SUPERIOR HIKING TRAIL ASSOCIATION

TRAIL MAINTENANCE MANUAL

2021

INTRODUCTION

Thank you for your interest and dedication to the Superior Hiking Trail (SHT).

Perhaps you have been volunteering for 20 years or more, or maybe this is your first time. You may dedicate days or even weeks of your time each season, or you may only help us out for a couple hours. Whatever the case, and you will hear this time and time again, your work is the backbone of the SHT. Without your support, we would not or could not exist, so THANK YOU! Your labor makes our Trail, enjoyed by tens of thousands of users each year, possible.

It is our hope that among the many ways volunteers can contribute to the Trail, you can find something that suits your personality, skills, and passion that will keep you fulfilled and returning year after year. It is also our hope that in the course of your service, you will meet and make new friends, deepen your knowledge, be challenged, learn new skills, develop a sense of pride and ownership in your work and the Trail, and finally, that you will have FUN!

There are many great books on the subject of trail building and maintenance out there, and we at the SHTA decided that there was no reason to reinvent the wheel. A resource guide with many of these titles will be included at the end of this Manual, and it is strongly recommended that you familiarize yourself with these books. The purpose of this particular manual is to supplement all these other wonderful resources out there with specific information on the techniques that are favored, either for aesthetics or practical reasons, here on the north shore of Lake Superior in northeastern Minnesota.

It gets very cold here, the winters are long, and summers are often very wet (and getting wetter). We have a lot of dense clay that produces spectacular mud and lots of rock that presents its own opportunities and challenges. Then, there's the extremely steep and rugged terrain.

We hope this manual clearly explains the basic tasks of trail maintenance, including the brushing, pruning, and clearing that anyone can do. It also touches on some of the more complex tasks, such as tread maintenance, water mitigation, and basic structure construction that volunteers should not attempt without prior training or hands-on experience with these specific techniques.

It is intended to be the basis for how SHTA's Trail Stewardship Teams will carry out their maintenance duties. And it will help guide volunteer Section Adopters as they go about their own maintenance tasks.

At its essence, this Manual provides a **set of standards** to be applied along the whole length of the SHT to bring consistency and cohesion to trail maintenance and construction. These standards are based on nationally accepted guidelines and best practices for trail maintenance and construction. Whatever your level of experience, and no matter if you have been doing things a certain way for years, **we ask that you take these standards seriously and adhere to them.** If something is unclear, or you disagree with something in particular, please ask, rather than disregarding it altogether.

The emphasis on fine detail for trail maintenance may cause some to think, "This is fussy for just a hiking trail!" But not adhering to these standards over the entire 300 miles of the SHT means sloppy practices will add up to noticeable problems down the line. In other words, it is important to take the time to do a good job, rather than rushing through and trying to get as much done as possible. Your investment of time and effort today will pay dividends for decades to come.

Some of the inspiration and source material for this manual came from the USDA's "Trail Construction and Maintenance Notebook"; the Student Conservation Association's "Lightly on the Land"; Volunteer for Outdoor Colorado's "Field Guide"; the North Country Trail Association's "Handbook"; and training manuals received from the Ice Age Trail Alliance.

ACKNOWLEDGEMENTS

Volunteers like you make the SHT possible, and a generous volunteer made this Trail Maintenance Manual possible too. We extend our deepest gratitude to graphic designer **Jennifer Osborne Anderson** (janderson.design) for contributing her time and expertise to assist with the development of this manual and the graphics within.

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MAINTAINING THE CORRIDOR

Performing basic trail maintenance, including corridor and tread maintenance, is so important for the health of the Trail and enjoyment of its visitors. A trail that is overgrown with brush and fallen trees will become impassable, and tread that has become compacted and channels water down the Trail rather than shedding it is far more susceptible to erosion and mud. The longer these issues remain, the more pronounced the problems become.

At some point, it may no longer be worth the effort. Damage may be beyond the scope of routine repair, and some kind of tread hardening (puncheon, boardwalk, or reinforced and raised tread) or reroute will be required. These will be discussed later, but are mostly outside the scope of this manual.

BRUSHING THE CORRIDOR

When we talk about the "trail corridor", we are referring to not just the worn path where people walk, but a distance to either side of that path, as well as overhead. Our standard for the SHT is a **maximum corridor width of 8 feet** (this is 4 feet to either side of the **centerline** of the Trail), and 8 feet overhead. Keeping the corridor to an average width between **5 to 6 feet is often ideal**, and the absolute **minimum corridor width is 4 feet**. It is best to use the centerline, rather than the edge of the tread to determine corridor width, because the edge does not remain consistent over time. It is important to remember that this is a standard, not a hard rule. You must use your judgement: if the brush is not too thick, it might be alright to leave a particular tree in that corridor, and if the brush is really thick you may want to cut it back a little further. If you are on a hillside, you always want to cut more from the uphill side of the Trail. It is a common practice to brush a little wider than you think is necessary to account for the fact that it may be years before you, or anyone else, performs maintenance on that spot again. A very easy (and general) test is to walk down the center of the Trail with both of your arms held straight out to the side. Anything that touches you should be entirely removed.

The only exception to this standard would be at certain intersections, especially bike trail and ATV crossings. In these locations, keep the trail to about a 4 foot wide corridor for about 10 to 20 feet to discourage any illegal use. Ensure that the Trail is clearly marked in

Prune all branches back to the trunk, not the edge of the Trail.

these locations, and notify staff if we need more signs. As with any blaze or sign on the trail, brush well around any signs so that they are visible from a distance.

In the end, you don't want a straight "hallway", but a natural, uneven edge. The goal of brushing is to keep the Trail's corridor free of encroaching small trees and brush. One must not only consider branches that are in the corridor, but ones that are currently outside that may grow in and become a problem before that section will be brushed again.

This is an important point to keep in mind: you will be cutting brush back about 3 feet (or more) from the edge of the Trail -- not just what is growing at the Trail's edge.

See SHTA's informative and amusing video on lopping the corridor: youtu.be/m0i7ZLW8Q-I

The primary tools you will be using for brushing and pruning (covered below) will be hand pruners, loppers, and hand saws. Focus your efforts on woody stemmed plants, as succulent plants will be whipped by crews coming through with motorized weed-whippers. Generally, shrub species (hazel, alder, mountain maple) will require you to cut out the entire plant, while with trees (conifers like pine, spruce and balsam and hardwoods like aspen, maple and birch), you will need to decide if you are going to take out the whole tree or just prune some branches. It really helps to have some knowledge of common local plants and their typical growth patterns, and while you are out brushing is a great time to learn!

When removing the entire plant, **cut stems flush with the ground**. Otherwise, they damage the whipper line on the weed whips and may become a tripping hazard. It is also important to **make straight cuts** so that there are not rows of pointy stobs sticking up

A very clean corridor. Note the branches cut back to the trunk on the balsam.

when you are finished. If those are left behind, they can harden, dry, and present a real danger if somebody trips and falls on one. If there is something growing into the Trail, but the main trunk is 15 feet back in the woods, go all the way back if you can and cut it flush (you will see this a lot with alder). When you are done, you can "fluff up" the ground litter, so hikers will not see any sign of your work.

As you work, pile cuttings off the Trail so that people can pass. Arrange them neatly, with all stems and tips oriented in the same direction. This makes swamping, or dragging the brush outside of the Trail corridor, easier. Swamping is the final stage in the process. All cut material must be carried into the woods, out of sight. Keep in mind that, once all the leaves fall off, visibility is greatly improved. Try to ensure that the pile has good ground contact (stomp it down if you need to) which will make it less visible and help in decomposition. For sanity, it really helps to have at least two people (although four is better), so people can switch off brushing and swamping -- everybody stays fresh.

PRUNING

If you decide to selectively cut branches from a larger tree, you must take care to do it properly. Sloppy work will look bad for years to come and may also damage the tree. It is important to be careful and precise!

If the tree is within the corridor, it is strongly advisable to remove the whole tree rather than trying to prune it. This applies especially to young conifers, as they have a lot of laterally growing branches that will be an issue for a long time, and a small tree (4-5 inches or less) is far easier to cut and swamp than a large one.

Smaller branches can simply be cut with loppers. **Cut the branch back at the trunk**, but take note of a slight "swelling" at the base of the branch where it grows out of the tree.

(left) Properly pruned tree. (right) Leave ¼ to ½ an inch of branch stub beyond the "branch collar".

This is called the branch collar: do not cut into this, as it is the tree's healing mechanism. Aim to leave about a quarter to half an inch of the branch when pruning.

If you cannot get all the way back to the trunk (which may be the case if the branch is too high but hangs down into the Trail), do your best to cut it at a fork in the branch structure. This will look more natural.

Larger or heavier branches should be cut with a saw (a sharp pruning saw is best) using a three-step process to ensure a clean cut and to prevent the branch from pulling bark off of the tree as it falls. First, make a shallow cut on the underside of the branch at least 8 inches away from the trunk, being careful not to cut so deep as to pinch your saw blade. Then, start the second cut a few inches away (further from the tree from the first) at the top, and saw all the way through. The branch may snap off at your first cut, but that is alright; the bark has been severed there, so it will not tear out. Your third cut, now that all the weight has been removed, is at the trunk, a half inch from the collar, to finish the job.

Special Concern: Oak Wilt. Oak Wilt is a fungus that infects oak trees, and is particularly devastating to Red Oak group species, which you will find in places along the SHT, mostly from the Southern Terminus up to the Finland area. Generally speaking, you should avoid cutting or pruning any oak tree from April through July. For more information on Oak Wilt and how to diagnose it, visit the following websites: U of MN Extension, and MN DNR.

CLEARING

Clearing the Trail of fallen trees is a very important part of corridor maintenance. In some instances the Trail can become completely impassable! It is usually done once a year in the spring, as many trees tend to come down over the winter, but it is sometimes necessary to redo a section after the passage of a major storm.

While a log lying on the ground is generally pretty safe to cut, recently fallen storm damaged trees can pose serious hazards and complexity, so it is always advisable to:

- Wear ALL required Personal Protective Equipment (PPE) for clearing trail.
- Size up every situation before you start cutting.
- Never attempt something that makes you feel uncomfortable or unsafe, or that is beyond your skill level.
- **Volunteers are not allowed to engage in any felling activities. Never cut down a standing tree, or one that is hung up.**

Remember that these trees can still contain some powerful forces, even when lying on the ground. You are working in a remote location where help may be long in arriving, and your personal safety is the top priority. If it's more than you can handle or are qualified to do, take a picture and notify SHTA staff.

In order to use a chainsaw, either gas or electric, you must first take a United States Forest Service (USFS) class (or one approved by them). The SHTA gets a certain number of spots in their annual training classes, so contact the SHTA to be enrolled. You must also have valid CPR and First Aid certifications. UNDER NO CIRCUMSTANCES SHOULD YOU OPERATE A CHAINSAW ON THE SHT WITHOUT THESE THREE VALID CERTIFICATIONS.

CLEARING TREES: THE DETAILS

Whether you use a chainsaw or hand tools, the process for trail clearing is the same. Size up the situation and determine if there are any overhead hazards before entering the site.

These treetops are right at the edge of the Trail and almost head-height. Buck them up, and remove them entirely out of the corridor.

Clearing the treetop exposed a nice rock, improved view, and provides better drainage. This really is the same spot, it just has new puncheon!

Some of these trees fell recently, but some were cut years ago. They all need to be bucked up and moved out of the corridor. This is not enjoyable to walk through, nor does it allow for drainage. This is a "slot" through the woods.

When you are closer, determine the best cutting sequence. If it is one log lying on the ground, it could be quite simple, while a tangled mess of trees and brush chest-high across the Trail can be rather complicated. Careful assessment and planning before you begin to cut will make your job easier and reduce the chances of a pinched saw.

Make as few cuts as possible to safely move the pieces off the Trail. Swamp (i.e. clear out, well away from the Trail) smaller branches as you would if you were brushing (described above). Larger logs do not have to be hauled out of sight, but it is crucial that they are moved outside the trail corridor, **meaning minimally 3 feet from the edge of the Trail.** Further away is always better, if you have the time and people-power. This ensures that the corridor is kept clear, and, if future maintenance occurs in that location, crews won't have to do major work clearing logs before they get started on the project. Do not leave the cut ends high (waist height or higher) in the air (also called a cannon; drop everything to the ground if you can) and do not create a narrow slot through the woods by cutting everything right at the edge of the Trail; both are unsightly and hinder maintenance. The exception here again is the same with brushing, where a narrow passage can discourage unauthorized use. This is typically not a problem on our Trail, but it may be in some locations. Use this technique minimally, and only in a known problem area. It is also understood that sometimes you may be running out of time or daylight, and you are just trying to carve out a path. This is fine, but either go back yourself and finish the job when you have the time, or let SHTA know about it, so that we can make arrangements to bring the work up to standard.

Please note: logs lying on the ground right next to the tread, especially parallel to the Trail on the downhill side, impede the flow of water and can cause problems. Good swamping is essential for brushing, whipping with mechanized (or hand) whippers, and any tread work or hardening. Clearing is very hard, satisfying work. As with any trail work, taking the time

to do it right and following established standards protects the Trail and reduces the amount of work needed in the future.

MAINTAINING THE TREAD

While this manual does not cover new trail construction, it is important to have an understanding of how a sustainably-built trail should look and function. This will help you to see deficiencies in the existing trail and know why they are occurring, and give you a model to strive towards as you attempt to maintain it. The SHTA is adopting a **24-inch tread width on heavily traveled sections (typically near trailheads), and an 18-inch tread width on more remote, or less traveled sections.** This will apply primarily to new construction, but should be taken into account if you perform any tread maintenance. If there is any question about how wide the trail should be in a particular location, please contact SHTA staff. This does not mean that you need to widen the trail everywhere to either 18 or 24 inches wide! As long as the Trail is comfortable to walk on and sheds water, you can leave it alone.

I will take a brief moment here to mention that **if it is very muddy when you are out doing maintenance, it is probably best not to do any tread work.** Any work that you do may not set up, and it is possible to do more harm than good. For this reason, it is usually best to do tread work when it is dry, although some moisture in the soil is helpful.

Properly designed and located trails (often called sustainable) efficiently shed water and need very little maintenance. Conversely, a trail that was placed in a less than optimal spot will require constant maintenance and will likely suffer from erosion and mud, leading to potentially serious environmental impacts and a less enjoyable (and sometimes unsafe) experience for users. In these cases, the Trail may eventually need to be rerouted, or retrofitted with drainage features if a reroute is not possible.

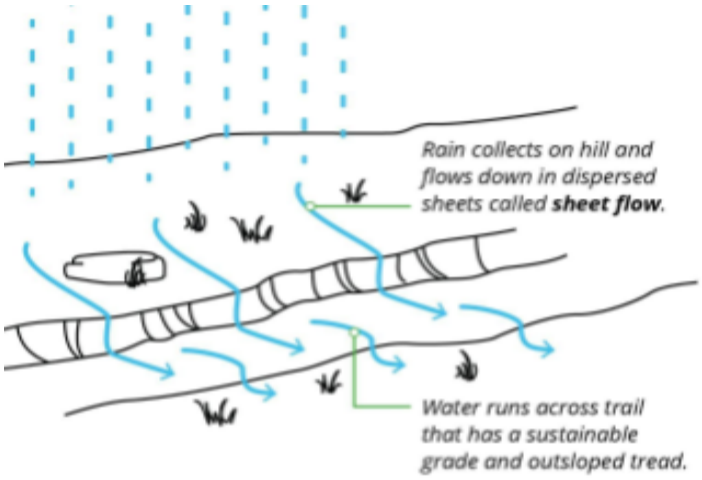
In essence, *it's all about water* – how to direct its flow off the Trail as quickly and efficiently as possible. The Trail and any structures must be built so that water can keep doing what it was doing before the Trail was there, or there will be problems.

TRAIL ANATOMY AND DEFINITIONS

When it rains, water naturally runs down a hill in dispersed sheets, also referred to as **sheet flow**. It is important that the Trail does not disrupt this natural action due to improper design or lack of maintenance. Ideally, the Trail will be located on the side of a hill with a slight downhill pitch **across the width** of the tread surface (about 5%), which means that, for a 24 inch wide tread, the outside edge will be about 1.5 to 2 inches lower than the

inside. This is called the outslope, and it facilitates the gentle drainage of water off the entire Trail. It's not much, but it makes a big difference.

Grade reversals are a feature found on sustainable trails that essentially breaks up long downhill runs with a short change in elevation, dipping down then back up. This provides an opportunity for drainage by requiring water to change direction, thus encouraging it to flow out at the lowest point of the dip.

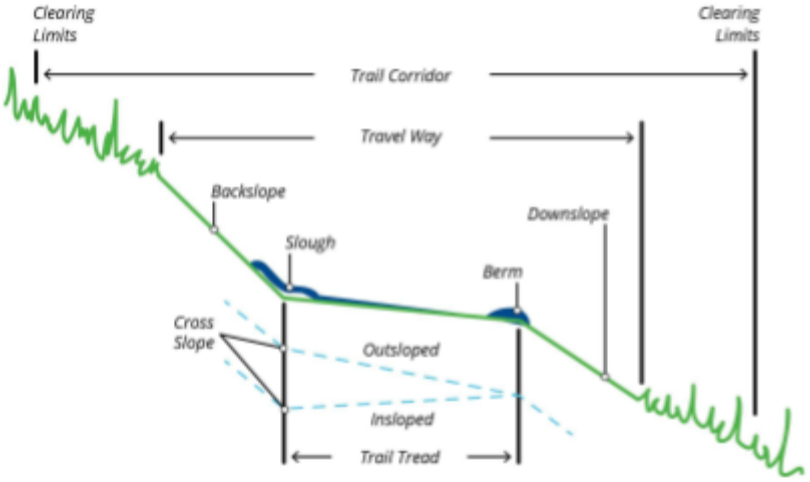


SHEET FLOW: Design elements for a rolling contour trail let water sheet across the trail. Sheet flow prevents water from being channeled down the trail, where it could cause erosion.

The **running, or overall grade of a trail**, refers to its steepness. Keeping this to no more than 10% ensures that if water does run down a trail, it does not gain enough speed to cause significant erosion.

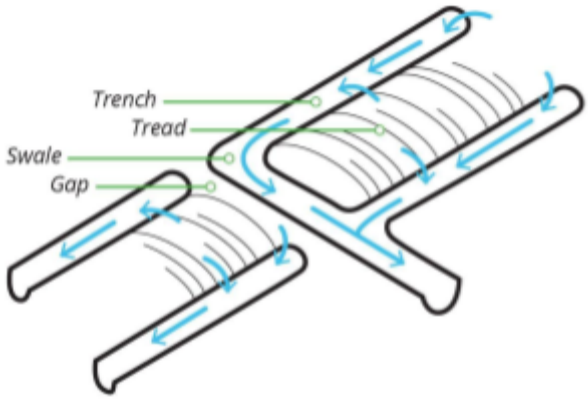
A cross-section of a properly built sidehill trail reveals four main components:

1. **The tread** is the walking surface.
2. **The backslope** is the excavated portion rising from the trail that provides the transition between the native hillside and the tread.
3. **The inside edge** is the point where the tread meets the backslope.
4. **The critical edge** is the rounded outside edge of the trail.



CROSS-SECTION OF A SUSTAINABLE TRAIL.

Sidehill trail functions best with well drained soils. We don't have a lot of that type of soil on the SHT (although we do have some!), and we have a lot of seeps, which prevent the Trail from ever drying out. In these instances, a well constructed trail located on a sidehill may suffer from water problems anyway due to heavy soils that are saturated by near-constant seepage. If this is the case, **a ditch may be needed** on the uphill side, along with periodic drains or swales (same as the diagram below "Side Ditches and Trenches", but with ditches on the uphill side only).



SIDE DITCHES AND TRENCHES: Trail in flat terrain is one of the hardest trail plumbing scenarios trail stewards face because there are few options available to get water off the trail. One effect tactic is to build a series of stacked swales and trenches.

Trails on flat ground, while not recommended, are sometimes necessary and have a different construction technique and shape. They are difficult to build and maintain and often have serious mud problems if the tread is not sufficiently raised, crowned, and ditched (a turnpike is similar to this, but built up and reinforced even more).

REMOVING ROCKS, ROOTS AND STUMPS

As the soil on the Trail becomes compacted, roots, rocks and stumps can become more exposed over time and become a tripping hazard. They can also trap or otherwise prevent water from flowing off the Trail, or they can force users around them, which can cause the Trail to widen. None of these are desirable, so as a trail maintainer, it is your job to **occasionally** remove these obstacles. We want to keep people on the Trail, which means making the route obvious and as free as possible from any impediment. It is not expected, nor is it desirable, that you remove every rock or root. Focus on places where there is an obvious problem.

Rocks in the Tread

Unless they were either properly placed or provided by divine intervention for a pleasant surface to walk on, rocks should be dug out and tossed aside (not too far, you may find a need for it later!). The hole left behind can be filled with smaller rocks, then covered and

packed well with good mineral soil (soil that is composed of little or no organic material). If the rock is really big and will likely leave a very big hole, it will probably be too much work to remove and then fill. There is also a good chance that people are already favoring one side or the other.

Consider "defining" that side by widening it to standard (tread width of 18 to 24 inches, brushed 4 feet from the centerline) and blending it with the main Trail. Now put debris or other rocks to block off the other side (try your best to make everything look **natural**!). In a few years, it should re-vegetate nicely.

Until you develop an eye and the sense for how to do this, it may be best to take some photos and consult with SHTA staff.

Roots

As you know, roots are everywhere on the SHT, thanks to our shallow soils; in many places, you can't look up for a second for fear of tripping. True, many of them belong to live trees, but there are an astonishing number of roots from an obviously dead tree that should be removed. If they are very big and provide stability to the tread, it might be best to leave them unless they are very rotten.

For live roots, remove them if they are running parallel with the tread, as these channel water down the Trail. Leave roots that are perpendicular to the tread if they are fairly flush (flat or even) with the tread surface.

If they are not flush, consider removing them as well. Remember that roots that are exposed are susceptible to damage from people walking on them, which can eventually kill them just as surely as cutting them. When removing roots, use a sharp pulaski or mattock (sometimes loppers work nicely), and cut them well out of the Trail's corridor (a foot or more). Smooth the tread or fill in where the root used to be.

For larger roots (5+ inches) that you plan to leave, or in an instance where you would have to remove many smaller roots (2-4 inches) from the same tree (severely injuring or possibly killing it), you may have to build a gradual earthen ramp, the full width of the Trail, up and over to mitigate the danger of tripping and to protect the root.

Stumps

You *shouldn't* find stumps in the Trail, but chances are that you will. Perhaps it could not be removed when the tree was originally cut, or it has popped up over time with compaction. And sometimes (if located on the downhill side of the Trail) they were left to stabilize the tread and keep the Trail from migrating downhill.

Consider these things before you remove a stump. But if they are clearly in the way, take them out. Often, prying with a pick to loosen things up, then chopping at the roots is a good technique. Stumps can be stubborn! If located on the side of the Trail and not in the main tread, cut those stumps as flush with the ground as possible.

REESTABLISHING THE TREAD

Any of the obstacles discussed in the previous section, no matter how small, can cause people to wander off trail and back again in search of a route that is easier on the feet. This can be as short as a five-foot jog to the left, or it can be quite extensive. In the worst cases, multiple worn out and soggy ruts appear when hikers search over and over for a dry path, which can lead to significant resource damage.

In these situations, it would be best to take pictures and report what you see to SHTA staff -- there is probably not a simple fix. However, if removing a couple rocks or roots and repairing the bench will redefine where people are supposed to walk, traffic will once again follow along a concise path. Remember, we want to **keep hikers on the Trail**, which means providing a clear and defined path through the landscape. When there is brush and branches encroaching, roots and rocks in the tread, and mud to contend with, people will find their own way, often resulting in resource damage.

SLOUGH AND BERM

Over time, a higher mound may form at the outside edge of a trail from compaction or the natural displacement of soil and organic material away from the center. This is called a **berm**. This can be very problematic, because when the center of the tread is deeper than the edges (which can be quite extreme in places), it essentially becomes a ditch that channels water down the Trail and prevents it from moving off the tread.

On steep sections, especially during prolonged or heavy rain, water gains velocity and can cause significant erosion over time. On flatter terrain, water pools up and sits, saturating the soil and creating a muddy mess.

When water can't get off the Trail, it flows down it and causes significant erosion.

Slough is another natural process that affects tread; it is defined by soil and debris that collect on the inside edge, deposited by water or gravity. This narrows the tread, often resulting in hikers favoring the outside edge as they walk, and can cause the Trail to gradually migrate downhill. Removing slough can allow for water to flow off or across the Trail more naturally and avoid pooling up on the tread.

Both slough and berm can have significant impacts on the tread. It is important to restore the tread to its original width (either 24 or 18 inches) and allow water to flow off the Trail once again. To do this: de-berm, remove the slough, and re-establish a 5% outslope. First, shave down the berm. Next, re-establish the backline, or inside edge of the Trail by removing any accumulated slough. Then, reshape the entire tread to form the proper outslope. Rocks, roots and stumps can be removed at this time. Performing this type of preventative maintenance is a huge need for us right now. A large section of tread can be de-bermed and reshaped fairly quickly and with minimal tools, and has the potential to prevent major maintenance issues in the future.

If the Trail is worn down too deep, effective de-berming may not be possible. In those cases, other solutions may be necessary. If in doubt, take photos and measurements (depth and length of the worn down section). While you are doing this, you should be inspecting every part of the Trail and repairing what you can. Ask yourself:

- Is the tread getting too narrow or wide? Try to maintain a consistent tread width (a slough and berm will also cause the Trail to narrow).
- Does the backslope need improvement?
- Do you see an opportunity, in a specific location, to direct a large volume of water off the Trail?

These tasks can all be addressed at the same time, and in the process, might give you some extra raw material (mineral soil, gravel and rocks) to work with. You'll need it!

DRAINING MUDHOLES

If you have spent any time on the SHT, then you are no stranger to mud. Many factors can come into play to create muddy conditions, and often, there is not an easy solution. But every now and then, there is, and that is your time to act.

If you happen to find a spot on the Trail that is holding water or muddy, due to a berm, log, or some other obstacle, the fix is easy -- simply remove that obstacle! Often, these holes are filled with rotten logs and other things that hikers have thrown in to try to keep their feet dry, but they have created a situation that is potentially hazardous, due to the slippery and unstable logs, that also blocks the flow of water. Pull out all that junk.

These logs in the Trail are clearly blocking the flow of water. Pull them out and toss them out of sight. Create a drain, if possible, or another tread hardening technique may be necessary.

Next, cut in a wide drain so that the water can begin to flow off the Trail to the downhill side. If it is on flat ground, look for an area on either side that is lower than the Trail, keeping in mind that the bottom of the hole may be considerably deeper than the surface of the water. You may have to clear some brush and debris away from the Trail to create a ditch for water to drain away.

Once the water has drained, the spot may still be quite muddy; it is probably best to leave it alone until it dries out (or scout these locations in the spring or when the Trail is very wet, then do the work when it is dry). At that time, you can reshape the tread to create the required slope for water to run towards the drain that you created. It is very satisfying to watch.

What you have essentially created is a knick in the Trail, which is a type of drainage structure. If the mudhole in question happens to already BE the lowest spot in the area (which is pretty common), this will not work. In that case, a tread hardening technique (raised tread, rock armoring, or puncheon) will be needed. This may make for a bigger project for which you may need technical and physical assistance.

INSTALLING AND MAINTAINING DRAINAGE STRUCTURES

As noted above, a trail that is properly laid out and sited sheds water along its entire length, and *should* not really need many built structures to specifically drain water. The SHT, built before modern trail standards were created, was neither properly laid out or sited (in most places). On top of that, it has very few drainage structures.

Old trails like the SHT can and should be retrofitted with these features in places where reshaping the tread or realigning the Trail are not an option. The actual construction of these structures, specifically knicks, drainage dips, and waterbars, will not be covered in this manual, but there are many good books on the subject (check the resource section).

It is recommended that you attend a training workshop, participate in a project, or work alongside someone with experience before attempting to install a drainage structure. Your experience building them will go a long way towards understanding how to maintain them. In the meantime, you can help by cleaning out existing drains and using the excavated soil on the Trail to create the required pitch for water to flow off the Trail BEFORE it hits any sort of bar or ramp.

It will really help train your eye if you start thinking about what water is doing while you are out hiking. Ask yourself: Where does the water want to go? Where is it actually going? Where would you locate an effective structure? Taking a walk in the rain will show you exactly what the water is doing, but even when it isn't raining, the evidence of moving water (deposits of debris and soil) is often present. If you do install any drainage features, watch them and see which ones are shedding water, and how efficiently, and which ones may have been unnecessary. All of these observations will help you as you begin to learn the relationship between water and the Trail.

INSPECTING

There are many challenges associated with maintaining a long hiking trail. Collecting reliable information about the Trail is the first step. Until we know what is out there, we cannot begin to make a plan for maintenance. The SHTA is fortunate to have many volunteers that perform crucial tasks like inspection. In the coming years, we will strive to do our part to provide training opportunities and better access to resources for our volunteers. We ask that you heed the standards, recommendations, and preferred practices that we adopt.

NOTING THE TRAIL'S CONDITION

Gathering information about the overall condition of the Trail and any structures on it (or that should be on it) is very useful. This data can be a great aid to SHTA in planning and prioritizing projects. In order to be useful, however, this information needs to be quantifiable and well documented with measurements, pictures, GPS data, and informed observations.

Noting that a mudhole is "bad", or that a boardwalk "needs replacement" is not helpful because it is subjective information. Take a picture and measure it! Your mobile phone is an indispensable trail tool that allows you to record all sorts of information.

What about measuring? Did you forget to bring a tape measure? Maybe you brought one, but what you want to measure is hundreds of feet long! Using your stride, you can measure anything by counting your pace. Learning to pace off distances is an extremely useful way to measure long distances in the field. If you are measuring for a built structure, you'll need to be more precise, but pacing is a great way to collect preliminary information. *Note:* Newer iPhones come equipped with a measuring device in Settings.

To find your pace:

- Start by walking a measured distance (50' is a good length) on flat ground and counting your paces (**every other step**). Divide the number of paces by the distance walked to determine the length of your pace. Do it a number of times to make sure that you are consistent.
- Try to walk as naturally as possible.
- When in the field, do your best to replicate your natural gait.

It can be hard when walking through mud, water and across slippery logs, but with practice, pacing can be quite accurate.

INSPECTING THE TREAD

Any time you are out on the Trail and especially if you are out doing maintenance work, take the time to note and document problems, and the overall condition of the Trail.

If you walk through a terrible mud pit that never seems to go away, stop and consider the following: Why is it muddy? Where is the water coming from, and where does it want to go? Is there something blocking the natural flow of water that can be removed to improve the situation, or is the Trail at the lowest point in the landscape? Pace it off to see how long it is.

Do the same with eroded areas: How long is the eroded section? How deep is the tread eroded? Can the water be diverted from the trail near the beginning of the slope? Take good notes of your observations and measurements (hint: carry a small waterproof notebook and draw pictures and diagrams if you like). A GPS point can also be useful, if you have the means to capture one. **Taking photographs is perhaps the most important and helpful thing you can do!** Report all this information back to SHTA, especially if you are unsure of the most effective way to address the problem.

While it is imperative to gather information about dangerous conditions and severe environmental degradation, try to take note of things that just need general maintenance as well. That will ensure that SHTA staff (or you) can get to it before it becomes a serious problem.

ASSESSING THE TRAIL

The only difference from what is described above and a formal trail assessment is that an assessment is far more detailed and systematic, documenting all of the problems in a given area. Assessments are usually completed on an entire section, from one trailhead to the next.

The SHTA has hired professional trail contractors to perform assessments in the past, but it has been done by volunteers as well. It is time consuming and meticulous, but the information gained from a thorough trail assessment is invaluable in understanding the needs of a particular section and in prioritizing work. To date, thorough assessments of the

SHT are few in number; our hope is to have the entire SHT thoroughly assessed in the coming months and years.

INSPECTING BUILT STRUCTURES

It is just as important to carefully document the condition of structures on the Trail, as a failing, dangerous structure is a hazard that must be addressed as soon as possible. Look for rotting lumber; loose, missing, or broken boards; steps that are unnaturally high; tilted, pitched, or unlevel structures; rebar or nails that are exposed; or anything else that seems unsafe. Take pictures!

Besides noting unsafe conditions, it would be helpful to document a structure that is not functioning as intended, such as puncheon that has sunken into the ground, restricting water from flowing freely beneath it and trapping mud and water on its uphill side. Pay attention to the ends of the structure: Is the ground at either end muddy, indicating that the current structure is not long enough? Or are there many short sections of puncheon with short muddy spots in between, where the Trail may be better served by one continuous structure?

The moss adds a certain aesthetic to the bridge, but in this case, hastens its decay. Clean all moss, dirt, and loose stones off of built structures.

These are pretty common problems. It is a good idea to carry a variety of nails and a hammer with you so that you can make minor repairs if need be. Another thing to look for is thick moss growing on structures, and dirt that has filled in the gaps between boards. Brush or scrape this off.

Dirt and moss hold in moisture and prevent wood from drying out, accelerating decay. Taking the time to keep lumber clean and free of any organic growth can really extend its life. If there is loose dirt or pebbles on the walking surface of a structure (especially steps), sweep them off. These are a major slipping hazard.

BUILDING SIMPLE STRUCTURES

When an area has such severe issues that general maintenance cannot adequately address, trail hardening techniques are employed in order to prevent further damage from occurring. This will help define the Trail and keep people on it. Techniques might include puncheon, boardwalk, a turnpike, or rock armoring. In places that are too steep and suffering from erosion, stairs of stone or lumber may be built, or soil checks may be used.

Suffice it to say, built structures using dimensional lumber or natural materials such as stone, dirt and rocks, are quite common and very necessary in certain locations. These are either going to be expensive, as is the case when lumber is used, or require a significant amount of time gathering and preparing materials, necessary when using natural materials. In both cases, they require a lot of planning.

Done correctly, these built structures will last many years, lessening the impact on the environment and adding to the enjoyment, quality, and safety of the Trail. If done incorrectly, they can be dangerous, fail prematurely, and add to or exacerbate environmental issues. For this reason, most of these types of structures will typically be built during a project with SHTA staff or contractor oversight. Take note: these structures are intended to minimize impacts to the Trail, prevent environmental damage from occurring, and for user safety, NOT for comfort or convenience. It is an important distinction to make. Structures that fulfill these requirements happen to be comfortable to walk on by default.

Here we describe three simple, yet very effective trail hardening techniques commonly used on natural surface trails: Type III puncheon, turnpikes, and cribbed steps.

TYPE III PUNCHEON

Building with lumber is expensive and getting it out onto the remote and rugged SHT is difficult. It stands to reason then, that if you are going to invest the money and effort into building a structure using lumber, you want it to be solid and safe for its entire life. And like your own self, you want the structure to enjoy a long life.

Let's take a moment to discuss what isn't working with the standard two-plank puncheon design that is commonly found on the SHT, supported either on sills or posts. This design has a low cost, but we end up replacing many of these structures long before the wood is rotten. In the long run, it may not be that much cheaper, and it presents significant danger

to trail users that cannot be ignored. This design uses eight or ten-foot planks of smooth lumber running parallel to the Trail that are usually placed on 4x4 timbers laid across the Trail, known as the sills, that are cut just a little longer than the width of the structure. Other times, posts are driven into the ground and the planks are supported by a cross-member between the posts.

(left) It is impossible to drive a post by hand below the frostline in NE Minnesota. The lumber is still solid, but due to the heaving, this structure is no longer functional. The span between supports is also too far. (right) Puncheon that has sunken into the ground, blocking the flow of water. Because it has sunk lower on the downhill side, there is an added element of danger to this structure.

The planks get very slippery when wet, muddy, or icy, and using them full-length placed in the direction of travel can lead to a “skating rink” effect, where there is a long surface to slide on should you slip. There is enough danger of slipping under normal (wet) conditions, but when you consider that many of these are twisted, warped, bowed, unlevel, or all of the above, the chances are compounded.

The 4x4 sills do not have enough height, flotation (to keep them from slowly sinking into the ground) or lateral stability, and as a result, the whole structure sinks into the mud, making it slicker. The sagging structure blocks the flow of water and defeats the very purpose of puncheon, which is to allow the natural movement of water underneath.

Besides this, there is often insufficient midspan support for the sections (sometimes you see one support in an 8’ section, sometimes none). This causes the structure to sag under the weight of countless trail users and places undue stress on the ends where it has been

nailed. Then you know all too well what happens: the boards eventually pop out, springing up on the unsuspecting user.

If placed on posts, the structure is often twisted and warped from years of heaving and settling. It is very difficult, if not impossible, to dig or drive by hand a post into the ground below the frostline in northeastern Minnesota, therefore this method of construction is not a good choice for us.

How then does Type III puncheon differ from the standard two-plank puncheon, or how does it solve the problems mentioned above?

First of all, the Type III design features 16' sections, which requires some long and heavy stringers. A stringer is the framing member that supports the deck. It runs parallel to, or with the direction of travel. This results in a stronger structure because there are fewer joints and simplifies the construction overall because fewer sills (the part in contact with the ground, laid perpendicular to the Trail) are used. Setting the sills level, and at the correct height, is the most difficult and time-consuming part of the process.

The other obvious difference is that the decking runs perpendicular to the direction of travel. This, coupled with the use of rough sawn lumber, makes the walking surface much less slick. The deck boards must also be spaced far enough apart (half an inch is good) which allows dirt and mud to drain away and air to circulate, keeping everything dry. The width of the deck is also important, **24 inches being a minimum, but 32 to 36 inches is preferable**. SHTA has built a number of these structures that are 32 inches wide, because that is the most economical use of the material that we sourced.

To provide flotation and to permit the free flow of water underneath, it uses bigger material for the sill, 6x6 at a minimum. A 2x12 can be attached to the bottom of the sill for even more flotation. For lateral stability, the sills are longer, and the recommendation is that they are at least twice the width of the decking. The placement of the sills is somewhat flexible as long as they are kept about 12 to 14 feet apart. This span is plenty rigid when using 4x6 stringers. This is most advantageous as there will inevitably be obstacles on the ground that are difficult to remove. Not being locked into an exact sill placement to build these structures is very helpful, as you would be if the sections were butted up together and needed to share a sill, for example.

The placement of the structure is very important, it must be oriented so that there is a natural transition from the natural surface trail to the structure, creating a sense of “flow” to the Trail. Any change in elevation, particularly steps to get onto and off of the structure, must be of a standard height (6 to 7 inches is ideal, and not more than 8). Whenever possible, an earthen ramp is built right up to the surface of the deck so that the change is seamless.

There should be very little maintenance needed with this type of structure, other than adding more soil to the earthen ramp to make up for compaction. Inspect for broken or rotten deck boards, and report those and any other concerns to SHTA staff.

While we strive to maintain continuity of design for the entire SHT, this is not to say that another style or design will never be allowed; we have installed another type of structure for use on extremely wet and saturated soil. But they must meet these basic design considerations and be submitted for approval.

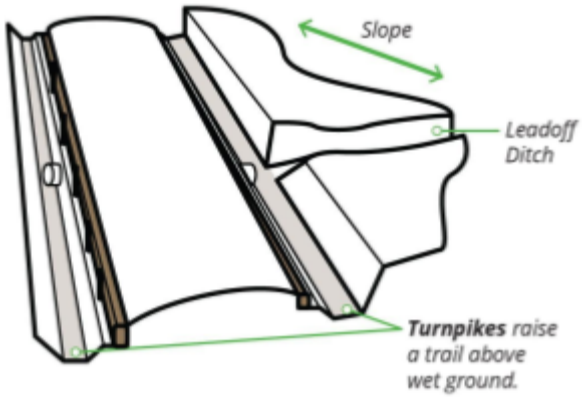
(left) Happy volunteers setting the sills and stringers for Type III puncheon. (center) Type III puncheon under construction showing sills, stringers and decking. (right) Completed Type III puncheon. Note the earthen ramp built up to the level of the decking for a smooth transition.

TURNPIKE

A **turnpike** is a section of built up trail, elevated above wet ground with ditches and culverts to allow the movement of water away from the Trail. Many of the specifics will be determined by the conditions of each location, such as how wet it is, for how long, and what type of soil is present.

This can be a good option, especially in remote areas, because you don't have to haul in lumber. However, this type of structure will require major excavation and movement of local materials, and the amount of labor this may require should not be underestimated.

More often than not these days, land management agencies discourage this type of activity (excavation) or will only allow it once the area has been surveyed. Always check before attempting something like this.



TURNPIKE WITH LEADOFF DITCH

Turnpikes raise a trail above wet ground.

This design, also called "raised tread", is often necessary when building a trail on flat ground. When building a turnpike, lay logs or rocks parallel to the Trail at the desired width and fill with a layer of natural or crushed stone at least 6" deep. Cap this with good, compactable mineral soil (soil with little or no organic material in it) or gravel, if you can get it.

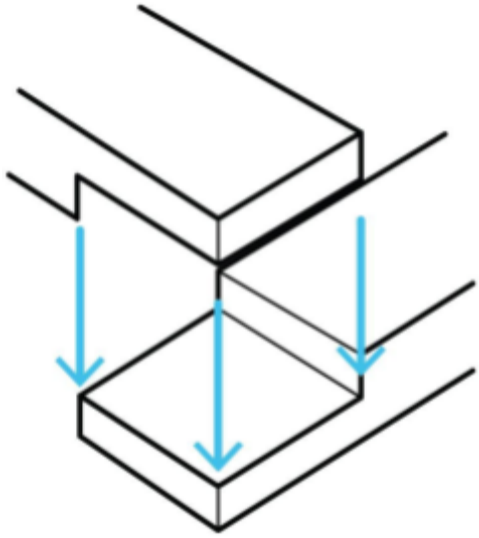
It is important that the tread is slightly crowned to shed water in both directions and that it is slightly higher than the surface of the log or rock that forms the border so that water is not held in. Dig a ditch on both sides (if this excavated material is good fill, save it) and create spaces (culverts) between sections of raised tread to allow water to flow across the Trail (these can be left open or covered with a large flat stone).

Maintenance will involve recrowning the tread (adding to and reshaping the soil of the turnpike) and cleaning out all the ditches and drains.

CRIBBED STEPS

Also known as C steps, cribbed steps are a simple staircase design that is easy to build, very solid, and maintain a consistent step height. C steps are built using 6x6 lumber, and the whole structure is tied together and into the hillside, functioning very well both as a walking surface and as a soil retention structure. While the depth of these steps can be adjusted during construction it is best to try to keep them consistent, and never less than 12 inches

deep. They should be at least 3 to 4 feet wide (some locations may require a narrower structure, but this is a special circumstance), as narrow structures of any kind encourage people to walk around them, defeating their purpose.



HALF LAP JOINT

Each step is composed of three pieces, notched with a half lap joint (shown left) so that they are interlocking. The front piece is called the riser and cut to the final width of the steps, and then two pieces that are dug back into the hillside. The length of the side pieces is determined by the step depth and must be long enough for the next riser to rest on top of them.

Lay the first riser down level, and so there is a comfortable transition between the Trail and steps, shoot for 5 ½", the height of a 6x6. Dig the side pieces into the hill so that they are level (you are only digging a trench here, do not dig out more than you need to). Make sure that they have good ground contact along their length. Put the three pieces together and drill and pin the center of the joints. Mark the desired depth, place your next riser on top and dig in

(left) First course of cribbed steps. The next course will be set directly on top of this, exposing only the desired step depth. All steps are a uniform 5 ½ inch height. Note the half-lapped joint in the front. (right) Finished cribbed steps.

your side pieces. The next “pin”, usually rebar, must be at least 12” long to attach the top step to the one below it. Continue until you reach the top!

As you work your way up, throw excavated soil to fill in any voids on the inside of each step. It is important the level of soil comes to the top surface of the 6x6 pieces (or even a little higher to allow for compaction), or they will eventually hold water. Fill the outsides back in with soil and grade for proper drainage. You want water to run away from the steps, not down the sides. Place an occasional “gargoyle” or other obstacle on the side to keep people on the steps and to help hold soil.

A structure built in this way is not locked together. It relies on rebar to hold the pieces in place, and they inevitably move. There is nothing to hold in the soil on the sides, so erosion continues.

Maintenance for this type of structure is simple and usually involves adding more mineral soil to the inside of the step to bring the level back to the top of the 6x6s.

This design is far preferable to the past practice of digging in individual 4x4s for steps at random intervals. Those steps lack the consistent step height (some are way too high), and they have a tendency to migrate downhill, tip forward, or become otherwise unstable. The side pieces are really critical for this stability and also serve to hold the soil in place.

MARKING THE TRAIL

The Superior Hiking Trail is marked by four devices:

- Trailhead signs, made of cedar boards and engraved lettering. (In the Duluth area, the signs are made of a vinyl composite.)
- Blazes, those 2-inch by 6-inch painted blue patches found on trees and rocks along the Trail. (On spur trails, those patches are white.)
- Small white vinyl signs (squares and rectangles) bearing the SHT logo and often a directional arrow.
- Small cedar signs with engraved lettering indicating campsites, overlooks and the direction of the Trail.

To the trained eye used to hiking on other national scenic trails, SHT signage may seem haphazard and, in places, maddingly absent. (Some of this is due to a feeling on the part of SHTA leadership in the 1990s that too many blazes were an affront to a wilderness experience. The SHT was not systematically blazed until 2006!)

The SHTA is striving to improve the signage and blazing on the Trail. Starting in 2018, there was a concerted effort to clean up trailhead signs of other stuff that got tacked onto them over the decades. In 2019, we launched the “Blue Blaze Blitz,” using volunteers to refresh and replenish blazing. Better blazing will lead to an SHTA goal of limiting vinyl signage on the Trail to intersections, road walks, and other ambiguous locations that leave a user not sure where to go.

SHTA has published a signage guidance. Because these protocols are relatively new and have been barely applied to the SHT, please contact SHTA staff if you are interested in signage or blazing.

SHTA also created an instructional video for “the right way” on blazing that explains our standards and protocols, including the very precise paint color. Blazing should be done in close cooperation with SHTA staff. Please do not go freelance blazing!

Special thanks to Denny Caneff for helping to establish these protocols for marking the Trail.

GLOSSARY OF COMMON TRAIL TERMS

Backslope: Portion of the hillside above the tread, it is excavated to serve as a smooth transition between the trail and the native slope.

Berm: Silt, soil, and other organic material mounded at the edge of a trail. Prevents water from flowing off the trail.

Boardwalk: A walkway that is supported by posts or otherwise elevated above the ground.

Causeway: Raised and crowned tread that is not ditched. Not suitable for very wet or saturated ground.

Center line: The middle of the tread.

Critical Edge: The edge of constructed tread located on the downhill side of the outslope. This is where sediment and other material tends to form a berm, and often requires attention.

Crowned Trail: Tread shape for flat ground, or in turnpikes or causeways, that is higher in the middle so that it sheds water in both directions.

Drainage Dip: A constructed feature that facilitates the drainage of water away from a trail. Mimics a grade reversal by forcing water to change direction.

Fall line: The direction that water wants to travel down a slope, i.e. straight up the hill. A trail should never follow this alignment.

Full Bench: Trail excavated into a hillside where the full width of the tread, or bench, is cut out. Much more durable, and desirable than half bench.

Gargoyles: A large ugly rock, placed or dug into the ground on the sides of a structure, especially at each end. Funnels use onto the structure by making it the obvious and most enjoyable place to walk.

Grade: The degree of inclination of a hill, expressed as a percentage.

Grade reversal: A sustainably designed trail moves across the land, following natural contours and taking advantage by forcing water to change direction, thus offering an opportunity for drainage.

Half Bench: Trail excavated into a hillside where only half of the tread, or bench, is cut out, and the other half is built up and compacted soil. This is quicker and easier to do, but not nearly as resistant to use and other natural forces.

Inslope: Tread that slopes into the hillside. Generally, not desirable, except in certain circumstances (as part of a switchback, for example).

Knick: An outsloped drain built on an existing trail, usually on flat ground. The tread must fall away on one side in order for this to function.

Mineral Soil: Dirt containing little or no organic material. This is what you want for tread construction, or other structures such as the fill in a turnpike.

Outslope: A slight downhill angle of the tread surface to facilitate drainage, about 5%.

Pace: Method of measuring distance using your stride, counting every other step. Need to determine pace length ahead of time by walking a measured distance on flat ground.

Puncheon: Wooden walkway that rests on sills and is typically low (around 1 inch high) to the ground, but still high enough to allow for the natural movement of water.

Rock armoring: Using rock in a muddy spot on a trail to create a solid and stable surface to walk on. Time consuming and difficult to do, some of the rocks need to be of large size, and all need to be set so that there is little to no movement.

Sheet Flow: The natural, dispersed flow of water down a hillside. All the sustainable design elements of a trail encourage this far less erosive action to continue.

Side Slope: The slope of a hillside. Ideal location for a trail, but a steeper hill will require greater excavation to cut the bench.

Sill: Structural support for the stringers or framing of puncheon or a bridge. Dug in level at the desired height, perpendicular to the direction of travel.

Slough: Soil, rocks, and organic material that migrates down a hillside and settles at the inside edge of the trail, effectively narrowing the tread.

Soil Check: An erosion mitigation technique where a log, timber, or line of stones is placed perpendicular across a gullied or badly eroded trail. Soil is then filled in behind the check, even with its top surface. It must be considerably wider than the trail or it will continue to erode out the sides.

Sustainable Trail: A trail that is carefully laid out and designed to require a minimum of maintenance and environmental impact.

Trail Hardening: Constructing or adding a feature on a trail in a wet area that cannot be drained or otherwise improved.

Tread: The walking surface of a trail.

Turnpike: Raised, crowned and ditched trail.

Waterbar: A drainage feature that is no longer recommended. Consists of a raised structure of rock, log or dirt across the trail at approximately a 45 degree angle, and a downhill drain.

NORTH SHORE REALITIES – ADDITIONAL RESOURCES

There are many excellent, thorough books and resources on all aspects of trail layout and design, construction, and maintenance. We've compiled a few that we highly recommend -- a search online will uncover much more! We strongly encourage anyone who plans to take part in any kind of trail work to read up and become familiar with the common techniques and standards described in these resources. If you find a discrepancy between this Manual and any other, please follow this Manual. If you have any questions, feel free to contact SHTA staff.

ONLINE RESOURCES

Trail Associations:

- From the North Country Trail Association's website (northcountrytrail.org): northcountrytrail.org/volunteer/volunteer-resource-center/trail-management/
    - Check out the NCTA Handbook in particular. The SHT is now a part of the route of the NCT. While our standards may vary, it makes sense to use this as a primary reference.
    - NCTA's volunteer page also provides additional videos and other helpful resources.
- From the Ice Age Trail Alliance's website (iceagetrail.org): iceagetrail.org/volunteer/resources-volunteer-leaders/
    - Many great booklets, including:
        - **Trail Plumbing:** iceagetrail.org/wp-content/uploads/Trail-Plumbing-Booklet.pdf
        - **Trail Structures Notebook:** iceagetrail.org/wp-content/uploads/2014/11/Notebook-Trail-Structures.pdf
        - **Cool Maintenance Flowchart:** iceagetrail.org/wp-content/uploads/Plumbing-Diagram.pdf
    - And much more!

The NCT and IAT bear similarities to the SHT because of their location in the Midwest, but there are many other trails and trail associations across the country (like the Appalachian Trail Club, and the Pacific Crest Trail Association, for example) that may have valuable and interesting information about all aspects of trail management and maintenance.

Other Organizations:

- American Trails is a wonderful organization with tons of resources and information. SHTA is a member, so we can purchase materials and webinars at a discount. americantrails.org/
- Volunteers for Outdoor Colorado set the standard for volunteer stewardship, involvement and training. They have some awesome manuals about maintenance, construction, and crew leadership, along with other resources. voc.org/
- The International Mountain Biking Association popularized and continues to advance sidehill trail construction and other sustainable trail designs. While their focus is obviously mountain biking, the standards apply to all trails. imba.com/

GREAT BOOKS

OSI Field Guide, Volunteers for Outdoor Colorado's Outdoor Stewardship Institute (OSI), 2018 edition.

Lightly on the Land: the SCA Trail Building and Maintenance Manual, by Robert Birkby, 2005.

Natural Surface Trails by Design: Physical and Human Design Essentials of Sustainable, Enjoyable Trails, by Troy Scott Parker, 2004

Trail Construction and Maintenance Notebook, 2007 edition, USDA Forest Service

Trail Planning, Design, and Development Guidelines, Minnesota Department of Natural Resources, Trails and Waterways, 2006.

CONTACT US

This Trail Maintenance Manual was primarily written and compiled by Tamer Ibrahim, Trail Operations Director for the Superior Hiking Trail Association. You can reach Tamer with any questions at tibrahim@superiorhiking.org.

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