Through!" Make eye contact with worker and get permission to enter their working circle (the so-called "Circle of Death." Do not enter without permission!)
- Remind volunteers to stay hydrated.
- Ask volunteers not to leave area without notifying the Crew Leader.

## 2 Communications

Event Leaders should also have a working form of communication with the managing land agency throughout the day. When issued a radio, it is important for Crew Leaders to limit radio chatter to prevent any confusion. If there is an emergency situation, contact the Event Leader. If your crew is not involved in the emergency, keep off the radio in order to keep the line of communication open.

# TOOLS

3

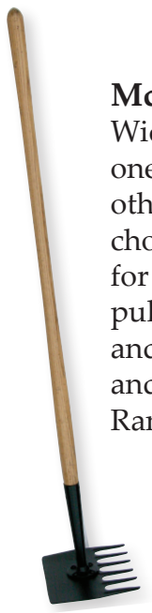
Most of the specialized tools used to build natural surface trails were originally designed to fight wildfires. Much of a firefighter's effort in battling a ground fire involves removing undergrowth and surface organic material to create firebreaks. Many of the same tools and techniques are used to create sustainable trails through both wooded and open areas.

For volunteers working on trail maintenance, the tools will probably appear more familiar. Anyone who has worked around the yard should be able to use these tools easily.

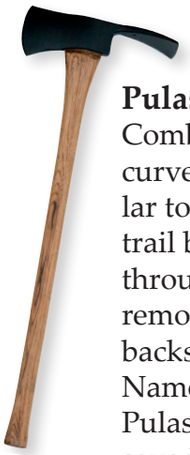
It is a Crew Leader's responsibility to provide training on how to use trail building and maintenance tools and well as to ensure that volunteers are supplied with appropriate safety equipment (see page 12). Crew Leaders should be familiar with every tool and explain the function of each. Conduct a risk assessment when encountering a problematic area to determine which tool will be most efficient and safe for the job.

The organization sponsoring the event should make sure that tools are kept sharpened. A sharp tool is safer than a dull tool. When using a dull tool, the user tends to swing harder or dangerously, which can lead to injuries.

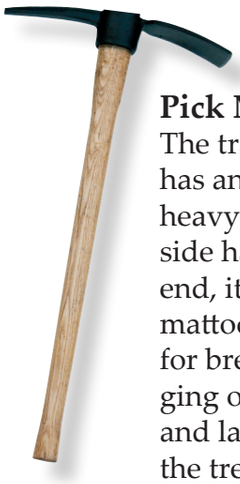
## Commonly-used Trail Building Tools



**McLeod**
Wide hoe-like blade on one side and tines on the other. An all-purpose choice for trail builders for creating trail tread, pulling debris downhill and cutting in backslope and outslope. Named for Ranger Malcolm McLeod.

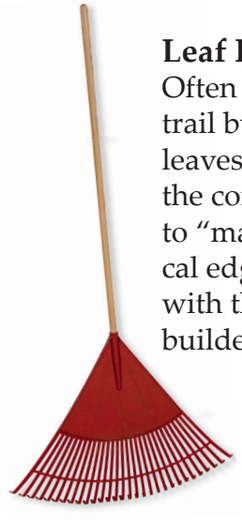


**Pulaski**
Combines axe blade with curved adze perpendicular to the shaft. Used in trail building for cutting through rocky soil and removing roots from backslope and tread. Name is credited to Ed Pulaski of the USFS who saved 45 firefighters during an outbreak of Idaho wildfires in 1910.



**Pick Mattock**
The traditional mattock has an adze blade and a heavy shaft. When one side has a longer pointed end, it becomes a pick mattock, a versatile tool for breaking up soil, digging out roots, stumps and large rocks from the tread and for cutting backslope.

**Fire Rake**
Broad head wtih four sharp triangular teeth. Used to establish critical edge of trail and remove slough. In firefighting, used to pull away fuel sources and moving burning materials.



**Leaf Rake**
Often used first in trail building to clear leaves and twigs from the corridor and last to "mask" the critical edge. A favorite with the youngest trail builders.

**Loppers**
Used to trim low branches, undergrowth and small roots. Often used by trail maintainers and great for young trail builders to clip twigs and small sticks.

**Bow Saw**
Course-toothed blade stretched in a metal frame. Used often in maintenance to remove larger branches and roots in tread and backslope or limbs overhanging trail.

## "Circle of Death"

One of the most important safety concerns when using tools is to maintain adequate distance from other people in a circle around them. This circle is the total area around a trail builder when a tool is held out to its entire length. The International Mountain Bike Association (IMBA) calls this "the Circle of Death". While the phrase is a bit dramatic—intended to be humorous—within this circle, tools may be moving at any time, often with great force. Anyone entering this area risks severe injury. Each worker should be attentive and watch for people entering their circle as well. It is just as important to or a trail builder to maintain his/her own circle as it is to make sure not to enter someone else's.

The Circle of Death extends around a trail builder in all directions.

## Tool Talk

The Crew Leader should conduct the safety talk on tools during the morning meeting or at the tool cache, but before any volunteers carry tools. Regardless of experience, everyone needs a refresher of the tool safety talk. This is a requirement for every event. Begin by identifying each tool by name. The safety talk should proceed to cover cover everything within the "C-U-S-S" system: Carry–Use–Safety–Storage.

Identify and demonstrate each tool before volunteers use them.

### Carry

Tools should be carried at a person's side, arms extended downward. Sharp edges should face down. Carry only one tool in each hand. While walking, ensure there is proper distance (at least ten feet) from people ahead and behind. Be prepared to toss tools to the side if a trip occurs. Tools should never be carried over the shoulder.

### Use

Explaining the function of each tool will also assist crew members in using it safely. Swinging the tool overhead is improper and unsafe use! Waist high is generally high enough but not above shoulder height. Let the weight of the tool do the work.

### Safety

Crew members should maintain control of the tool being used and/or carried at all times. Watch for others who may enter the Circle of Death or the general work area.

### Storage

When not using a tool, crew members should store it on the uphill side of the trail with the handle facing the trail. Carry out the same number of tools carried in and assemble them in a designated area for proper storage.

Volunteers should maintain a ten-foot distance from others when carrying tools.

# VOLUNTEER TRAIL BUILDING EVENTS 4

Whether your event has five people or 150, all successful volunteer trail work outings will have the components described here. Examples of OTA events where Crew Leaders are needed include Mega Events, as well as other construction and maintenance events. At smaller events, Crew Leaders begin to wear more hats. On a ten-person event, there may be no Agency Representative and one person may perform all the preparation and leadership responsibilities. A 100-person outing may require more than one Crew Manager, multiple Technical Advisors and several Crew Leaders.

## The Project Team

### Event Leader

The person in this role is responsible for coordinating the event, recruiting and managing the leadership roles listed below. It includes pulling together not just field-related tasks but pre-event advertising, sign-up coordination, planning for meals and other activities as well as coordination with land managers.

The Event Leader may address volunteers and give an overview of the organization or plans for the event.

### Technical Advisor

Each section of trail will undoubtedly contain areas that offer challenges. There are often multiple solutions but usually one best solution. The Technical Advisor needs to be prepared to offer a best-practices response to trail building challenges. A bit of diplomacy and teaching ability is helpful in the role. This person should also participate in pre-event field planning to identify potential problem areas and create solutions to be executed on event day.

### Crew Manager

This role is often the same person who fulfills the Technical Advisor position. The Crew Manager on event day will move from crew to crew, checking in with Crew Leaders for technical and/or volunteer issues. They will do some cheerleading with the crew members and work with Crew Leaders on construction issues. They will monitor how the volunteers are feeling

and determine when to end the work part of the outing. Fatigue leads to accidents and the "Have Fun" part of the outing can wane as well.


A Crew Leader works most closely with volunteers and has the greatest impact on the quality of their trail building experience.

### Crew Leader

Crew Leaders are the glue that holds the event together. The people in this role have the greatest impact on a volunteer's experience in the field. They should be well-versed in the technical aspects of basic trail construction and be ambassadors of the trail and sponsoring organization. For any trail building or maintenance event, there will be additional event management duties that Crew Leaders may take part in setting out tool caches, site preparation, signage, assisting with sign-ups and forms, rosters, food management and more.

### Assistant Crew Leader

For any size event, the Assistant Crew Leader (or Co-leader) is an important role and for large event with many volunteers, this person becomes more critical. Those in this role often demonstrate tools and safety guidelines while the Crew Leader describes them. The Assistant is often in charge of the First Aid kit and radio and acts as sweeper, following the last volunteer, during the walk to the work site and walk-out.

### Project Support Coordinator

Large events will require someone to help with the event details such as securing camping, ordering lunches, coordinating registration and supplies, printing maps and generally assisting the Event Leader in pulling the event together.

### Tool Manager

The Tool Manager coordinates with the Technical Advisor to plan the types and quantities of tools needed for an outing. They will also arrange for the sharpening of the tools, delivery to the work site and the return and storage of the gear.

### Crew Member

Volunteer crews are the lifeblood of any group building trail. They spread the word about the trail and your organization's mission. They bring their friends out on future events, provide inexpensive labor which can be used to match funding in grants and are the key to completing ambitious trail projects.

### Agency Representative

It is always great to have a representative of the land steward present to witness the excitement and energy of a well-planned and well-executed work outing. Volunteers like seeing a uniformed person or agency representative at outings and like to be thanked directly by them. The credibility gained by your organization when agency representatives witness a well-run event will help strengthen bonds and encourage buy-in of your methods.

Volunteer crew members can help spread the word about the organization and encourage others to come out.

## A Typical Trail Construction Outing

### One-day project components

- Pre-project planning – Identify the work site. Work with land managers.
- Managing signups – Communicate with volunteers. Send additional details of the outing and what they should bring.
- Obtaining tools – The number of tools available may determine the size of your outing. Not bringing enough tools will upset volunteers who really want to work and not stand idle with empty hands. Sharp tools in good repair are safer and more efficient than dull dirty ones.
- Project support planning (signs, toilets, food, registration, etc.) – The size of your outing will determine how many creature comforts you will need to provide.
- The project day – This is the time to "have an agenda". See Appendix B, "Example Crew Leader Instructions" for a sample itinerary.
- Breakdown – Police the area for any tools, trash or other belongings. There always seems to be a stray folding chair to rescue. Thank volunteers and look forward to the next outing!
- Reporting – The business end of relationship building with land stewards and fundraising requires prompt and accurate reporting. Land stewards want an update to help with their planning and the volunteer labor can often be used to make an argument for

future funding or to contribute to a match for a grant already awarded. Some land managers offer volunteer recognition awards that can further establish relationships and productive collaborations.

**Overview of a typical crew's project day**

- Crew Leader meeting or prep work – Tool sharpening, preparing a sign-in sheet, etc.
- Meet and greet volunteers arriving.
- Morning meeting – Introductions, discuss project, safety talk, questions.
- Walk-in to the worksite.
- Training and building demonstration.
- Build trail – Safety first, monitor and mentor, problem solving, hydration, breaks.
- Walk-out – Best part of the day! The trail built will be there for decades and you own a piece of it by your hard work in creating it. It is time to be proud.
- Social gathering – Optional but important! Opportunities to socialize after the work day is key to getting closer to your volunteer base and to learn what works and what doesn't. Volunteers always appreciate food, from a hibachi BBQ to sub sandwiches and chips. Take this time to learn from the volunteers and to enjoy the camaraderie of sharing a valuable hard day's work.
- Reporting – Be sure everyone signed in and gets credit for their effort. Your organization wants credit for the work done as well. Submit reports to the land manager including work completed, attendance, any issues or injuries and what work remains.

## A Note About Smaller Events

During smaller events, the safety and demonstration talks can easily be overlooked, but be aware there is almost always someone who is either attending for the first time, or has not attended an event in a long time. Never skip the talks in an effort to get to work faster. Even if there are some veteran trail builders anxious to get working, be sure to cover safety and tool demonstrations.


Taking time to talk helps connect Crew Leaders to their crews on a more personal level.

## Build relationships

- Pre-event communications – Informative and friendly notices, timely and informative responses.

- Take time to talk on the trail – Crew Leaders and other leaders need to talk not just about technical trail concepts but also about how trails build family bonds, improve health, increase awareness and stewardship of the natural world. It is also a way to get over-eager workers to take a break.
- Social activities after the work event – Even small gestures like a cooler of soda at the trailhead and a bag of fruit can go a long way to say "thank you" and add more time to build people relationships.
- Post-event feedback – An e-mail thank-you to crew members, web postings about the event, picture galleries, press releases, letters, awards, etc.

OTA Mega Events always include social time with volunteer recognition, prize raffles, entertainment and an evening meal.

## Keys to success

- Make it safe.
- Make it rewarding
- Position outing within the larger trail system/project – Why is this trail important?
- Make their volunteer work count, be organized, help them be effective.
- Don't forget to praise and share the pride in a job well done.
- Emphasize the new trail during the walk-out.
- Announce the amount of work achieved. People love to tell their friends, "We build a half-mile of trail this weekend!" or "We cleared brush from 25 miles of trail!"

# TRAIL DESIGN

5

A good trail may appear to have "just happened," but that appearance belies an incredible amount of work in scouting, design, layout, construction, and maintenance. By the time a crew arrives to build trail, much has been done. The process of creating the trail may have started years prior with the agency establishing Trail Management Objectives (TMOs) and master planning. The overall trail corridor may have been mapped for ownership boundaries, topographical features and natural resources. Trail designers have scouted the hillsides, evaluating potential routes and cataloging "control points." Environmental, historical and archeological clearances have been obtained. Pre-construction preparation work such as corridor sawing and pin-flagging may have been performed. The number of hours required for planning and preparation rivals the total needed for trail construction.

**Well-designed trail blends well into the landscape and can seem like it's always been there.**

First, look at your Trail Management Objectives (TMOs). Why is the trail needed? Who will use the trail? What experience is desired? What are the agency's management objectives? What problems may arise from drawing the attention of unintended users?

Next, develop construction specifications and corridor guidelines based on the list of features below.

- Sustainability issues for the area (soil type, terrain, weather, intended use).
- Trail type — hard, crusher fines (finely crushed rock) or natural surface.
- Tread width.
- Grade limits.
- Turning radius.
- Desirable corridor features.
- Structure guidelines/specifications.
- Safety and risk management.
- Spurs, loops, networks.

## The Art of Trail Design

5

The role of topography is well recognized in trail design and construction literature. Drainage patterns and the erosive force of water are directly related to topographic forms. Areas with greater relief or cross slope are more susceptible to erosion than more gently sloped areas due to the higher velocity of water flow. The construction of trails in flat areas is generally very difficult. This is because nicely cross sloped areas allow water to flow with adequate velocity across the trail in a sheet  instead of slowing and turning down the tread. However, highly cross sloped conditions can also present a difficult challenge to the designer when grades are exceedingly steep, rainfall amounts are significant and/or intense, and soils are susceptible to erosion. A trail designer must have a thorough understanding of how to read topography in order to minimize resource damage.

Begin by studying the proposed route on a topographic map and aerial photos. This will enable you to utilize the topography to the greatest extent and see the trail in a broader view. Physically mark the map, or utilize Geographic Information System (GIS) technology to digitally lay out the proposed route. Google Earth has a free tool that works well for this purpose. On the map, identify control points or places where the trail can go because of destination, trailheads, water crossings, and/or rock outcrops. Include positive control points such as a scenic overlook, a waterfall or lakes. Avoid negative control points like areas that have noxious weeds, threatened or endangered species, critical wildlife habitat, caves or poor soils.

A scenic area such as a watefall can act as a postive control point for selecting a trail route.

When plotting the trail on a map, connect the control points, following contour lines. In most Ozark soil conditions, plotting your trail with sustained grades of 10% or less will keep the route at a sustainable grade. The sustained grade is measured over as long a distance as possible. It could be 100 feet or more. While 10% is the maximum recommended sustained grade, planning at 8% will give you more flexibility to tweak the grades when in the field.

## The Two Most Critical Aspects of Planning Sustainable Trails

1. Avoid the Fall-Line – Fall-line trails usually follow the shortest route down a hill which is the same path that water flows. The problem with fall-line trails is that they focus water down their length. The speeding water strips the trail of soil, exposing roots, creating gullies, and scarring the environment.

2. Avoid Flat Areas – Flat terrain lures many trailbuilders with the initial ease of trail construction. However, if a trail is not located on a slope, there is the potential for the trail to become a collection basin for water as traffic eventually compacts the soils in the tread and the trail becomes the low point. The trail tread must always be slightly higher than the ground on at least one side and slightly sloped so that water can sheet across properly and not stay on the trail.

Next, walk the proposed route. Study the area in a wide corridor around the proposed route to find natural features that add to the user's enjoyment while avoiding sensitive areas. Strive to balance both anticipated environmental impacts and the intended visitor experience when designing trails. This can prevent any delays that may occur later in the approval process or impact analysis.

Don't be surprised that once in the field, a masterfully planned route meets unexpected drainages, gullies and other features that do not appear on the topographic map. These situations are why the sustained grade over an area should be set at 8%. Unexpected issues on the ground can then be worked around and the trail can remain within the defined specifications. Use a GPS to record the track of a proposed trail, which can be added as an overlay to the topographic map back in the office. Additional tracks should be recorded after flagging is completed.

## Flagging a Route

When the proposed route is finalized, either during this first trip or on an additional outing, flag the route to mark the location. Use bright colored flagging tape when marking the proposed trail corridor. Use colors that stand out from the vegetation. Fluorescent pink should work in most areas. Check with the land manager to be sure they are not using the same color tape to denote other meanings. Flagging marks your intended trail layout on the ground. While flagging the route, you will discover impassable terrain, additional control points, and obstacles that weren't evident on the map. Use different colors of tape for the other possible routes as you lay in the trail options.

Don't forget to tie the knot in the flagging tape so that it faces the intended trail location. This way, if another crew continues the work, they will know your intentions.

Don't scrimp. Flagging is cheap compared with the time spent locating the route. Flagging deteriorates in the sun, limbs fall with the flag attached and wind can blow tape down. Using ample flagging will make the line evident even if some flags are lost. Flagging that is close together will also help you visualize the flow of the trail. Use pin flags instead of flagging in open areas without enough vegetation to create a representative line.

Always use a clinometer to measure grades. A clinometer or "clino" is a surveying instrument that measures angle of elevation, slope or incline. When making a grade reading, if the other person is your same height, use their eye level to make the reading. If they are taller or shorter, take that difference into account when making your reading. If they are taller, you may use their chin as the reference point. If they are shorter, perhaps the top of their head or hat brim can be used. Try to stay below 10% over any distance and aim for a sustained grade of 8%. Most soils in the Ozarks will handle a short 15% section but these sections should be the rare exception and as short as possible. Places where 15% max may come into play are when crossing small drainages or when climbing out of a creek.

### Two or More Persons Flagging

A person with a clino stands at the starting point and directs the other person to the desired location. It is desirable to establish the sustained grade first, generally 8% to 10%, over as long a distance as practical. Shoot a reading with your clinometer over this distance and have the lead

person flag the spot. The lead person then comes back toward the person with the clinometer. Smaller sections are then flagged in above and below the sustained grade line as required for grade reversals, trees, rocks and control points. The team moves up the flag line to the last flag where the person with the clino will stop and make this the new starting point. The process is repeated. A third person can be scouting ahead for obstacles or good locations.

### One-Person Flagging

With clino in hand, go to the starting point and tie flagging at your eye level. You will use the top of this flag to shoot your grade. Move along your intended route as far away from this starting point as practical to shoot the sustained grade (8-10%). Tie a flag at eye level at this far point. Return to the starting point noting any obstacles you want to avoid along the way. Then move about three to six meters (ten to 20 feet) along the intended route and sight back to the last flag. When you have the desired location, tie another piece of flagging at eye level.

# TRAIL TERMINOLOGY

6

Understanding common trail terminology will assist Crew Leaders in understanding trail issues while also increasing confidence in communicating trail concepts to crew members. Common terminology used to build sustainable trails include the cross slope, backslope, tread, outslope, inside edge, and the critical edge. Several of these terms are shown in Figure 1 and are discussed below.

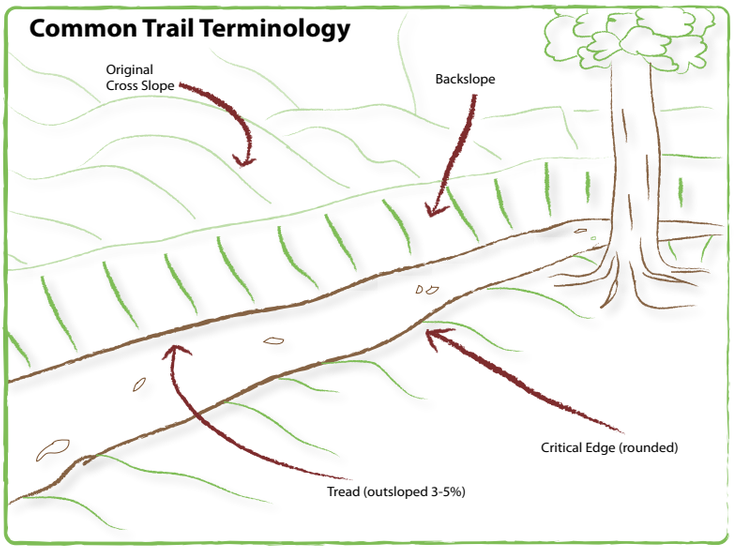



**Figure 1:** Common terms used in trail building include Cross Slope, Backslope, Tread and Critical Edge.

## Cross Slope

The slope or gradient of the undisturbed hillside is called cross slope (Figure 1). It is generally referred to in percent, not degrees. A good analogy is to alpine skiing terminology – the fall line is the line the skier follows downhill and also the path water follows downhill along the cross slope.

## Half Rule

The half rule says that the trail grade should be no more than half the cross slope grade (Figure 2). This rule really helps when putting trails on gentle cross slopes. For example, if you're working on a hill with a 20% cross slope, your trail grade should be no more than 10%. If the trail is any steeper, it will be a fall-line trail. When the half rule is exceeded, it becomes easier for the water to run down the trail instead

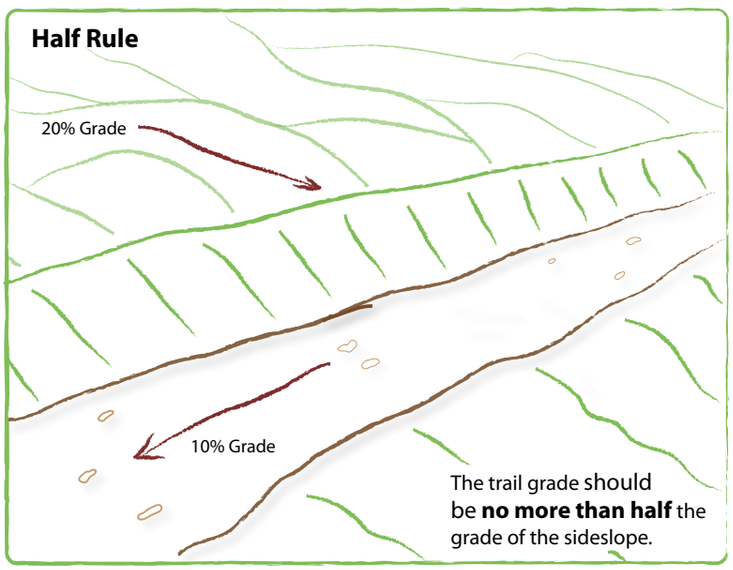



**Figure 2:** Building trail on gentle cross slopes using the Half Rule helps them to shed water.

of crossing the trail. Water will funnel down and pick up velocity, causing erosion and ruts. As cross slope grades increase, trails designed only using the half rule can be too steep. The half rule works in conjunction with sustained grade guidelines.

## Backslope

The excavated slope rising above the inside edge of the tread is called the backslope (Figure 1). The slope is cut back to transition into the original hillside. The backslope is a merger or transition of the natural hillside cross slope with that of the tread. It is "laid back" or reclined into the native hillside. When vegetation returns, the backslope will blend into the hillside and the trail will seem like it has always been there.

## Tread

The tread is the surface of the trail on which users walk or ride (Figure 1). The tread may be either built as a "partial" or "full bench" trail. Partial bench trail is essentially cut-and-fill, where all or part of the trail is composed of excavated (loose) soil, which is prone to erosion and is inappropriate for equestrian trails. Full bench construction means the trail is built entirely on native mineral soil. It can support heavier use. Full bench trails are cut into the hillside, and are generally more sustainable than partial bench trails. The land management agency will establish the width of the tread in their construction or maintenance standards for trails under their jurisdiction.

## Outslope

Notice in Figure 1 that the tread is not level perpendicular to the direction of travel. Like the hillside, the tread slopes downward. Outsloping a trail is one technique to get water to flow across the tread in a sheet, rather than follow it or stay on the trail causing puddles. Water flowing down the hillside simply crosses the trail and continues down the hill. Trails that are insloped or have no outslope will tend to trap water and allow it to flow down the trail. Puddles tend to force users to walk around, damaging the critical edge and widening the trail. A simple way to measure the outslope is to stand a McLeod with the handle pointing upward in the center of the tread. Then step back 15 feet from the tool and ensure the angle of the handle is sloped outward at approximately 3-5%.

## Critical Edge

The rounded outside or downhill edge of the trail is called the "critical edge" (Figure 1). The critical edge is the transition between the cut-in tread and the return to the natural hillside. Rounding the critical edge helps water to flow off of the trail. There should not be a berm on the critical edge or a ledge cut into the slope below. Volunteers may incorrectly line the critical edge of the trail with rocks or logs. While this may be aesthetically pleasing to some, over time, silt will become trapped by the obstacle and keep water on the trail.

## Centerline

The middle of the trail is called the centerline. Trails are sometimes marked for construction by placing a row of pin flags along this centerline.

## Trail Corridor

This is the area of passage of the trail, including all cleared and managed areas above, below and adjacent to the tread. The trail corridor is wider than the tread surface itself and is as high as necessary for the trail users. Trail corridors that blend in with the landscape and accommodate traffic will encourage appropriate trail use. When the trail corridor is not maintained, trail users will leave the trail tread and cause unnecessary trailside impacts.

## Switchback

A turn in the trail that has a distinct intersection between upper and lower sections is a switchback (Figure 3). It's typically a U-shaped structure that includes a landing connecting the legs that is wider than the than standard trail width. Switchbacks often require a crib wall to reinforce the tread and include special drainage with both insloped and outsloped tread.

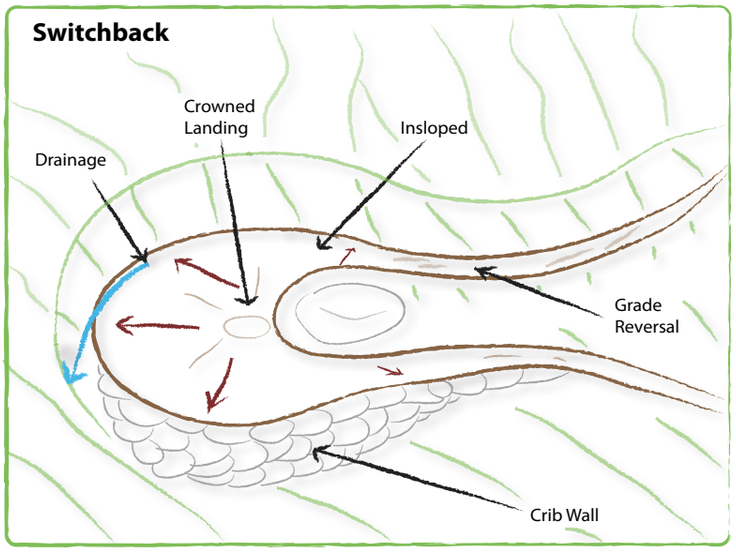



**Figure 3:** Switchbacks are turns that can help make trail more sustainable while providing easier navigation.

## Crib Wall

Also called a retaining or rock wall, a crib wall is constructed to support the trail (Figure 4). A crib wall may be located beneath the tread in steep areas or above it to retain the slope above. Crib walls must be carefully constructed with rock specifically selected for size and shape. The plan for a crib wall takes into consideration the slope and an appropriate "batter" or tilt into the slope, with the rocks placed in layers.

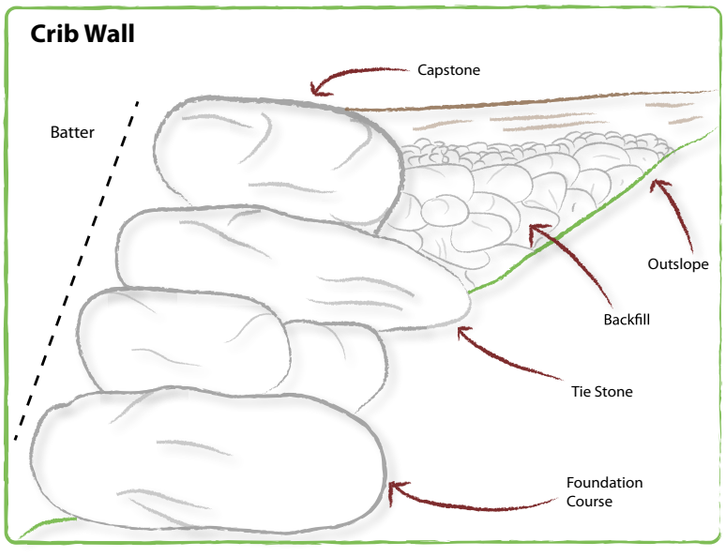



**Figure 4:** With expert supervision, constructing a crib wall is a satisfying job for seasoned trail builders and new volunteers alike.

# SURFACE WATER CONTROL

7

Diverting surface water off the trail should be at the top of your list of priorities. Water control drives the design process and needs to translate into putting trail on the ground. Running water erodes tread and support structures and can even lead to loss of the trail itself. Standing water often results in soft, boggy tread or failure of the tread and support structures. The very best drainage features are those designed and built into new construction. These include frequent grade reversals and outsloping the entire tread. The classic mark of good drainage is that it's self-maintaining, requiring minimal care.

## Sheet Flow

When rain falls on hillsides, the water flows down the hill in dispersed sheets called sheet flow (Figure 5). An example of sheet flow is a cup of water knocked over on a smooth table. The water does not stay in the shape of the cup; it flattens and spreads out smoothly into a sheet. All the design elements for a rolling contour trail including building the trail into the cross slope, maintaining sustainable grades, following the half rule, adding frequent grade reversals, outsloped tread and a rounded critical edge allow water to continue to sheet across the trail where it will do little damage.

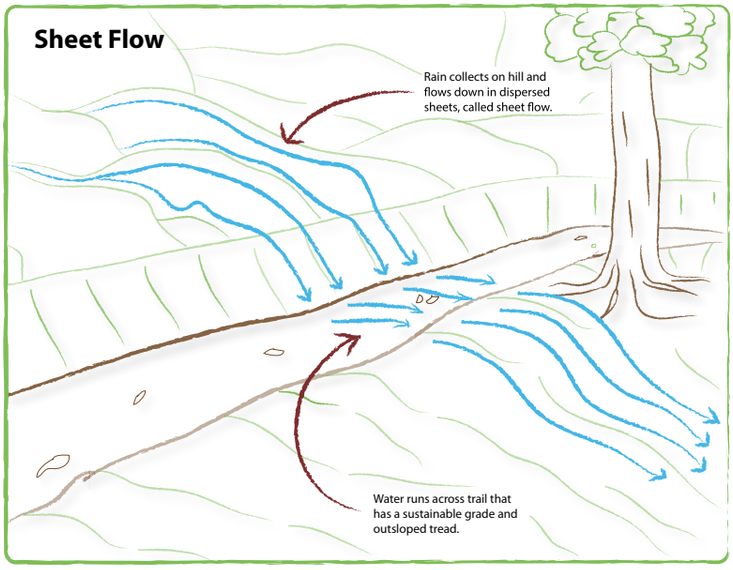



**Figure 5:** Dispersed sheets of water sheet down the cross slope and should continue across the trail for minimal damage.

## Grade Reversal

Sometimes grade reversals are referred to as grade dips, terrain dips, or swales (Figure 6). The basic idea is to use a reversal in grade to allow any water trapped on the tread to move off the trail at frequent inter-

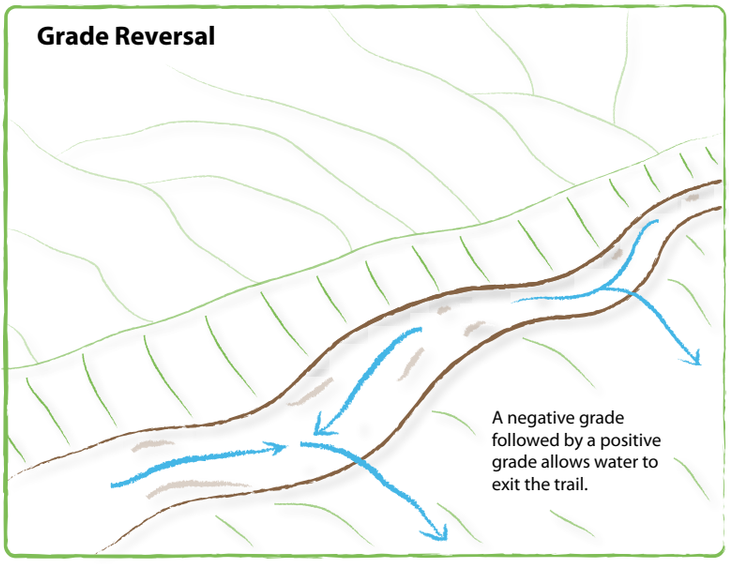



**Figure 6:** Grade reversals allow water to move off the tread at frequent intervals and should be designed into new trails.

vals. They are especially effective on long sustained grades without natural drainages to encourage water to move off the trail. Grade reversals are designed and built into new trails.

A trail with grade reversals anticipates that at some point a well-used trail may develop a compacted tread and will capture some water. The water will take the path of least resistance which means down the trail. Once the water comes to the grade reversal, it will move off the trail at the low point of the reversal. Grade reversals are the most unobtrusive of all drainage features when they are constructed with smooth grade transitions.

Grade reversals take advantage of natural dips in the terrain (Figure 10). The grade of the trail is reversed for about 10 to 15 feet, then "rolled" back over to resume the descent. Grade reversals should be placed frequently; about every 50 feet. The trail user's experience is enhanced by providing an up-and-down motion as the trail curves up and around large trees or winds around boulders. Users also enjoy the brief respite from a constant grade in the climb from a streambed to a ridge top.

## Draining Water off Existing Trails

Water will always follow the path of least resistance, most likely the trail. Gullies form as water loosens and sweeps away the tread material captured on steep trails. Puddles may form in low-lying areas. When water severerly impacts the trek, trail users move around the damage. The trail becomes wider or new "social" trails are formed alongside the planned trail route.

Creating small drainage ditches with a bootheel, while draining a puddle in the short term has no long term benefit. These small openings are rapidly plugged by floating debris that drops into the trench and by mud displaced by passing traffic. More substantial strucures are needed to control the flow.

### Knick

The knick is an effective outsloped drain also referred to as a rolling grade dip. Knicks are "retrofitted" grade reversals (Figure 7). For a knick to be effective, the trail tread must have lower ground next to it so the water has a place to drain. A knick is a semicircle about 3 meters (10 feet) long that is shaved down and outsloped about 15% in the center. Knicks are smooth and subtle and should be unnoticeable to casual users.

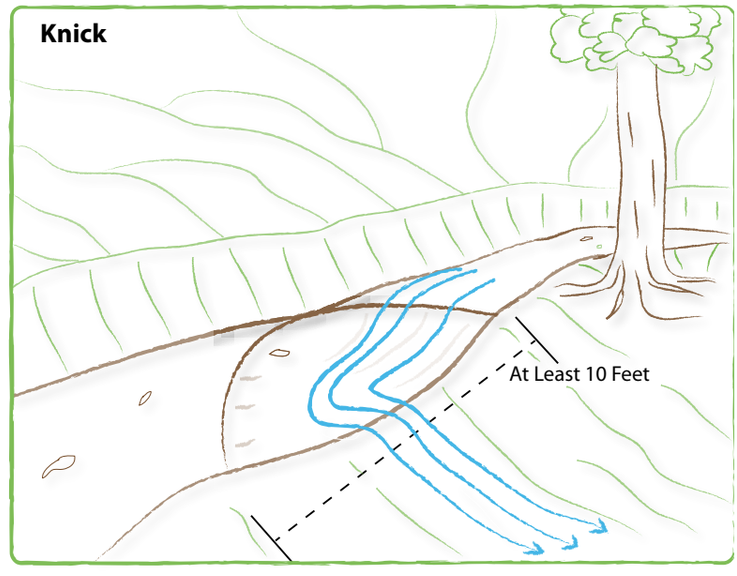



**Figure 7:** Knicks can be built into existing trails to help control water without altering the trail visibly.

Knicks have replaced the use of waterbars in many situations. The drains of waterbars are generally much smaller than the wide semicircle of a knick. By design, water hits the waterbar drain area and is turned. The water slows down and sediment settles in the drain and onto the trail. Water then overflows the waterbar and continues down the trail. Regular maintenance is required to clear the narrow drains.

The wide mouth of the knick will not fill with sediments as rapidly as a waterbar. A knick can be constructed more quickly than a waterbar without the need to carry in a tie or stripped log to anchor the structure. They also require less maintenance in the long term.



## Relocating Problem Sections of Trail

If drainage methods have failed and water is still impacting the trail, rerouting the problem sections may be the only viable alternative. Re-routes are short sections of newly constructed trail. Not only will rutted and difficult to traverse trail be decommissioned, new trail using sustainable construction methods will be put in its place. If the current tread failed, making a parallel tread next to it will certainly fail for the same reasons.

A section of the Berryman Loop Trail with erosion caused by water and trail location.

Make the reroute sustainable by:

- Locating the new section of trail on a sideslope.
- Keeping the trail grade less than half of the grade of the hillside (using the Half Rule).
- Building with a full bench cut to create a solid, durable tread.
- Incorporating plenty of grade reversals.
- Outsloping the tread.
- Compacting the entire trail tread.

The same area on the Berryman after a re-route along the natural contours of the terrain.

Make sure the new section that connects to the old trail has smooth transitions with no abrupt turns. Decommission the old trail by blocking it with native materials such as deadfall and rocks. See the references section for greater detail on trail decommissioning.

Some short sections of eroded trails may not be major problems. If the trail surface is rocky and water, use, and grades are moderate, the section could be saved by incorporating drain features like trail knicks or a waterbar if there are no other options. A short section of eroded but stabilized trail may cause less environmental damage than the construction of a longer rerouted section. Weigh your options wisely.

# BUILDING SUSTAINABLE TRAIL 8

The two primary techniques of single track trail construction used throughout the Ozarks are mechanized and hand line. Mechanized construction typically involves using equipment, such as a trail dozer or a walk behind skid steer. Trail dozers, are becoming more common for cutting in trail. When an experienced operator follows a good design, the trails roughed in by a dozer are impressive.

## Some Advantages to Using Mechanized Equipment

Mechanized equipment can speed up the construction process of a new trail and create more trails, faster.

Mechanized tools have the power to easily move large and heavy obstacles such as small tree stumps and rocks allowing volunteers to concentrate on finishing the corridor and tread.

It can help excite a volunteer base by giving volunteers quicker gratification for their hard work. Volunteers are still involved with mechanized trailbuilding by doing the corridor clearing, backslope construction and tread finishing work.

Difficult but rewarding features such as switchbacks, crib walls and other special drainage features are still done by hand.

A trail dozer is a one-man, small scale earth mover for roughing in trail to allow volunteers a head start on building.

Vounteers building hand-line trail.

## Some Disadvantages of Mechanized Equipment

It may be expensive if not provided by the land management agency.

The environmental impact depends greatly on the proficiency of the operator.

Sensitive environments can be adversely impacted by the machine.



For a sustainable trail to be properly constructed, volunteer hand labor is still required for the tread development and final touches. The dozer basically expedites the digging process.

The hand line method utilizes hand tools and starts from scratch. While this is a more labor intensive process and takes longer, volunteers often gain a larger sense of pride and accomplishment knowing they built the entire trail. In cases of steep topography or remote settings, hand line trail may be the only option available.

A consideration in constructing hand line trail is ensuring that volunteers are working along the same line of construction. With a hand line trail, it is easy for volunteers to get off the flagged line. Pin flagging may be needed to ensure the proper line is established and adjoining pieces of trail meet at the same level.

Key to a successful build goes back to the Crew Leaders. Construction crews that are aware of a project's goals and objectives will build better trail. Crews that understand the basic principles of sustainability and water control will build better trail. A good Crew Leader understands a trail's objectives and basic trail design and effectively communicates this information to the crew. Educated volunteer crews are not only more effective, they take ownership, feel like part of the process and are more likely to volunteer again and again.

## Six-step Construction Method

The Ozark Trail Association follows a six step construction method when constructing new hand line trail.

There are many circumstances where you will encounter methods of construction other than hand line. For trails within a National Forest and for large Ozark Trail Association events, trail dozers and other mechanized equipment  are often used for initial trail development and volunteers may begin their work with by clearing dozer "slough" (dirt and organic material cut from the cross slope). On dozed trail, volunteers may begin with the second or third steps below.

There will also be times where trails need specialized construction including drainage, crib walls, French drains, bridges and other features. The land management agency will often handle these special needs, but it will be beneficial for Crew Leaders to develop the knowledge to recognize areas that are in need of these special features. Resources for further training in the field of trail design and constructing special structures are identified in the references of this manual.

### Step 1: Clear the Corridor

Every trail needs an opening or corridor through the complex "enviroscape" of trees, shrubs, grassland, rocks, and water (Figure 8). This corridor needs to be wider than the tread itself, but should look as natural as possible. The height and width of the corridor vary according to the intended users, the site, and the dominant vegetation. Trail standards of height and width are established by the land management agency. The following guidelines are for clearing the corridor:

- Remove rocks and vegetation to create an opening and establish the corridor.
- If over half of a plant needs to be pruned, it is better to remove it.
- Cut trees and other vegetation leaning into the corridor but not in the tread at ground level. Use duff or dirt to hide the ground level stump of a tree.
- Small trees growing in the tread will need to be dug out.
- Limbs extending into the corridor should be pruned back at the tree, not at the edge of the corridor. Prune branches of trees to within no more than ½ inch of the bark collar.

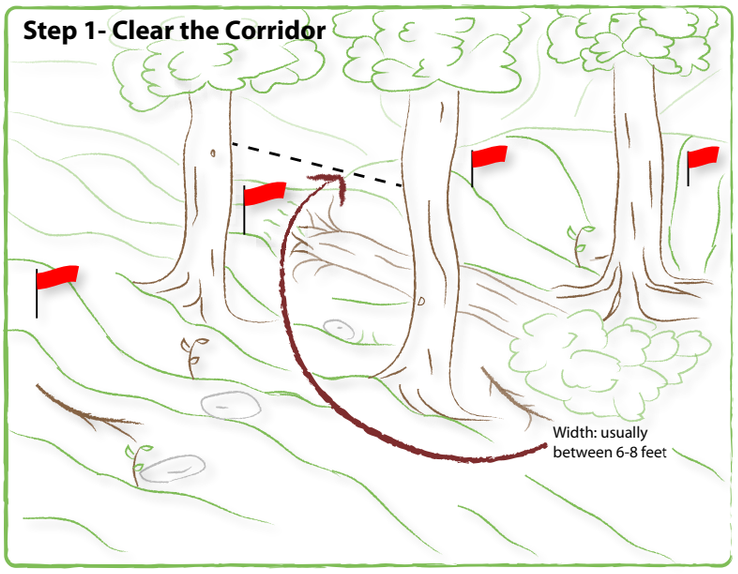



**Figure 8:** The corridor is a path 6-8 feet wide, including the tread, free of rocks, vegetation limbs and trees.

- Brush removed from the tread should be moved uphill at least 30 feet from the corridor with cut ends facing away from the corridor.

## Step 2: Establish Starting Point of Construction

There are several methods that trail designers will use to mark or flag a new trail so that Crew Leaders will know where to begin construction. This training will discuss three different methods used by trail designers.

1. **Inside Edge Method (Figure 9) –** The inside edge, where the tread meets the backslope, is marked with a line of pin flags or stakes.

- Cut a shallow line between the pin flags.
- Additional pin flags may be marked along the lower edge of the proposed tread so volunteers have a gauge of the width of the tread.

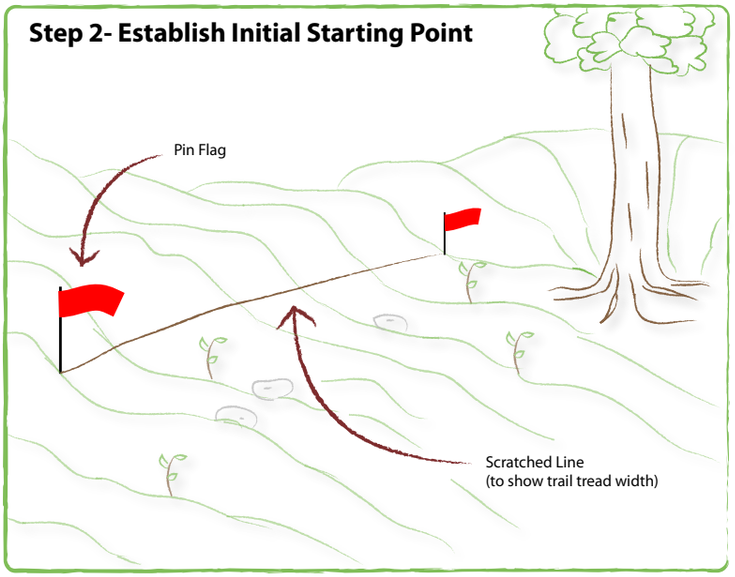



**Figure 9:** Inside edge method uses marking on the spot where the tread will meet the backslope.

**2. Center Line Method** – In this method, the center line of the trail tread is usually marked with a line of pin flags or stakes placed at intervals of 5 to 10 feet along the length of the trail route.

- Cut a shallow line along the uphill edge of the tread at half of the tread width measuring from the centerline flag for the entire section of work.
- Check location of flag line frequently as you cut this line so as to stay on course.
- This upper line can be marked with more flags to make it easier for the crew to follow.

**3. Critical Edge Method –** The critical edge is marked with a line of pin flags or stakes.

- Cut a shallow line along the uphill edge of the tread for the full tread width measured from the critical edge flag for the entire section of work.
- Check location of flag line frequently as you cut this line so as to stay on course.
- You can mark this upper line with more flags to make it easier for your crew.

**When mechanized construction methods are used, volunteers start with Step 3. They will be removing "slough" (soil cut out to form the bench by the trail dozer) to reveal the natural soil surface.**

### Step 3: Establish Initial Tread Surface

- After cutting a shallow line, start digging and grubbing to establish a rough trail bench and tread(Figure 10). While working on the tread, it is important that the crew not walk on the critical edge in order to protect the integrity of the trail surface.
- Clear organic matter (leaf litter, small twigs, hair roots, etc.) from the surface.
- Save some slough (mineral soil from cutting the bench) for later restoration work if needed, otherwise disperse and scatter down the slope about 15 feet or to agency specifications.
- Cut flat or slightly outsloped tread with slanted backslope.
- Excavate less than you think you need to in terms of both width and depth of the tread. Better to excavate more

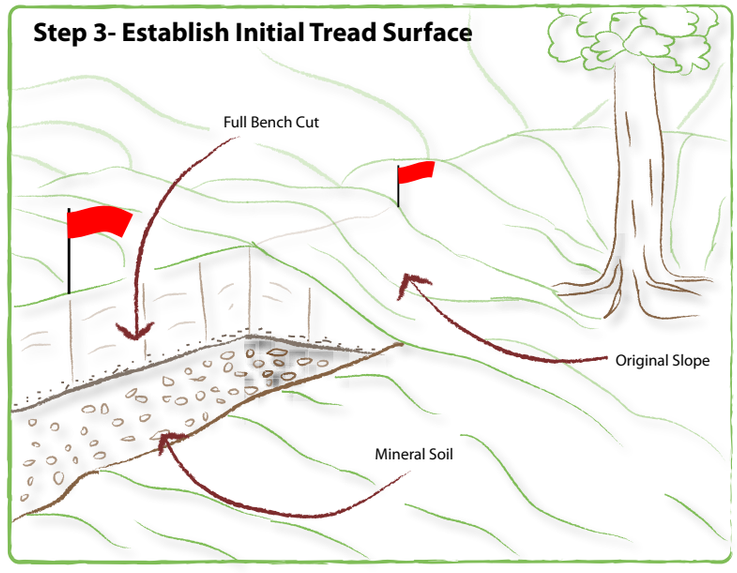



**Figure 10:** Establishing initial tread means removing organic matter from the surface down to original soil.

later than try to re-pack soil in holes left because of too much excavation.

- Remove any object that will act as a dam or gutter to collect and hold water on the trail.

Volunteers who worked together to move a large rock from the trail tread

### Rocks

Large round or rectangular rocks at the surface of the tread can make a good, durable trail surface and should generally be left in place. Jagged, pointy, sharp rocks force users off the trail, create trip hazards and should be removed if reasonable. Keep in mind, when these rocks occur near, but not in, the tread, they will keep the user on the trail. Remove any rocks that will work loose and leave holes. If a rock is too large to remove, consider chipping with a pick mattock to remove the jagged portion (wear eye protection!).

### Roots

Take out roots that run parallel to the trail as they tend to hold water on the tread. Remove any roots that may become trip hazards. Leave any exposed roots with a diameter the size of your little finger or smaller.

For both rocks and roots, do not remove if:

- It poses a hazard to the crew.
- It's not clear how to remove them.
- Proper tools/resources/fill materials are lacking.
- It would make the trail worse than leaving it.

## Step 4: Establish Backslope

The backslope (Figure 11) is important as a transition between the trail and the slope above the tread and controls how water enters the tread from above. As water moves down the native slope, it is broken up by leaf litter on the forest floor and flows in a dispersed sheet. Water moves more slowly as a sheet than as a stream and is therefore less erosive. The backslope helps maintain a sheet

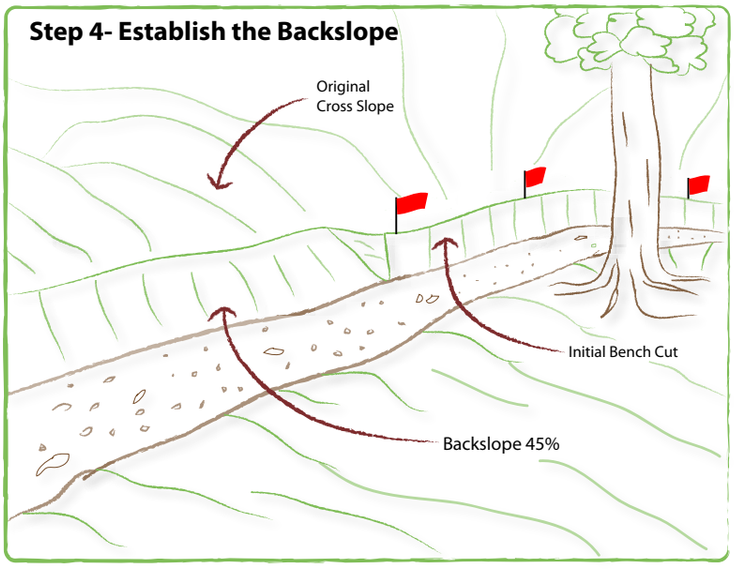



**Figure 11:** The backslope is "laid back" into the hillside as a transition between the trail and the cross slope.

flow and prevents a waterfall effect where the water encounters a vertical drop to the tread (like water flowing over a clogged gutter and eroding the ground below). A general rule is to construct the backslpe at about half the slope of the native hillside. Shave the backslope in from the top down, taking care not to cut into the tread.

The backslope is cut in from the existing slope down to the tread.

### Step 5: Establish Outslope

Now that the trail tread has been cut and the backslope created, it is time to establish the critical edge and refine the outslope of the tread (Figure 12). A level trail will create puddles and encourage water to flow down the trail. An outslope of 3-5% will allow the water to continue to sheet across the tread and over the critical edge. To check for proper outslope, use a McLeod and stand it upright on the tread. Step back 15 feet from the tool. The tool should lean outward at 3-5%.

The trail should be well compacted and fairly smooth with no place for water to puddle. The critical edge should have no loose fill or debris. Do not create berms, or outline the trail with rocks or logs. The critical edge is more revealed than constructed. It is a smooth, rounded transition between the constructed tread and the native hillside.

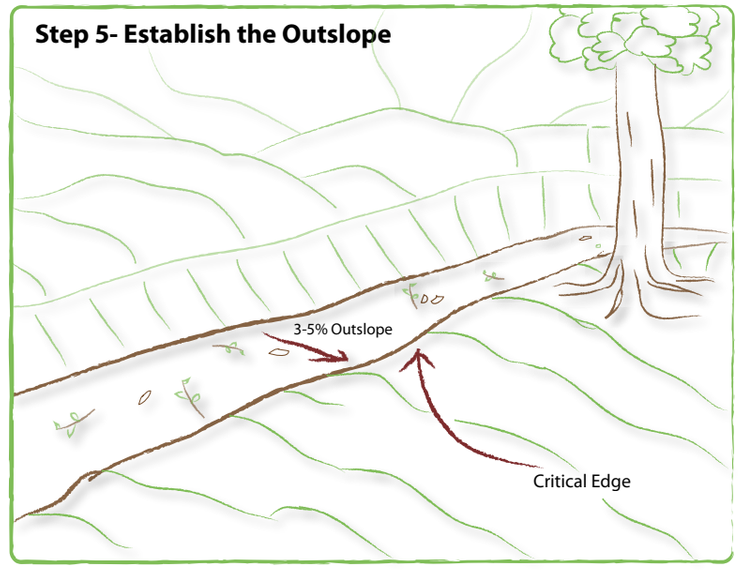



**Figure 12:** An outslope of 3-5% will allow water to continue sheeting action across the tread and over the critical edge.

## Step 6 : Reclamation and Finish Work

Take the time to evaluate the work (Figure 13). Step back and view the whole picture. Have the standards for the project been met; for appropriate trail corridor height and width, tread width, backslope, outslope and obstacle removal? Give the new trail the "boot test." Walk the length of the new tread several times; your feet will tell you if anything needs a little more attention.

When finished with a section of new trail it should appear as if it has always been there.

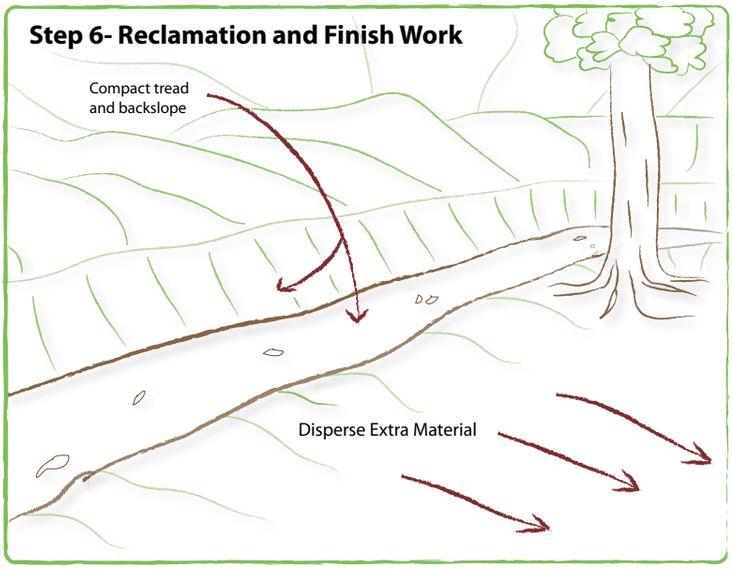



**Figure 13:** After the final step of trail building, the trail should appear as if it has always been there.

- Repair any scars to the area surrounding the trail.
- Do not leave rocks that are clearly "out of place."
- Mask the area below the critical edge with leaves to give the trail a more mature appearance and keep users from walking off the tread. Be careful not to impede water flow over the critical edge.
- Make sure no trash or tools are left behind.

# BASIC TRAIL MAINTENANCE

9

Trail maintenance is a critical activity that ensures the success of a trail. Problems that may need special attention include repairing tread, removing berms of soil that may have accumulated along the critical edge, or repairing damage caused by excessive or improper use or motorized vehicles. Techniques that use hand tools will be the focus of this section with an emphasis on trail corridor and tread maintenance.

Trail maintenance often includes clearing overgrown vegetation, especially after a growing season.

Most trail maintenance issues throughout the Ozarks result from downed trees and excessive vegetation growth. For seasonal mowing, the Ozark Trail Association has brush mowers that are capable of cutting vegetation along some of the trail, but grass trimmers are the tool of choice. Removal of downed trees may require specific certification from the land managing agency. For example, the U.S. Forest Service requires sawyer certification before allowing volunteers to operate a chainsaw for trail maintenance. If unsure, check with the land managing agency and always be certain that the volunteers on trail maintenance crews have the correct certification (especially in the case of chainsaws) and proper safety gear before allowing them to conduct these types of activities.

Finding solutions to continuous problems with the trail, such as major erosion problems, boggy areas, or loose soils, may be more efficiently handled by rerouting the trail. For this task, work with the land manager and utilize the planning steps listed in this manual for trail design and construction. Trails that are built using the sustainability concepts listed here will require much less maintenance.

## Priorities in Trail Maintenance

If the land managing agency does not have a specific maintenance plan, the following three priorities can be used to determine which tasks to complete:

1. Correct unsafe situations. This could mean repairing impassable washouts along a cliff or removing leaning or downed trees.

2. Correct natural resource damage like erosion, sedimentation and off-site trampling.

3. Restore the trail to the planned design standard. This means that the ease of finding and traveling the trail matches the construction standard for the recreational setting and anticipated user group. Actions may range from simply adding signs to reconstruction of eroded tread or failed structures.

Prior to the work event, determine what projects can be accomplished as basic maintenance, what projects can be deferred, and what projects will need major work. Always inform the land management agency of all work completed and any work not completed.

## Trail Corridor Maintenance

Trimming overhanging limbs is an important part of ongoing corridor maintenance.

Plants growing into a trail corridor or trees falling across a tread surface are a threat to user safety and trail integrity. Encroaching plants may make travel unpleasant or even completely hide the trail. In the Ozarks, ticks are a major concern and are more likely to be found in areas with tall vegetation. In regards to downed trees, it doesn't take a full obstruction of the tread to push users to one side or the other. Anything that impinges on the user's visual perception of how clear the trail is will push them to one side or the other. For example, a low branch that comes to within a foot of the tread, when it is about at eye level, will tend to push the user to the other side of the trail. Most trail corridors are cleared an equal distance on either side of the tread centerline. Construction or maintenance standards established for that trail determine the height and width of a trail corridor. A Crew Leader needs to follow the trail standards set by the managing agency. Within the trail corridor, plant material and debris are cleared all the way to the ground. Large trees and boulders within this corridor are obvious exceptions and should remain.

## Tread Maintenance

Tread maintenance ensures that a solid, obstacle-free tread is established and enough protection is provided to keep it in place. Tread work requires maintaining tread to the original standards set in the TMOs. This means removing slough and berm, filling ruts, holes, and low spots. It may include removing obstacles such as protruding roots and rocks. Do not leave any exposed roots or tree stubs that can become

Downfall from storm damage on the Middle Fork-John Roth Memorial section of the Ozark Trail

a tripping hazard or a sharp stub that could cause injury. Tread maintenance returns the surface to a solid outsloped trail. Some land management agencies advocate pulling the lower edge berm back onto the tread surface and using it to restore the tread outslope as well as using any slough material in the same fashion. Only do so if the material can be firmly packed, not creating another berm. Remove and widely scatter organic debris well beyond the clearing limits, preferably out of sight.

## Tread Creep

Remove slough and berm that has formed on the tread (Figure 14). On hillside trails, slough is soil, rock, and debris that have moved downhill to the inside of the tread, narrowing it. Leaving slough will cause the trail to "creep" downhill as users seek the remaining narrow tread, often walking on the critical edge. Loosen compacted slough and then push or pull the soil down the slope. Blend the slope of the tread into the backslope area and compact the repaired tread.

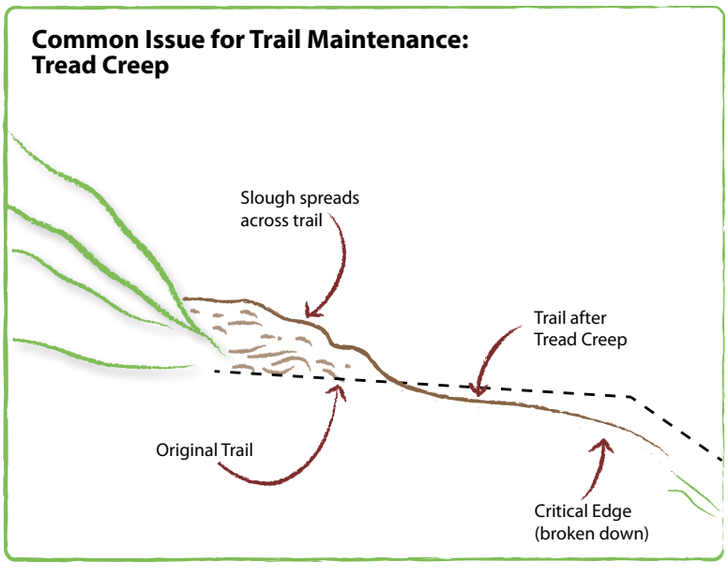



**Figure 14:** Soil rock and debris building up on the inside of the tread causes the trail to creep downhill.

## Berms

Berm formation is the single largest contributor to erosion of the tread surface and its removal is the most important task for trail maintenance (Figure 15). Berm is a combination of soil that has built up on the critical edge through erosion and re-depositing of soils and the middle of the tread becoming compacted with use over time. The combination forms a barrier that prevents water from sheeting across the trail. The berm forms a false edge that is unconsolidated and unstable material, often including significant amounts of organic material.

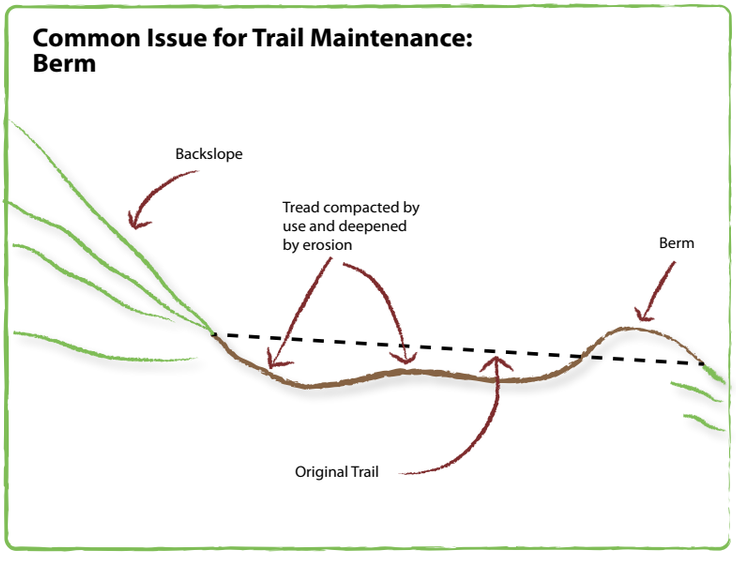



**Figure 15:** Berms on the tread prevent water from sheeting across the tread and can lead to erosion of the tread surface.

Bermed tread may be the result of slough deposited on the inner edge causing compaction of the designed tread. Reestablishing the tread may require removal of inner edge slough and the berm. The tread must be returned to a firm outsloped tread with a rounded critical edge. A common error is removing most of the berm but not being sure that the tread is fully outsloped so water can sheet across the tread. Use the McLeod or other method to check the outslope.

## Appendix A: References

Forest Service Handbook (FSH 2309.18). U.S. Forest Service, 2008, http://www.fs.fed.us/cgi-bin/Directives/get_dirs/fsh?2309.18

Forest Service Standard Specifications for Construction and Maintenance of Trails (EM-7720-103).U.S. Forest Service, 1996.

Hesselbarth, Woody, Brian Vachowski and Mary Ann Davies. Forest Service Trail Construction and Maintenance Notebook. U.S. Forest Service, 2007. http://www.fs.fed.us/t-d/pubs/htmlpubs/htm07232806/page02.htm#job

Forest Service Health and Safety Code Handbook (FSH 6709.11). U.S. Forest Service, 1999.

Trail Skills Series: Basic Trails-Overview: Construction and Maintenance. Outdoor Stewardship Institute (OSI), Volunteers for Outdoor Colorado, (VOC) 2008.

Crew Leader Manual: Working with volunteers to build quality non-motorized, multi-use trails. Volunteers for Outdoor Arizona, 2003.

# CREW LEADER INSTRUCTIONS

**CREW: _____**

**Crew Leader: _____**

**Crew Co-Leader: _____**

Welcome to the joys of leadership! The second-best thing about being a Crew Leader is that your back shouldn't hurt as much. The best thing is that you get to teach your trail-building skills to others. You know most of what is covered in these instructions, aside from a few agenda items. But it never hurts to remind ourselves why we're here. First, the agenda and a few procedural issues:

- **8:00 a.m. Crew Leader & Co-Leader Meeting.**
- **8:30 a.m. Group Welcome Meeting.**
- **8:45 a.m. Assemble your crew.**
    - The Event Manager will give you a list of crew members.
    - Verify you have everyone present; if anyone is missing, contact the Crew Manager.
    - Arrange carpooling—try to use as few vehicles as possible.
    - Proceed to the Starting Point .
- **9:00 a.m. Re-assemble your crew; proceed to control point.**
    - Make sure you have everyone.
    - Give safety instructions.
    - Gather your tools.
    - The Crew Leader is in front and the Co-Leader sweeps. Keep 10' apart, carry tools on downhill side, sharp end down.
    - Go to your assigned worksite.
    - Give trail building instructions and tool demonstration.
    - Build some trail!
- **Noon Lunch.**
- **1:00 p.m. Continue trail building**
- **3:00 p.m. Walk-Out to Starting Point, verify headcount, return to camp.**

# CREW LEADER INSTRUCTIONS

*Page 2*

Second, reminders for volunteers:

**Safety**

- Instruct volunteers on the proper way to carry tools with 10′ between people.
- When not in use, tools are laid gently on the upslope, handle facing the trail.
- Announce 'Coming Through!' when passing someone on trail.
- Do not overexert yourself.
- Drink plenty of fluids.
- Take needed rests on upslope of the trail away from other workers.
- Lift with your legs, not your back.
- Immediately notify Crew Leader of any injury.
- Do not leave early without notifying Crew Leader.

**Trail Construction**

1. Clear trail corridor.
    a. 6′ wide, 10′ high or as instructed by the land manager.
    b. Prune limbs flush with the limb collar.
    c. Remove saplings flush with the ground ("Drop & Lop!" No exposed stubs!)
    d. Drag limbs, branches and trees 30′ from trail with the cut end away from the trail.
    e. If you need chainsaw cuts made, contact the Crew Manager.
2. Rough-set trail bench – This step may be done by a trail dozer in advance.
3. Remove slough and establish initial tread.
    a. Pull off slough from the bench cut downhill and disperse.
    b. Remove rocks and roots as needed.
    c. Dig out stumps in tread.

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# CREW LEADER INSTRUCTIONS

*Page 3*

4. Establish Backslope.
    a. Transition from original slope to tread.
    b. Cut in at about half the slope of the original hillside or 45 degrees on gentle slopes.
5. Finish tread.
    a. 30" wide or width specified by land steward.
    b. 3-5% outslope.
    c. Establish Critical Edge.
    d. Apply the "Boot Test."
6. Finish Work.
    a. Mask slope below tread with leaf litter.
    b. Recheck corridor height and width.
    c. Self and team evaluation of trail built.

**Leadership**

1. Good communications.
2. Tell your crew the expectations & goals.
3. Teaching is one of your important tasks – don't work so much that you ignore the work of your crew.
4. Consistency in trail construction.
5. Role modeling – your conduct and the trail you build should be a guide to your crew.
6. Problem solving.
7. Constructive criticism.
8. Praise the work of your crew.
9. Handle serious rule violations promptly.

**Radio Procedures**

- Every crew should have a radio. If you don't have one and need radio communications, walk to the next crew.
- Clear text only (no "10-codes").
- Depress transmit button, speak, release transmit button.

# CREW LEADER INSTRUCTIONS

*Page 4*

- State your name then who you are calling. Example: "Jones to Smith."
- When responding to a call, say "Go ahead, calling <party name.>"
- Use "affirmative" for yes, "negative" for no.
- Reply with "copy" if you received and understand a message, and have nothing more to say.
- Keep messages brief. No chatter!

**Emergency Procedures**

Crew Leaders are to immediately report all incidents to the Event Manager. First-Aid kits will be available for small cuts, insect stings, and minor incidents. More serious incidents may need emergency care. Know who to call in case of emergency.

# TEAM SIGN-UP FORM

## Crew # ____

Team Leader: _____

Co-Leader: _____

Team Members:

| NAME | CHECK IN | CHECK OUT |
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## CARD 1 – INITIAL CONTACT

- Gather Crew – Take roll call
- Introduction (yourself and Co-leader; Thank everyone)
- Brief review of the day's project – why important
- Initial Safety Talk
    - Check for proper footwear, clothing, gloves, water, food
    - Hand out safety gear (PPE) – eye protection, hard hats
    - Find out who has First-Aid or medical training
    - Ask about special health issues (discuss in private)
- Get head count (Co-leader's duty)
- Arrange for carpools - give directions
- Depart for worksite - "convoy" to the worksite

## CARD 2 – WALK-IN POINT

- Reassemble crew near tools and take head count
- Safety Talk
    - Safety First! Notify Leader of injuries or emergencies
    - Keep 10' spacing at all times while walking in
    - Carrying tools – at side, sharp end down
    - Dogs should remain on leashes
    - Stress staying together – Notify Leader if leaving
    - "Coming Through" – Asking, make eye contact
    - Work at own pace, take breaks, stay hydrated
- Recheck safety gear, assign tools
- Proceed to site – Leader in front, Co-leader last (sweeper)
- Discuss key trail construction points on the way in

## CARD 3 – WORKSITE

- Reassemble crew and get a head count
- Allow experienced volunteers to start working
- Place tools and gear on uphill slope
- Brief repeat of key safety issues
- Tool Talk

**Loppers:** cut limbs (bark collar). Cut saplings (ground level). "Drop and Lop" – No sharp stubs

**McLeod:** Move dirt, rake, finish tread, measure outslope

**Fire Rake:** cut surface roots and organic surface material

**Pulaski:** hoe end for cutting in backslope tread. Axe end for cutting roots and stumps

**Pick Mattock:** dig out and chip rocks, cut in bench

**Bow Saw:** remove branches, roots in tread and backslope

**Leaf Rake:** clear leaves and mask critical edge

## CARD 4 – CONSTRUCTION DEMO

- Crew Leader talks, Co-leader (or volunteer) demos with tools
- Goals: create solid travel surface, keep water off the trail
- Six Step Method –

1. Clear the Corridor – Trim limbs, remove stumps, large rocks. Remove brush 30' uphill – cut end away
2. Starting point of construction – Inside edge method
3. Cut in bench and establish initial tread surface
4. Establish backslope – ½ original slope, > or = 45°
5. Outslope tread 3-5%, establish Critical Edge
6. Finish work – compact tread and backslope, masking

## Appendix E: Suggested Tool Mix



Adult volunteers may safely carry two tools each – one in each hand. A leashed dog occupies a hand and that volunteer will only be able to carry one tool safely. A pair of loppers may be carried as a third tool if safely stored in a pack. Be sure that children are strong enough and attentive enough to carry any tools. The Crew Leader will need to watch children closely since their parents may not recognize the danger if they are novice trail volunteers.

| Gear | Dozer Cut | Hand Cut | Maintenance – Light Corridor Clearing | Maintenance – Tread work, Minor Reroute |
|---|---|---|---|---|
| McLeod | 8 | 7 | - | 8 |
| Pulaski | 5 | 5 | - | 4 |
| Pick Mattock | 2 | 5 | - | 4 |
| Fire Rake | 2 | - | - | - |
| Lopper | 2 | 2 | 10 | 2 |
| Hand Saw | 1 | 1 | 10 | 2 |
| Shovel | Optional | Optional | 0 | Optional |
| 5 Gallon Bucket | Optional | Optional | 0 | Optional |
| Rock Bar | Optional | Optional | 0 | Optional |
| Hard Hats | 10 | 10 | 10 | 10 |
| Gloves | 10 | 10 | 10 | 10 |
| Eye Protection | 10 | 10 | 10 | 10 |
| First Aid Kit | 1 | 1 | 4 | 1 |
| DEET | 1 | 1 | 4 | 1 |
| Hornet Spray | 1 | 1 | 4 | 1 |

Tool mix based on a crew of 10 adult volunteers in average conditions.

### Notes

Adjustments to the mix may be needed based on conditions. For example, rocky conditions call for fewer fire rakes and more mattocks. A rock bar may be needed. A shovel and bucket may be wise in case the removal of large rocks require fill dirt to be brought in from somewhere adjacent to the work site.

The variation in tools between dozer cut and hand cut (called "hand line") is due to the higher volume of grubbing needed with hand line construction. The heavier mattocks are more efficient at cutting a deep backslope. Fire Rakes are good for finishing tread when working dozer cut, but are left behind for hand line trail.

## Appendix E: Suggested Tool Mix (cont).

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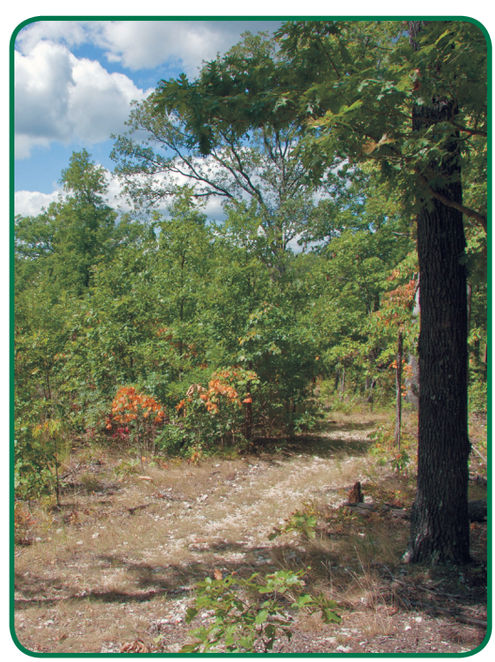
Hard hats are required by many land managers. This is for safety and usually reflects the fact that volunteers are asked to comply with the same safety standards developed for the land manager's own employees. Safety goggles are especially good to have since flying rock shards, wood chips and dirt are all part of the trail building experience.

Volunteers invariably forget gloves. Inexpensive leather palmed gloves will protect hands, making the day last longer and not be remembered just for the painful blisters. Additional First Aid kits are required for light maintenance outings since groups tend to disperse over larger distances.

Volunteers often forget to pack an insect repellent with DEET and they are relieved to find some with their Crew Leader. Hornet spray should be part of the mix during the fall. Don't pick a fight with a hornet's nest! Mark the area and leave nest removal for a time when volunteers are not present.



Ozark Trail Association  406 W. High St.  Potosi MO  63664  **ozarktrail.com**