KEEP MAINE GREEN

PREVENT FOREST FIRES

Printed: Off-Road Vehicle Division
014 - 04A - 83
014 - 04A - 81

July 2020

Best Maintenance Practices

Maine Motorized Trail Construction and Maintenance Manual

Keeping trails out of the water and water out of the Trails

Bureau of Parks & Lands
Off-Road Recreational Vehicle Office

ACKNOWLEDGEMENTS

This document was prepared by the

Maine Department of Agriculture, Conservation, and Forestry, Bureau of Parks and Lands Off-Road Recreational Vehicle Office

with additional information provided from the following Agencies and Organizations:

Maine Forest Service
Maine Department of Environmental Protection
Maine Land Use Planning Commission
Maine Soil & Water Conservation Districts
The Nature Conservancy of Maine
National Park Service
National Forest Service
Maine Woodland Owners
Maine Forest Products Council
Maine ATV Task Force

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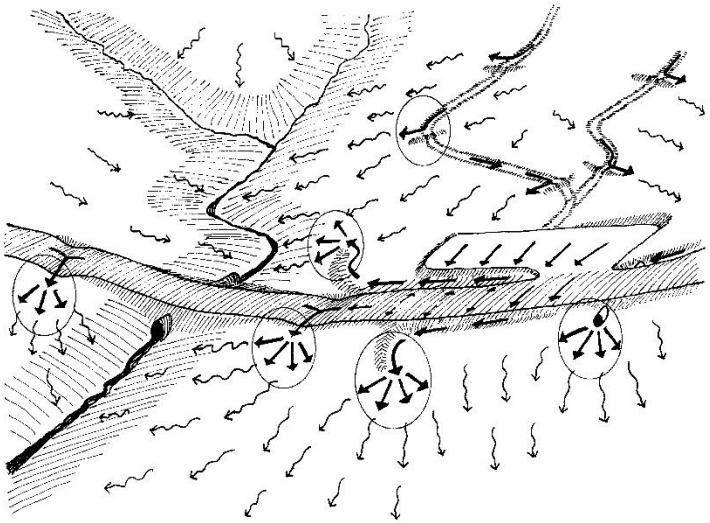
What do BMP's Do?

Best Management Practices are designed to imitate and protect the natural functions of forests and lands.

BMPs minimize the risk of sediment and other pollutants getting into waterbodies, and wetlands, by protecting shoreland vegetation and providing a safe stable trail system.

Treating water in small amounts is key, preventing run off from concentrating and allowing it to be absorbed by the undisturbed soils adjacent to the trail.



BMPs typically minimize impacts to water quality by dispersing concentrated water flow. Circles indicate how BMPs disperse flow to the undisturbed ground.

Trail Impacts

Here in the Northeast, we have inherited a legacy of poor trail layout. Many of our trails went from point A to point B with no consideration for steepness or terrain. Many ATV or snowmobile trails have evolved over time on old woods roads or skid trails that were never designed for the type of use they get today. The result is inappropriate water management and erosion which is a trails' arch enemy.

Erosion destroys trails and results in sedimentation of our lakes, wetlands, streams, and rivers where it has a detrimental effect on water quality, fish and smaller organisms. It can also contribute to algae blooms.

In addition to causing sedimentation problems, erosion also creates ruts, bumps, potholes, and washouts that can make trails impassable. Each year, clubs and towns spend precious dollars to 'repair' these problems.

Your trail design, construction, and maintenance determine how the natural environment around your trail will be impacted. A well-built trail will provide access, while conserving our natural resources.

This handbook will show you examples of how to construct and maintain trails that minimize erosion and environmental impacts while providing safe accessible trails. The key is to ***keep the trail out of the water and the water out of the trail!***

Landowner Concerns

Most trails in Maine cross private land, which means ***trail users need landowner permission***. Much of that land is managed for purposes other than recreation. Keep in mind that a successful partnership with a landowner, may depend on your ability to recognize their priorities and to work with them.

A trail that winds through forestland may need to be crossed by a skid road or temporarily closed or relocated due to harvesting activities. If a trail passes through agricultural lands and utility corridors, it is extremely important that trail users stay on the specific trail location to retain the landowner's permission. Do everything you can to educate trail users about all your landowners wishes. Keep in mind the daily challenges they face and work hard to protect their interests. We must never forget the landowners are providing access as a courtesy and we must never take that for granted.

One more thing to keep in mind: Though you may invest precious time, energy, and money in a trail, if you don't own the land, then you don't own the trail. Always be aware and considerate of the landowner's needs or desires and be careful to never assume your club owns or has some right to the trail.

With most of our trails on private land it is critical that we ***remember the landowner always has the final word and to respect the landowner's wishes!***

Soil, Water, and Gravity

Soil, water, and gravity are what trail work is all about. Soil is your trail's support. The whole point of trail construction is to manage soil by keeping it where you want it. Water is the most powerful influence in the trail world and its mission is to remove your soil. The goal of good trail construction should be to keep your trail out of the water's grip.

Groundwater Impact

Groundwater in the trail base will make it soft, muddy and susceptible to rutting. Ideally, subsurface water should be drained from the trail base or the base should be elevated to allow it to dry out.

Surface Water Impact

The goal is to get water off the tread surface as quickly as possible and to direct it to a natural or constructed drainage area that can handle the flow without eroding. When surface water is not drained off the surface of the trail, it leads to potholes, washouts, slush and even open water in winter.

Examples of good drainage include:

- ❑ Culverts and cross drains.
- ❑ Ditches to drain water from the trail.
- ❑ A well-constructed trail foundation of coarse soil material (i.e., sand, gravel, or rock).
- ❑ Reduced water concentration and velocity.

Understanding Soil Erosion

Soil erosion is the trail builder's worst enemy. Soil erosion is also the single largest pollutant (by volume) of our lakes and rivers.

It's important to understand how water and gravity combine to move dirt before you install water control devices. If you travel enough trails, you will see examples of trail structures built with little understanding of Natures' forces. You will save time, money, and your sanity if you get grounded in the basic physics first.

Water has ***"carrying capacity."*** Water erodes soil surfaces by picking up soil particles and carrying them off. Damage depends on the 2 V's Volume and Velocity. The higher the volume of water and the faster it travels the more dirt it will carry. Reducing the 2 V's reduces erosion.

Water also has ***"deposit"*** ability. It can build soil surfaces by getting tired and dropping soil particles. If you slow water down, it loses its ability to carry soil and deposits it. You need to slow water down and get it off the trail, but the location will determine what sort of water control or drainage structure you use.

Water also affects soil strength. Generally dry soils are stronger than saturated soils, but fine dry soils are also susceptible to wind erosion or use patterns. Trail builders and maintainers need to be able to identify basic soils and know their properties. Learning to identify trees and plants that are indicators of soil types will help you determine what exists for underlying soils and drainage.

Erosion starts with raindrop erosion, and then progresses into sheet flow erosion, rill or gully erosion, and then channel erosion. As erosion increases, so do the problems; therefore, it is very important to try to control water in small amounts which is easier than having to repair erosion.

Raindrop erosion occurs when falling raindrops dislodge exposed soil particles. The dislodged soil particles are suspended in the storm water runoff and can easily be transported great distances.

Sheet erosion occurs when surface storm water runoff travels across an entire layer of exposed soil.

Rill and gully erosion occur when surface water runoff concentrates into small grooves cutting into the soil's surface.

Channel erosion results when the above described types of erosion are uncontrolled, resulting in deep ruts and washouts.

Factors Linked to Erosion

The extent to which erosion occurs depends on soil types, slope, climate, vegetation and volume of trail use.

Soil type: Gravel erodes less because it has bigger and heavier particles which are harder to move. Course sand and gravel also absorb water faster, resulting in less runoff. Loam and fine sands are more likely to erode because their smaller and lighter sized particles are more easily carried away. Clay generally erodes less than loam because it sticks together however it doesn't absorb water well.

Topography: Longer slopes are more likely to erode than short slopes, because they collect larger volumes of storm water runoff. Likewise, steep slopes are more likely to erode than gentle ones, because water travels faster.

Climate: Maine soils are particularly prone to erosion due to the amount of annual precipitation. Soil erosion is often worst in the spring due to the compounding effects of frost, saturated soils, snow melt, and spring rains.

Vegetative cover: Vegetation shields the soil from the impacts of rain and helps reduce the speed and volume of surface water runoff. Grass will also help hold the soil together and prevent erosion. Plants also aid in aerating and removing water from the soil, thus maintaining the soil's capacity to absorb water.
The key to controlling erosion is to reduce both the volume and speed of water runoff.

Erosion Control Principles

It is difficult to control erosion once it has started, which is why emphasis should be placed on prevention. Effective erosion control must follow the following guiding principles:

- ❑ Proper design and construction.
- ❑ Regular trail inspection and maintenance.
- ❑ Remove water from trail surfaces.
- ❑ Mulch and seed or riprap.
- ❑ Avoid concentrating runoff.
- ❑ Avoid discharging runoff directly into natural surface waters (streams, brooks, rivers, ponds, lakes or vernal pools).
- ❑ Make sure you maintain the existing hydrology of the wetland *(see below)*.

How to Maintain the Hydrology of Wetlands

Wetlands are the ultimate example of saturated soils. They can be easily and permanently damaged by off-road vehicles, therefore it's important we try to avoid these areas. Occasionally, there will be no reasonable alternative other than to build a trail over or near a wetland. It is important that natural hydrology be maintained. Avoid compacting soils as they act as an underground dam reducing natural subsurface flow causing increased drainage problems. When constructing a trail across a wetland, allow cross drainage of standing water and the top 12 inches of ground water; this ensures that wetland water levels are not changed, and natural drainage patterns remain intact. Use culverts, rock sandwiches or bridges to allow water to pass under the trail.

DEP and LUPC Regulations

The following laws will in some cases apply to your trail construction or maintenance: ***Erosion and Sedimentation Control Law, the Natural Resource Protection Act, and the Mandatory Shoreland Zoning Act.***

The Erosion and Sedimentation Control Law requires erosion control devices be installed and maintained until the site is permanently stabilized. The law also requires that existing erosion be stabilized. This applies to any location where work is being done, not just near protected natural resources. The most common techniques during construction include hay mulching exposed soils as soon as the earthwork is completed, maintaining vegetative filter strips and properly installing erosion control fabrics between the work site and waterbodies.
https://www.maine.gov/dep/land/erosion/

The Natural Resources Protection Act (NRPA) regulates activities in, on, over, or within 100 feet of lakes, ponds, rivers, streams, brooks, and wetlands. Regulated activities include filling, disturbing the soil, building permanent structures, removing, or displacing vegetation, dredging, or draining.
https://www.maine.gov/dep/land/nrpa/index.html

The Mandatory Shoreland Zoning Act (and associated municipal ordinances) regulates development within 250 feet of lakes, rivers, tidal areas, and 75 feet of streams.

When Do I Need a Permit?

A Permit by Rule or Notification Permit ***may*** be required for any of the following activities.

- ❑ Crossing a brook, stream, river or wetland.
- ❑ Disturbing soil or clearing vegetation within 250 feet of a Waterbody, Wetland, or Vernal Pool.

Generally, maintenance activity does not require a permit. However, if you plan to widen the trail, change culvert sizes or build a bridge a permit may be required.

In organized/incorporated towns two types of permits may be required: a permit from the town and either a Permit-by-Rule, or full permit from DEP. Most trail-related activities can be done under the Permit-by-Rule program. You should always check with the local code enforcement officer to help guide you.

The Land Use Planning Commission has jurisdiction in unorganized towns. Normally a landowner or their agent only needs to complete a ***general notification*** for bridge and trail construction or maintenance but for certain projects a full permit may also be required. You should contact the regional LUPC office to verify what is required.

Army Corps of Engineers permitting may be required for fill placed in a wetland. A bog bridge, boardwalk or corduroy can fall into this category.

Trail Specifications

All trails are not created equal. Each should be designed and constructed for the expected use. The trail tread is the actual travel surface of the trail. The tread needs to be constructed and maintained to support the intended use. Most trail construction revolves around making sure a solid, obstacle-free tread is established. If we don't do a good job of locating, constructing, and maintaining an adequate tread surface, the users will find their own alternative.

Steepness or grade helps determine how difficult a trail is to use. The grade also has a direct bearing on how much design, construction, and maintenance work will be needed to establish a solid tread and keep it that way. Grades can range from 1 to 40 percent but most trails should be constructed in areas with less than 15 percent grade. Trails of greater challenge in more durable soils can be built at grades approaching 25 percent but trails exceeding that become very difficult to maintain, without hardening the tread.

Planning the Route

Use topographic maps and aerial photos to map the potential route. Identify control point locations where the trail has to go or avoid because of landowner restrictions, wetland crossings, saturated soils, steep slopes, etc. or desirable features such as scenic vistas and waterfalls.

You can then connect the control points and determine the trails feasibility and if special structures like switchbacks, bridges or boardwalks will be needed.

Existing versus New

In some cases, there may be an existing road or trail you can use. However, just because it already exists doesn’t mean it’s in a good location. Some trails and old roads were never designed for the use they are receiving. Many ATV problems and landowner conflicts are the result of use on snowmobile trails that weren’t designed for ATVs and have very wet soils.

Many old roads are very close to waterbodies and the ground water is close to the surface causing the trail to be soft and easily damaged. Don’t assume that an existing road/trail is the best location for your trail. In many cases it may be less expensive to build a new trail.

Trail Layout

There is an art to trail layout. Sometimes people assume that a trail is laid out like a road. This is often not true.

A road is generally wider and straighter so we look at the terrain through the eyes of a large bulldozer or excavator whereas the trail is narrower and may be built with smaller equipment or even with hand tools. Try to be more creative and go around large trees or rocks if possible.

This does not mean the land isn't disturbed during trail construction. The terrain will sometimes require substantial construction, but the result should be blended in to fit the topography. Well-designed trails take advantage of natural drainage features and are low-maintenance. The trail might pitch around trees and rocks, following natural benches, and otherwise taking advantage of existing natural land features.

The best trails show little evidence of the work that goes into them. It often looks like it just "happened." A little extra effort spent scattering cut vegetation, blending back slopes, burying stumps, removing downed trees, and restoring borrow pit sites pays off with a more natural looking trail. ***Avoid the Bulldozer Bob Look***

Flagging the Trail

This is best done with at least two people. Bring your detailed topographical map, aerial photo and a compass (plus the skills to use them). A GPS unit and the knowledge to use it can greatly reduce the time involved. Get a few rolls of highly visible flagging tape. It's cheap, and you don't want to run out while you are in the woods. Be careful not to use the same colors as the landowner's forester or surveyor may be using and remember to remove it when your project is complete.

A clinometer to measure the slope can be handy if you are laying out trails in steep terrain. Another way to determine the slope is measured in rise (vertical distance) and run (horizontal distance). A slope described in rise and run can be converted to percent by dividing the rise by the run. For example, a section of trail that rises three feet over a run of 60 feet (divide 3 by 60) can also be expressed as having a slope of 5%.

Resources such as soils and wetlands maps are also a great resource and are available through local Soil & Water Conservation Districts. Knowing what types of soils exists and where the wetlands are located before you get started will save you time, energy and aggravation.

The landowner will also be very familiar with the property and walking through the area with them before you get started will also be a significant help.

Here are some general hints:

- Scout during wet conditions while the leaves are off to identify drainage issues.
- Install flags every 15 to 25 ft, making sure they are visible in both directions.
- Utilize the general contours of the land.
- Stay on high ground avoiding low spots.
- Avoid having long steep grades that run directly up or down the fall line (where a ball would go if you released it).
- Avoid slopes greater than 20% to minimize erosion problems.
- Follow the contour using switchbacks or climbing turns to gently gain elevation.
- Take advantage of natural drainages.
- Avoid flat terraces and standing water.
- Stay out of wet areas and away from the edges of stream or river banks.
- If you have no choice but to cross an area that should normally be avoided, be certain the trail can be constructed correctly.
- Leave a large vegetative buffer strip between the trail and bodies of water.
- Keep water crossings to a minimum.
- Once the route is flagged, walk back along it to make needed adjustments. The old saying “measure twice and cut once” applies to trail building as well.

Cutting the Trail

Once landowner permissions and regulatory permits have been obtained, and the trail is flagged, construction can begin.

Work in small crews to ensure safety.
Cut brush and remove trees to form the trail route. This task requires cutting tools such as chainsaws, brush saws, bow saws, loppers or possible tree harvesting equipment for larger multi-use trails. A pole saw is handy for overhanging limbs. The clearing limit should be about 2 feet wider than the trail width and approximately 12 feet high depending upon intended use. Where the trail is multi-use and will include horses or snowmobile groomers the cleared area may need to be larger.

Removing standing trees, especially dead ones, is statistically one of the most dangerous activities you can engage in. Don’t even consider felling trees unless you have been formally trained and are wearing appropriate safety gear. ***Safety First!***

If the leaner is within the trail clearing zone, it should be removed but be sure to consider your safety when making the decision. The soundness of the tree, what equipment is available, your experience, and the potential hazard all need to be considered.

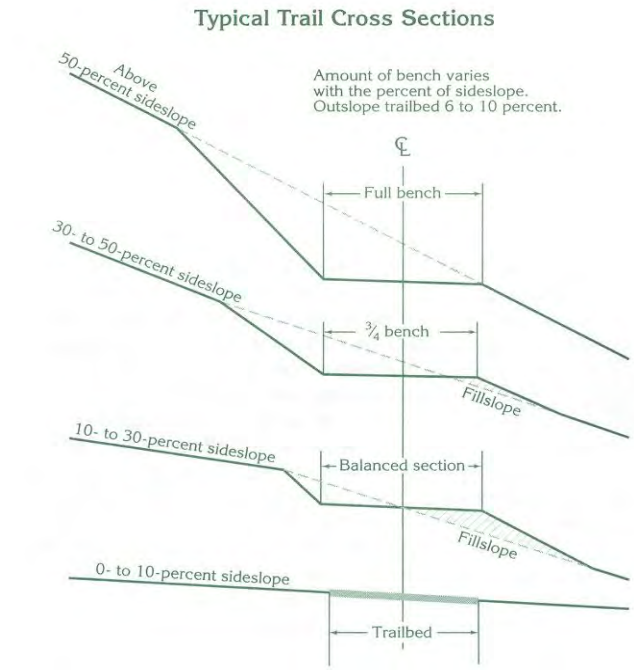
If possible, adjust the trail alignment to avoid cutting large trees, especially trees important to land management and wildlife, like beech, oak and apple. Also, be aware that many large dead trees with cavities are wildlife den trees.

Stump and Brush Removal

Cut trees off at ground level unless stumps are to be removed. If you plan to excavate the stumps, leave them a couple of feet high for easier removal with an excavator or backhoe.
Cut up downed trees and stumps and work with natural vegetation to meander the edges of your clearing so they don't have a severe appearance. Cut intruding brush back at the base rather than in midair at the clearing limit. Brush should be chipped or dragged off the trail and dispersed so the cut end lies away from the trail, out of sight. Don't stack the brush together, unless you plan to chip or remove it, as it will kill existing vegetation and promote erosion. **Never dump brush or slash in a ditch or stream.**

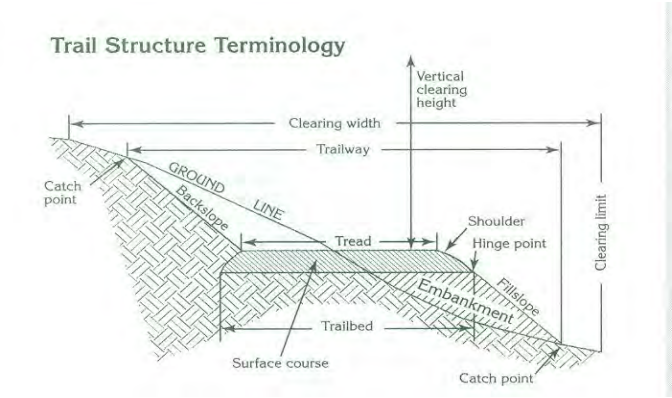
Slopes

Gentle slopes may allow you to travel straight up and down but generally you need to consider one of several side hill techniques to insure a stable trail.



Steeper slopes may require a bench construction technique. Balanced bench construction uses some of the excavated soil for the trail. Be sure to remove all organic matter before you begin to compact your fill or the tread will settle and slump. While less stable than a full bench, a balanced bench takes less time to construct.

Steep slopes will require full bench construction, and the removal of a lot of soil. With full bench construction, excavated soil may be hauled away or reshaped over the outside shoulder for re-vegetation. Your tread will literally be cut into the side of the hill which requires the removal of not just material on the trail surface, but on the back-slope as well.



An out-sloped trail is one that is **lower** on the downhill (outside) of the trail than it is on the uphill (inside). Out-sloping allows water to cross a trail perpendicularly and sheet flow off the trail, thus minimizing erosion. Be sure to shape the tread surface to get the right out-slope. A 3% out-slope is ideal and will allow good drainage while being safe for all users. Make sure grade dips and other drainage structures are flagged and constructed in the trail as you go. The filled area on the downhill side of the trail is called the fill-slope. The inside uphill cut bank is called the back-slope which should never exceed a 45% angle; lesser angles will re-vegetate faster and is less likely to erode and fall into the trail.

Special Structures for Steep Slopes

This section covers some of the more complex trail structures. **Climbing Turns, Switchbacks, Crib Walls, Rolling Dips, Waterbars and Trail Armoring** are all used in trail construction. They can be expensive and difficult to design and construct correctly. However, a well-designed, well-built trail structure lasts a very long time.

Due to the prohibitive cost of building trail in more difficult terrain look for alternatives first and build only as many structures as necessary, to reach your goal.

Climbing Turns and Switchbacks

Switchbacks and climbing turns are used to reverse the direction of travel on hillsides steeper than 15 to 20 percent to gain elevation in a limited distance.

What is the difference between the two? A ***climbing turn*** is a reversal in direction that maintains the existing grade going through the turn. A ***switchback*** is also a reversal in direction but involves a sharper turn and has a relatively level constructed landing. Switchbacks usually involve special treatment of the approaches and drainage installation.

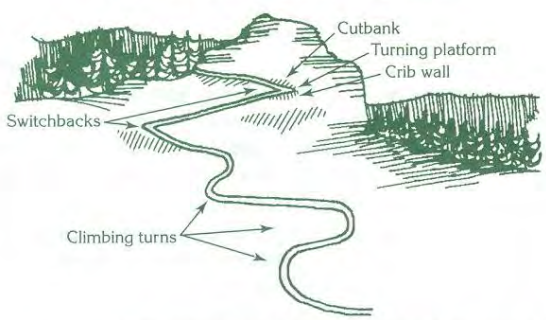
Choosing which one to use is not always easy but generally climbing turns are easier and less expensive to build and are more practical for snowmobile and cross-country skiing trails.

Climbing Turns

The advantages of a climbing turn in appropriate terrain is that the larger radius turn (15 to 20 ft) is relatively easy to construct. Climbing turns are usually less expensive than switchbacks because much less excavation is required, and fill is not used. They are also less likely to require tread hardening and/or crib walls and facilitate easier winter trail grooming.

Climbing turns are often constructed inappropriately. The usual problem is that a climbing turn is built (or attempted) on too steep of terrain where a switchback is needed. A climbing turn is built on the slope surface, so it climbs at the same rate as the slope itself. It is almost impossible to keep a climbing turn from eroding if slopes exceed 20 percent unless you harden the tread.

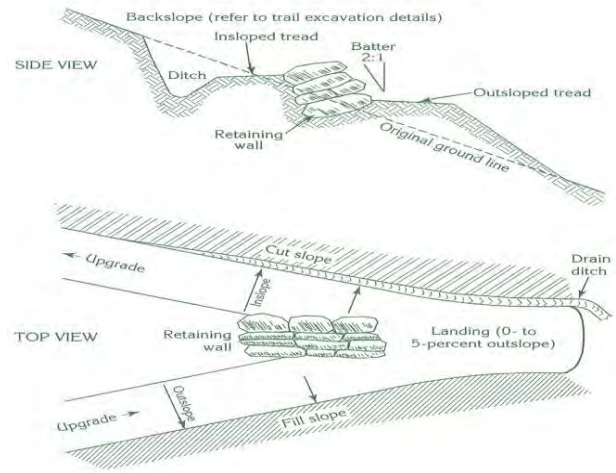
Switchbacks and Climbing Turns



Climbing turns can be built on gentler slopes, usually not more than 15 to 20 percent. Switchbacks are needed on steeper sites.

Switchbacks

Switchback With Retaining Wall



A switchback consists of upper and lower approaches, and a landing or turn platform. When scouting for switchback locations look for "natural" platforms. This will save you time later by reducing the amount of excavation needed.

The key to successful switchback construction involves adequate excavation and appropriate structures to hold the fill. The upper approach and upper half of the turn are excavated from the slope. Construct the lower side from the fill removed from the upper side. The lower portion of the turn should be compacted and out-sloped.

A rolling grade dip or waterbar should be installed on the upper approach. The turn platform should be nearly flat. Switchbacks on steep side-slopes can require a lot of excavation to obtain a stable back-slope and provide adequate turning clearance. Retaining walls may be needed to provide stabilization.

Crib Retaining Walls

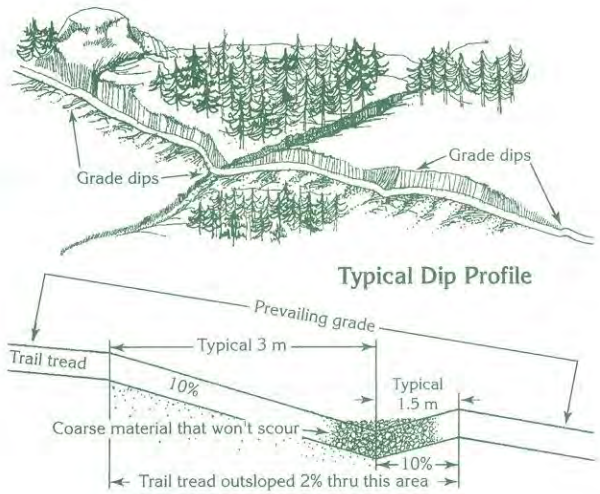
Retaining walls are useful for keeping back-slopes from slumping into the trail. The most common structure is the crib wall.

Construct a wood crib by interlocking logs or beams and pinning them at the joints. Be sure to select Pressure treated or pealed rot-resistant logs such as Hemlock or Cedar. Lay sill logs at right angles to the direction of travel and alternate tiers of face logs and header logs. Add rocks to plug the space between the logs.

Gabion Basket Installation

Rock/block retaining walls are another option when a sturdy wall is needed. To build a rock wall, excavate a footing sloped in and deep enough to support the foundation tier of rocks. Ideally, foundation rocks should weigh 50lb or more. Rock retaining walls should be built out of flat rock. If all you have is round rock, then Gabion baskets must be used. Rocks are stacked on one another with each layer being moved slightly into the hillside so the finished product tilts slightly into the hill.

Rolling (Grade) Dips



When you design and layout the trail, look for natural features to enhance the drainage. A rolling dip sometimes called terrain or grade dips are a great way to achieve this outcome. A rolling dip is simply a grade reversal to take advantage of a low spot to drain water off the trail.

The trail grade is reversed for (10 to 15 feet) before resuming the descent. A trail that lies lightly on the land will take advantage of natural drainages to remove water from the trail. The beauty of a rolling dip is that water collected from the hillside is not intercepted and carried by the trail. **These rolling dips are the most unobtrusive of all drainage structures and require less maintenance.**

Rolling dips are superior to waterbars because they fit naturally on the trail and there is nothing to rot or be dislodged. A perfectly designed trail (in a perfect world) would use only rolling dips and out-sloping for drainage.

As with any water control device, rolling dips should be placed frequently enough to prevent water from building enough volume and velocity to erode the trail. Usually, mid-slope following the grade is the best location taking care to avoid introducing sediment-laden water into brooks or streams. Always be sure there is a filter strip between the outlet of the water control device and the waterbody.

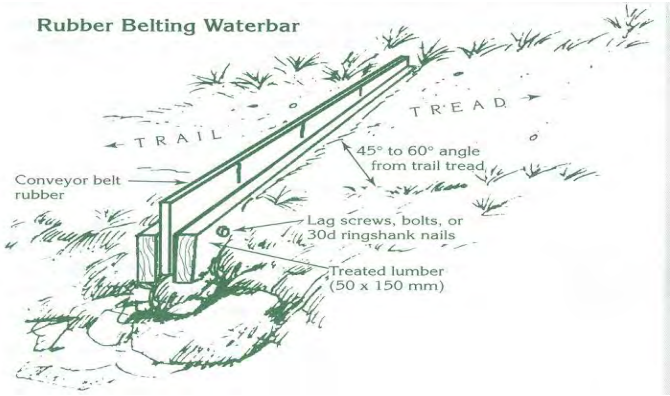
Waterbars

The waterbar is one of the most common drainage structures. Water moving down the trail is turned by contact with the waterbar and, in theory, is directed off the lower edge of the trail. On grades less than 5 percent, waterbars are less susceptible to plugging up. On steeper slopes, waterbars are very prone to filling in and may require additional maintenance.

Many waterbars are too short and not installed at the correct angle causing it to plug and become ineffective. The waterbar needs to be anchored into the back-slope and still extend (12 in.) down-slope. If your trail is 6 feet wide, the bar must be (12 ft) long to be correctly installed at a 45° angle. Wider trails require even longer waterbars.

Rubber Waterbars

Rubber waterbars are made of rubber belting sandwiched between two pieces of 2” x 6” pressure treated lumber and protruding 2 to 3 inches on the top. The timbers are then buried flush with the trail surface so only the belting protrudes into the trail. The belting will bend for ATV tires but will effectively drain the water. **Rubber water bars do not work well for snowmobile or multi-use trails due to possible damage from grooming.** Rubber waterbars can become less effective over time, if sediment builds up causing the belt to fold over. Regular cleaning is important!



Waterbar Installation Guidelines	
Trail Grade (percent)	**Distance between Waterbars** (feet)
1-2	250
3-5	200-135
6-10	100-80
11-15	80-60
16-20	60-45
21+	40

Waterbar Maintenance

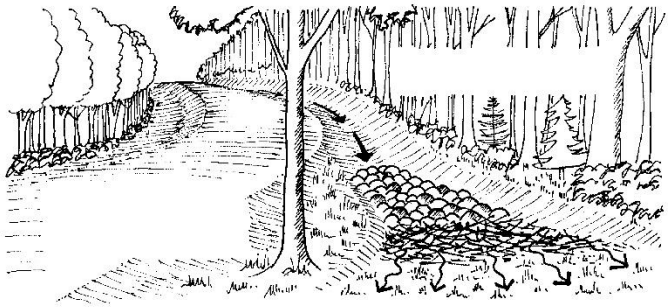
In a perfect world water control structures would be "self-cleaning" but in the real world most collect debris and sediment. Most problems occur when water is slowed by hitting the waterbar causing debris and sediment to build up. This usually happens because the angle is wrong or there is too much distance between the waterbars. If you need to reset the waterbar at a steeper angle, you will usually need a longer waterbar. You also may need to install additional waterbars, if erosion is evident.

Bridged Waterbars

Another effective set up is to make large 2-foot-deep ditch waterbars like the ones used to put a road to bed. Then you can install short bridges over them, so they aren’t destroyed by ATVs driving through them. The bridge decking should have gaps so any water running down the trail will run into the waterbar and drain off. These large ditch waterbars will last indefinitely when installed and bridged correctly.

Ditches and Turnouts

Ditches collect runoff from the trail. Ideally, runoff would be discharged in small amounts off the trail surface and into grassed or wooded areas (filter strip) where it will percolate into the ground, however, this is generally not the case. Instead, runoff accumulates in a ditch before it is discharged. Stone check dams may aid in slowing down water, making it less likely to cause erosion.



Flow is dispersed at the outlet with rock and/or slash

Turnouts are used to direct ditch water away from the trail. The turnout should have a flared level end that is lined with rock riprap to spread out the flow. The main purpose of the turnout is to reduce the quantity and velocity of water reaching the bottom of the hill. Turnouts should be located so they take advantage of the natural contour of the land and should be installed frequently enough to prevent large volumes of water from accumulating in the ditches. Steeper slopes will require more turnouts to counteract the fast-moving water. **In no case should ditches discharge water directly into a waterbody**.

Filter Strips

Turnouts dump ditch water into a vegetated buffer area called a Filter Strip. A filter strip is an undisturbed area of ground, consisting of natural vegetation, located between the trail, or associated ditches and a water body. Filter strips prevent sediment from washing directly into water bodies. It is important to note that filter strips are only effective when runoff is flowing through them as sheet flow. Concentrating too much water into a filter strip will create a channel defeating the purpose.

Fortunately, many of our trails still have plenty of vegetated buffers along the edges. Forested areas make the best buffers, because the uneven ground, leaves, needles, and twigs trap and absorb water. Tree and shrub roots also absorb the nutrients in the runoff, preventing them from getting into lakes and rivers. Use table below for filter strip width guide:

FILTER STRIPS

Slope of Land Between Trail and Water Body	Width of Filter Strip Between Trail and Water Body
0%-9%	25'
10%-19%	45'
20%-29%	65'
30%-39%	85'
40%+*	100'

* Add 20 ft. of width for each additional 10% of slope

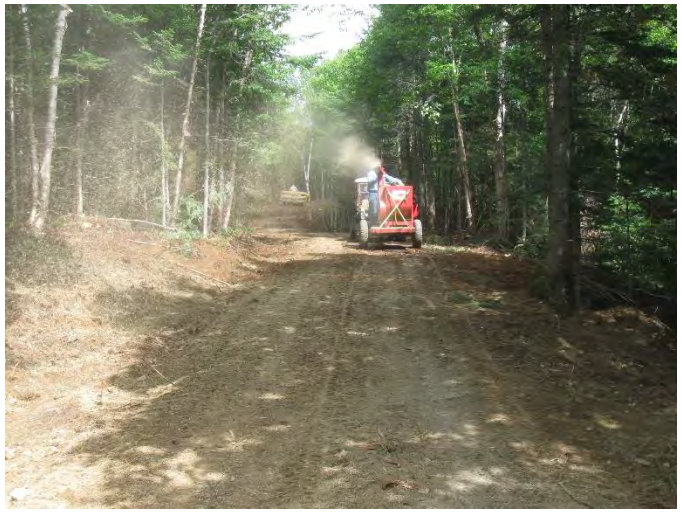
Seeding and Mulching

Seeding and mulching is an effective and affordable way to prevent erosion of exposed soils. Whenever you disturb the soil (such as digging or maintaining ditches) or wherever exposed soil exist, seed and mulch to prevent erosion. Spread hay or straw mulch over the seeded area to prevent the erosion that can occur before the permanent vegetation takes hold. Mulch also helps maintain soil moisture thereby promoting seed germination.

It is especially important to immediately seed and mulch "sensitive areas" that have high erosion potential, such as excavated areas on steep slopes or approaches to water crossings. Erosion in these areas can cause sediment buildup in streams. Seed and mulch the area immediately after the excavation work is done.

All exposed soil must be mulched prior to any rainfall.

Only use "native, non-invasive" grass seed that will tolerate Maine's climate.

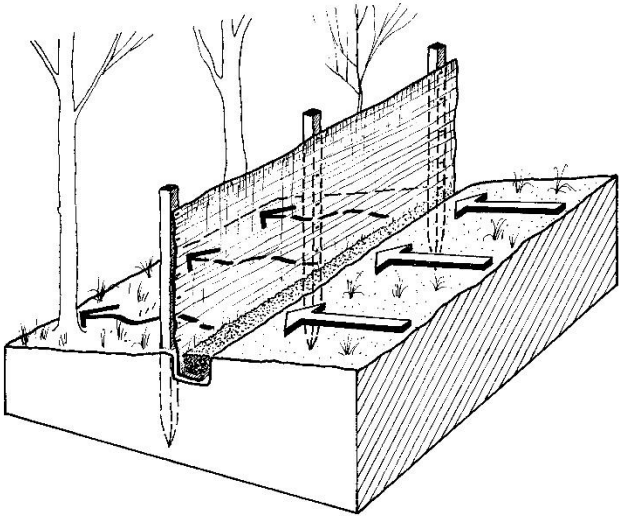


Temporary Sediment Barriers

Temporary sediment barriers such as Silt fences or socks are used to trap sediment during the construction of roads, ditches and BMPs until other measures, especially permanent vegetation, can be installed. Silt fences are not intended as permanent structures and should be removed during closeout or after site has stabilized.

Silt Fence Installation:

- Install a synthetic filter fence by first setting stakes at least every 6-8 feet. Three feet is needed for light fabric, while 10 feet is adequate when using extra strength fabric and/or wire mesh support fence.
- Follow the manufacturer's recommendations and choose a filter fabric capable of handling the expected water flow. The fabric may be 15-36 inches high.
- Excavate a 4-inch deep trench upslope along the line of the stakes.
- Place a 4-6-inch skirt of fabric in the trench; staple the fabric to the stakes; then backfill and compact the soil.



Use of filter fence as temporary sediment barrier.

Borrow Pits

Often filling of areas on the trail will be needed. If you can find adequate gravel on site, it will save both time and money. The hole you dig is called a borrow pit. It should be as close to the work site as possible but screened from view. The material in the pit also needs to be suitable for the desired use. Gravel is ideal, but soil with a balanced mixture of different size particles is also a good choice. Saturated soils from wet areas are not normally suitable for fill.

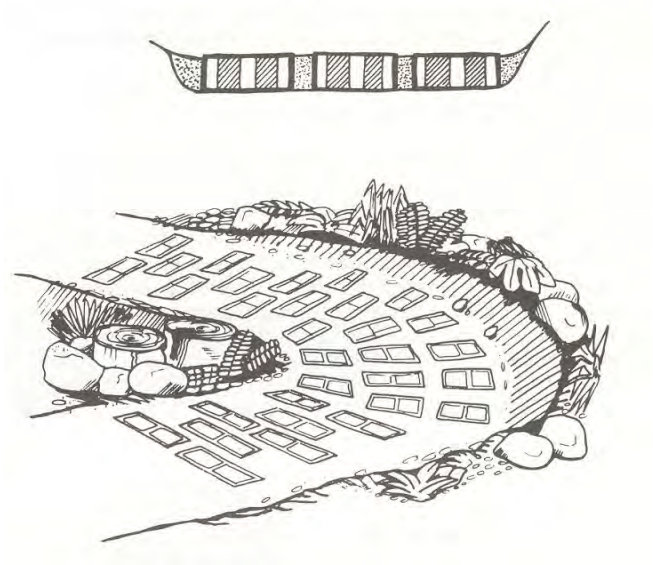
Save vegetation removed from the top of the borrow pit. You can use it to help with the rehabilitation and restoration of the site. To rehabilitate, grade the pit out to natural contours with topsoil. Camouflage the area with boulders and dead wood. Borrow pits are a great place to bury stumps or rocks that are removed from the trail tread.

Trail Hardening

Trail hardening is simply the act of making a trail tread more durable. It could involve armoring a trail up a slope or across a wet area. Tread hardening is used to allow the trail to be used without causing ruts, soil loss, erosion and damage. Trail relocation should be considered before resorting to trail hardening.

Armored Trails

Armoring may be required on switchbacks and sections of trail where grades exceed 20%. However, it is also very effective in places like gate openings. Regular half high blocks, tri-loc blocks, and turf pavers are all examples of concrete blocks that have been used effectively to armor a trail. Crushed rock and flat rock are also used effectively in soft soils and look more natural.



Before deciding to install concrete blocks, take time to make a thorough evaluation of the site. If a trail or switchback is improperly located or designed, then that problem should be corrected first.

To install the blocks, dig the tread out a little deeper than the height of the blocks being installed for the entire distance of the installation.

Place the excavated soils in a handy location to be used for filling around the blocks after they are installed. Make sure the bottom is as smooth as possible to allow for level installation and to prevent breaking.

Place blocks open side up. When using regular half high concrete blocks it is a good idea to install a row of regular full-size blocks at the base to help hold the blocks and prevent the approach from breaking down.

The most difficult part of the job may be getting the blocks to the site. It can be done many ways but the easiest way is to shrink wrap blocks on a pallet and use a tractor or tracked skid steer with forks to carry them in. Be sure to have them packaged in weights your equipment can safely handle.

After the blocks are in place cover them completely with fill to a depth of about 2 inches.

The ideal fill is a loamy/gravel soil with no rocks larger than 2 inches in diameter. If you don't have this on site, you may need to haul the material in or get it from a borrow pit.

It is best not to backfill with a dozer or other steel tracked vehicle, so you don't break the blocks. Using a tractor or some rubber-tired vehicle is best. Be sure to fill ahead of you as you go to prevent damage to the blocks. Normal ATV traffic will sift the material down into all the voids and compact it well. In some cases, voids may occur due to water running down the trail, if this happens you need to add some additional fill. It is important that you keep water off the trail by installing waterbars or drainage ditches at the top.

While a winter trail may be 12' in width, the hardened surface may only be 5-6 feet wide.

NOTE: Heaving of blocks by frost can be a problem on trails that also receive winter use.

Trails Crossing Wet Areas

Remember that ATV use in wetlands is prohibited unless on an authorized trail. Permits may be required. (See Page 11 & 12)

Because nearly every technique for repairing trails in boggy areas is expensive, relocating should be considered first. Reviewing soil maps and scouting for suitable places to relocate trails is time well spent. The alternative route should be on a slope for better drainage and have mineral rather than organic soil for its tread. Never reroute a problem section of trail to another wet piece of ground.

Sometimes, improving drainage will cure the problem. Although an area may appear flat, often it will have a slight gradient and flow of water. In those conditions drainage ditches and culverts can help ensure that water drains off and under the trail.

Multi-use boardwalk

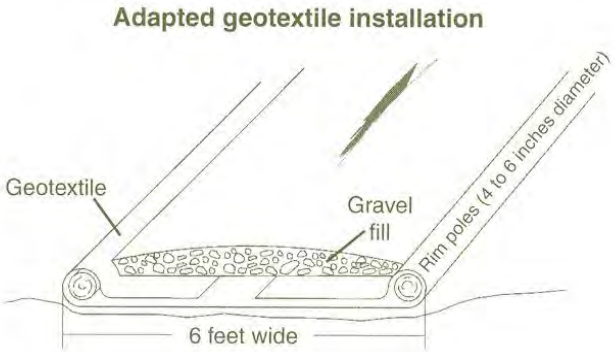
Two types of structures - **Turnpike and Puncheon** - are commonly used to construct dry trails across wet boggy areas.

Turnpike

Turnpike is used to elevate the trail above wet ground. Turnpike should be used primarily in flat areas where there is wet or boggy ground. The most important consideration is to lower the water level below the trail base and carry the water under and away from the trail at frequent intervals. Turnpike requires some degree of drainage. Where the ground is saturated and drainage is not possible, use puncheon surfacing instead. However, turnpike is easier and cheaper to build and may last longer than puncheon. The technique uses fill material from parallel side ditches and from offsite to build the trail base higher than the surrounding water table. Turnpikes work only on trail grades up to 10 percent. This technique works well on multi-use trails.

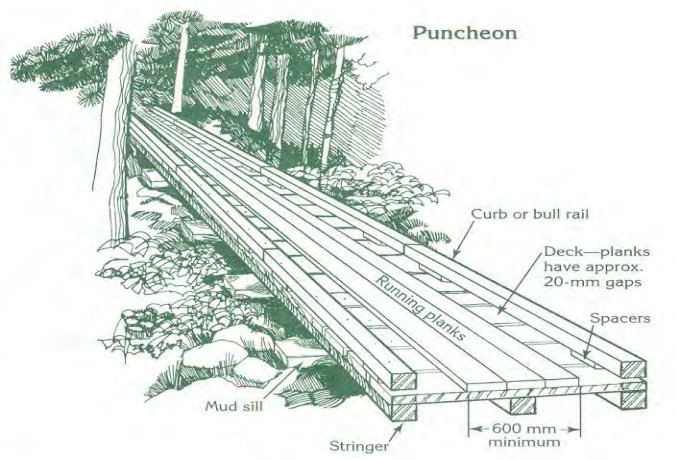
Begin your turnpike by clearing the site wide enough for the trail tread plus a ditch and retainer log or rocks on either side of the trail tread. Rocks, stumps, and stubs that would protrude above the turnpike tread or cause rips in geotextile fabric should be removed or at least cut flush below the final base grade.

Ditch both sides to lower the water table and install geofabric on the bottom of the trail. Using fabric will result in a better trail, requiring less fill. Rocks or logs can be used for retainers, if needed. If you use logs, they should be at least (6 in) in diameter and peeled.



Firm coarse-grained soils or granular material are needed for fill. Sometimes the ditching material can be used if you can leave the trail unused for a few weeks to allow the soils to dry out. Often it is necessary to haul in gravel or other well-drained material to surface the trail tread. Fill the trail until the crown of the trail tread is above the retainers. It doesn't hurt to overfill to begin with, as the fill will settle. Initial maintenance will be required the year after construction; since most settling occurs then.

Puncheon (boardwalk)

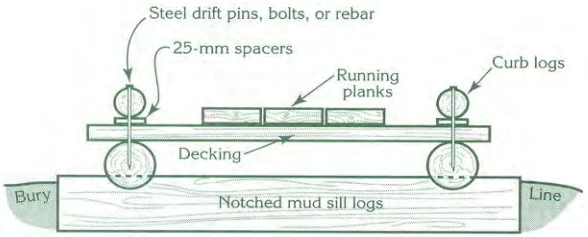


Puncheon is a wooden walkway (boardwalk) used to cross bogs or small streams. It consists of decking placed on stringers to elevate the trail across wet areas. It can be used and is preferred where rocky uneven terrain, muddy surfaces, or lack of mineral soils makes turnpike construction impractical. This is not generally suited for snowmobiles in areas that use wide and heavy trail groomers.

When building a puncheon, the entire structure must extend to solid soil so soft spots do not develop at either end. Approaches should be straight for at least (10 ft) on each end. If the puncheon is very long, you may need to include turnouts for riders to pass.

To begin construction, install mud sills. These support the stringers. Mud sills can be made of native logs, treated posts, large flat rocks or precast concrete.

The mud sills are laid in trenches at both ends of the area to be bridged and at intervals of 6 to 12 ft. If firm footing is not available, increase the length of the sill log to give it better flotation, or use more sills.

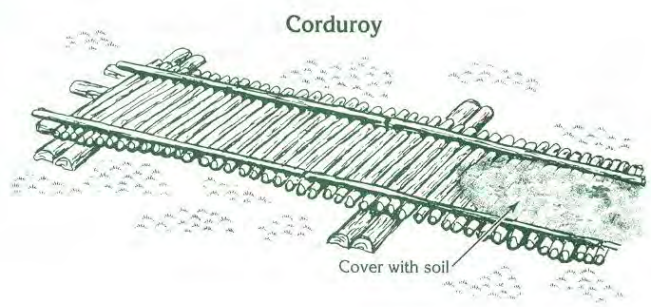


Stringers made from peeled logs or treated timbers are set on top of the mud sills. Stringers need to be level with each other so the surface will be level when the decking is added. Two stringers are usually enough for ATVs and snowmobiles, but for horses, three or four are recommended.

The decking is much like that on a bridge. The thickness needs to be strong enough to support the intended loads. The decking should be at least 5 feet wide and 4 inches thick. Decking should be placed with tree growth rings curving down. This encourages water to run off rather than soak in.

Curb logs or bumpers should be placed on each side of the structure to keep traffic in the center. To provide for drainage, nail spacers between the curb logs and the decking.

Avoid using puncheon on grades steeper than 5 percent as they are slippery.



Corduroy

Corduroy roads were basically a primitive version of subsurface puncheon. It consists of laying native logs on the ground side by side and bound together. Corduroy is notorious for consuming large amounts of material and not lasting very long. Other alternatives are usually a better choice.

It is important to remember to allow for the natural flow of water no matter what trail treatment type you are using. Failure to provide for water crossings will cause the trail to remain wet and lead to rutting and erosion.

Geosynthetics can increase the effectiveness of construction methods by **performing *three functions: separation, reinforcement, and drainage.*** *Geosynthetic materials include* ***geo-textiles (construction fabrics), geocells, and geogrids.*** All these materials become a permanent part of the trail but must be covered with soil to prevent deterioration from sun light.

Geotextiles, commonly called construction fabrics, are often used in trail turnpike construction. They are made from long-lasting synthetic fibers bonded to form a fabric. They serve as a barrier between the mucky saturated soil beneath the fabric and the mineral or granular soil placed on top.

The importance of separation cannot be overemphasized. It takes only about 20 percent silt or clay before mineral soil takes on the characteristics of mud when wet. The fabric allows water to pass through but prevents silt from passing through. Geotextiles commonly used in road construction work for trails but those used for septic systems do not.

Geocells are a polyethylene honeycomb structure. Geocells help reduce the amount of fill material required by helping hold the fill in place. Geocells cannot be used on any kind of slope as they don’t stand up to wheel spin.

Geoblocks are formed into very open grid-like configurations. Geogrids are effective because they have high tensile strength, they link together, and coarse aggregate can fit into the structure. They can support fairly heavy loads with very little additional fill when properly installed. They must be installed on level soils, hooked together and require construction fabric underneath when filled to help support the load and contain the gravel. What makes them especially attractive is they can be used in areas that often are completely submerged during wet times of the year.

Geoblocks are best used to harden wet sections of trail.

Some locations may allow for a variety of treatment options depending on anticipated user group, soil types and availability of materials.

Be sure to talk with experienced trail builders in the area before beginning construction because there may be a simple workable solution that is less expensive or easier to install.

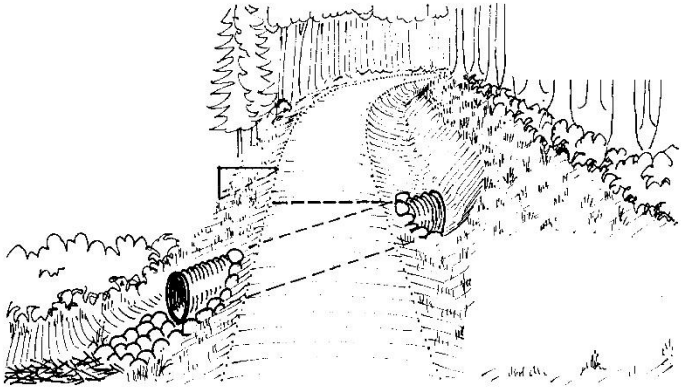
Crossing Streams and Rivers

Stream and River crossings present a challenge to trail managers grappling with a mix of safety, convenience, cost, anticipated use, and environmental impact. Each kind of water crossing has consequences for the recreation experience and the lands being accessed. Carefully consider all your options before committing present and future resources to any given crossing.

Basic Requirements for water crossings

Must be constructed in a manner that causes no disturbance to the stream bed and no substantial disturbance to the banks or shoreland zone area.

Must not impede the flow of water or the passage of fish or other aquatic organisms.



Culverts

Culverts are used to allow water to pass beneath the trail from one side to the other.

Culverts should be installed when:

- the trail needs to cross a small brook, or seasonal runoff which isn't big enough to require a bridge.
- the water volume in a ditch requires it to be drained to the opposite side of the trail.

Culvert Strengths:
Provide for a smooth uninterrupted trail while protecting the natural water flow.

Culvert Weaknesses:
Require regular inspections and cleaning;

Failure caused by lack of maintenance or a heavy rain event can be expensive to repair;

Are more easily plugged by beavers than bridges.

Culvert Sizing

It is very important to have the proper culvert length. All too often, people install culverts that are too short, causing the shoulder around the culvert to collapse and plug the openings. Be sure the culvert is long enough that the inlet and outlet extend beyond the edge of the fill by at least a foot.

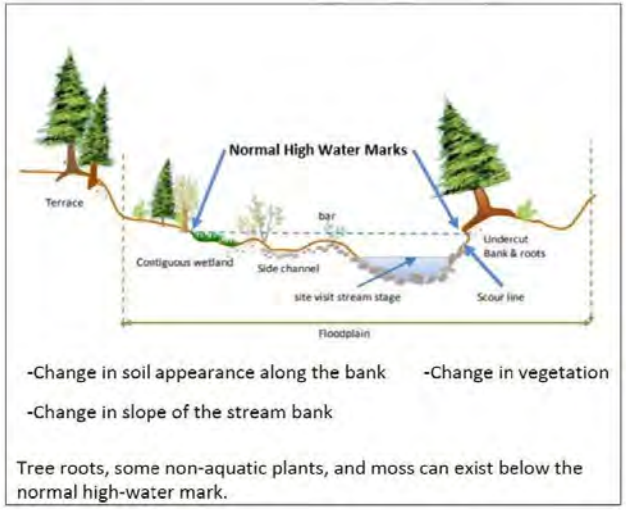
Culvert diameter is the most important aspect of culvert selection. Proper sizing can eliminate washouts and plugging. Money spent for a larger culvert often results in a net savings because of reduced maintenance and repair. A minimum diameter of 15 inches for round culverts is recommended. Smaller culverts plug too easily and are hard to clean.

Average Stream Width (ft)	Average Stream Channel Depth (ft)			
	0.5	1	1.5	2
	Culvert Size			
1	24”	30”	36”	42”
2	30”	42”	48”	54”
3	48”	48”	60”	72”
4	60”	60”	72”	84”
5	72”	72”	72”	84”
6	96”	96”	96”	96”

Most of the time a much larger culvert is needed, if used in an actual stream due to the fish passage requirements. Generally, a large box culvert or bridge is a better less expensive option when crossing brooks and streams, however, a culvert is a good option in cross drainage situations.

Culverts must be large enough to handle expected 25-year storm flow. This means the opening must be at least 3½ times the cross-sectional area of the stream:
(*Average depth x average width) x 3.5*

Determine the size needed to accommodate normal high water by running a string or tape from bank to bank at the high-water marks and then measure down in several locations to determine average stream depth at high water multiplying width x average depth x 3.5.



Culverts should be covered with compacted gravel to a depth equal to the culvert diameter but never less than at least 1’ deep. Stabilize the inlet and outlet of culverts and bridges using rock, timber abutments or other armoring. The soil surrounding the culvert provides its strength, therefore good properly compacted gravel is essential for proper installation.

Wood Box culvert: no gravel cover needed

Culvert Installation Tips

Install the culvert so that:

- culvert is at a 2% grade (¼-inch of drop per foot of length).
- Culverts must have at least one foot of gravel covering them.
- gravel must be compacted around the culvert for its full length.
- rock riprap is installed on both the inlet and outlet of the culvert at a 2 to 1 slope with end of culvert extending beyond the fill to prevent erosion.
- Culverts installed in natural streams should be embedded into the streambed to allow fish to travel freely through the culvert. A better option is a bottomless (box) culvert or a bridge that spans the entire stream channel to provide adequate fish passage.

Culvert Types

There are four basic types of culverts used in trail construction: corrugated metal, plastic, concrete and wood box culverts. Each has advantages and disadvantages, as shown in the following table.

Culvert Type	Advantage	Disadvantage
metal	❑ inexpensive for sizes < 24” ❑ easy to install ❑ 25-year life	❑ expensive for sizes > 24” ❑ heavier to handle
plastic	❑ inexpensive for sizes > 18” ❑ <25-year life ❑ easily cut with power saw ❑ lightweight	❑ easily broken if not handled carefully ❑ more difficult to install ❑ easily crushed
concrete	❑ 50-year life ❑ handles heavier weights ❑ No impact to stream bottom	❑ expensive ❑ very heavy hard to handle
wood	❑ strong (when built with 4x6 or larger material) ❑ >25 year life (when built from P.T.) ❑ no impact to stream ❑ No fill required ❑ does not require heavy equipment if constructed on site	❑ usually have to be built on site. ❑ pre-built box culverts are heavy and hard to move

Open-Top Cross Drain

Open-Top cross drains can be very effective when used on trails for ATVs and snowmobiles but can create a challenge for dirt bikes, horses, and bicycles. If used on multi-use trails, a protective top grate must be used. These box-like structures collect and divert both trail and surface water runoff away from the trail, combining the jobs of a waterbar and culvert into one. Open-top culverts can be constructed of logs or from sawn lumber. If constructed of pressure treated lumber, they will last for many years. Open-top culverts should drain into stable vegetated filter strips**.** They will need to be cleaned regularly to remove debris and sediment.

Bridges

Use bridges at medium to large stream or river crossings and when site conditions make a bridge more practical than a culvert. Small bridges are easy to construct but once spans exceed 30-40 feet, bridges become a greater challenge often requiring engineered plans and significant funding. The span length, remoteness of location, weight capacity, and design, all affect cost. Before you build a bridge, weigh your site options carefully to make the best choice.

When building a bridge, it is important to avoid or minimize bank disturbance. Abutments may be needed to reduce the span length and/or support the bridge weight. Piers or islands can be used to break the entire distance into shorter spans. However, DEP/LUPC and the Army Corps of Engineers will be concerned about structures in the water channel, so always scout for a location carefully to avoid piers if possible.

Bridge Strengths:

- No impact to stream channel
- Very little fill needed
- Won’t plug up

Bridge Weaknesses:

- May require engineering
- More time consuming
- Railings or bumpers required
- Long-term maintenance required

As with culverts, bridges should be designed to accommodate at least a minimum 25-year storm flow.

Considerations for Bridge Installation

- Safe, strait, nearly level approaches are best. If possible, avoid ramps.
- The availability of materials and ease to get them on site.
- Required clearance for watercraft etc.
- Required capacity? Normal operation may only require it to hold several ATVs, but other uses and may require load capacities of 5+ tons (tractor/groomer).
- Who else will use it? Horses or snowmobile grooming equipment may require stronger decking and stringers.

Basic Bridge Structural Components

- Abutments & Supports
- Stringers
- Decking
- Railings

Abutments & Supports

Bridge abutments and supports provide the “seats” on which the bridge structure rests. They can be log sleepers, large flat rock slabs, stone filled log cribs, wood or steel pilings, precast or poured concrete. The purpose is to provide a solid foundation and keep the stringers high and dry to prevent rot.

With the exception of sleepers and pilings, most abutment and support options require some degree of stream bank excavation for installation. It is this aspect of bridge construction that requires the greatest attention to environmental impacts and protection against erosion and sedimentation. Installation of abutments behind the natural stream bank is preferred.

Stringers

The stringer is the primary support device for the bridge deck. These are beams that extend between abutments and/or in-stream supports. Stringers can be logs, utility poles, timbers (solid or laminated), steel beams, or fabricated trusses of either wood or steel. The correct choice depends on length of span, weight capacities, availability, and construction cost.

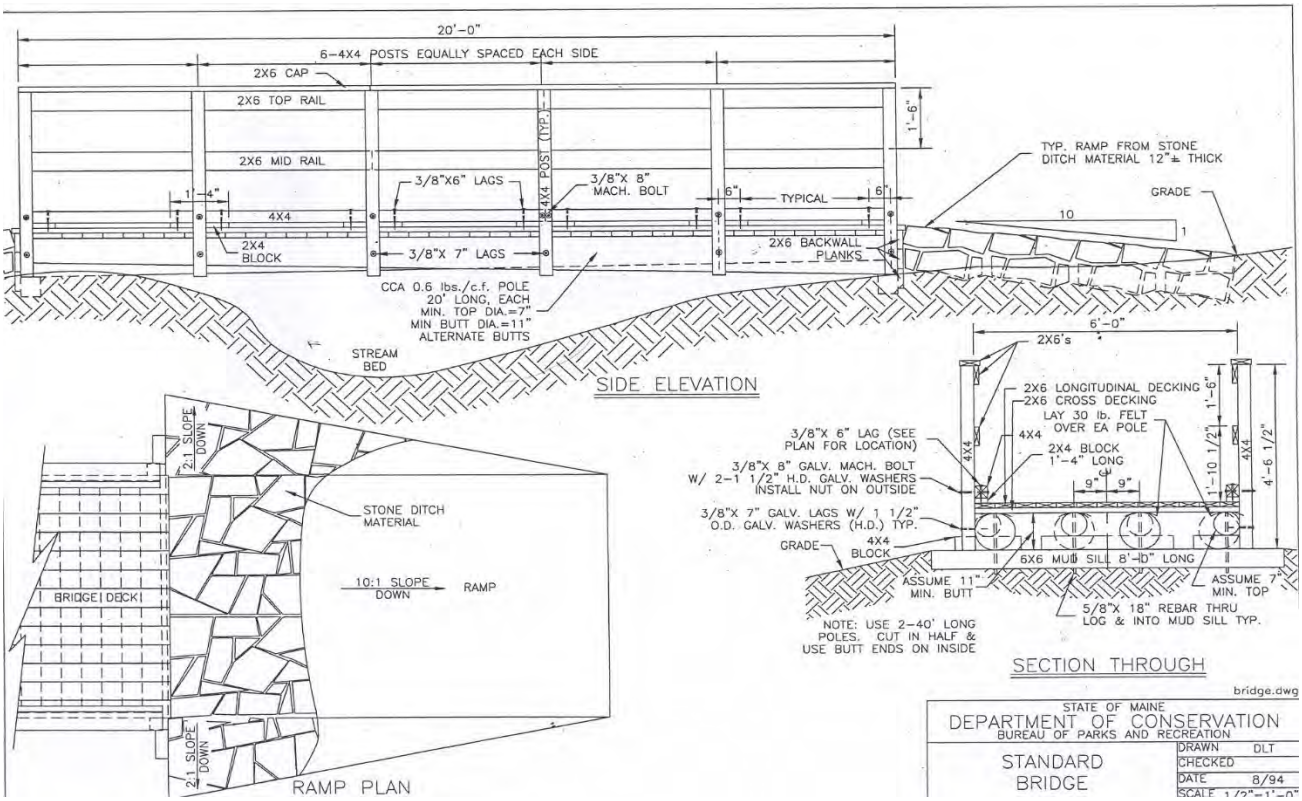
Laminating beams (nailed and glued at staggered lengths) can greatly increase the strength of wood stringers. Knee braces between stringers and abutments can also significantly increase load capacities. If you are unsure of capacity, it is best to err on the side of strength. The cost of an extra stringer, or larger size, is a small price to pay for peace of mind.

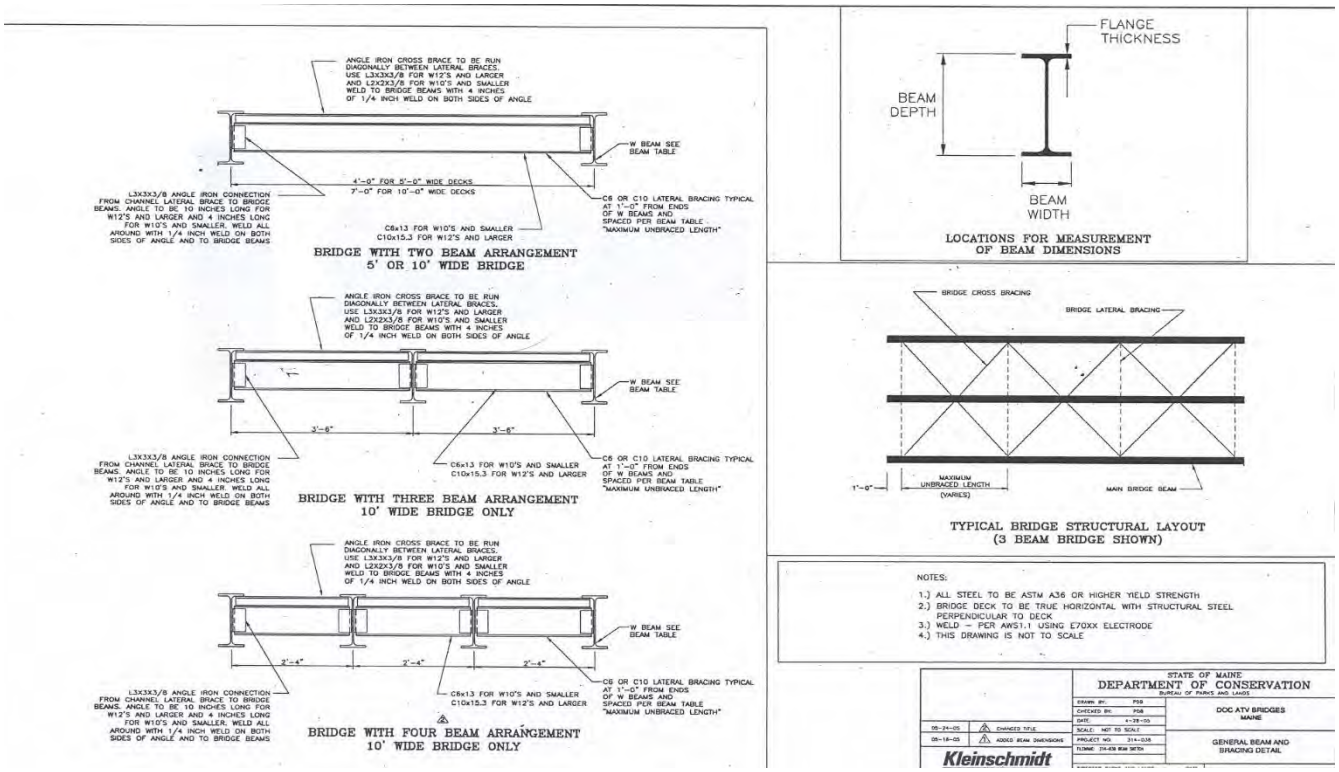
For wood construction, pressure-treated is hard to beat with several northeastern firms producing affordable, treated, woods with life expectancies of 40 years. Naturally rot-resistant species should be used, if pressure treated wood is not an option. Hemlock or tamarack are both good choices, but cedar is generally too weak for structural components.

All log stringers will last more than twice as long, if the bark is peeled, and the ends are kept free of soil contact (i.e., set on rocks or sleepers).

If a span exceeds 40 feet, stringer options should be evaluated by a professional. Metal beams or trusses are an excellent choice especially if they are readily available. If a span exceeds 100 feet, suspension bridges may be the best and most affordable choice.

LOG STRINGER TABLE FOR 100 PSF SNOW LOAD					
SPAN	DOUGLAS FIR AND WESTERN LARCH		PONDEROSA PINE AND LODGEPOLE PINE		
	MIN. MID-SPAN DIAMETER	MINIMUM TIP DIAMTER	MIN. MID-SPAN DIAMETER	MINIMUM TIP DIAMTER	
FOR 8'-0" DECKING WIDTH					ASSUMES 4
10'-0"	12"	9"	12"	9"	
15'-0"	12"	9"	12"	9"	
20'-0"	12"	9"	12"	9"	
25'-0"	13"	10"	14"	11"	
30'-0"	14"	11"	16"	13"	
35'-0"	15"	12"	18"	15"	
40'-0"	17"	14"	20"	17"	
45'-0"	18"	15"	21"	18"	
50'-0"	20"	17"	23"	20"	
55'-0"	21"	18"	25"	22"	
60'-0"	23"	20"	27"	24"	
FOR 6'-0" DECKING WIDTH					ASSUMES 3
10'-0"	12"	9"	12"	9"	
15'-0"	12"	9"	12"	9"	
20'-0"	12"	9"	12"	9"	
25'-0"	12"	9"	13"	10"	
30'-0"	12"	9"	14"	11"	
35'-0"	14"	11"	16"	13"	
40'-0"	15"	12"	18"	15"	
45'-0"	17"	14"	20"	17"	
50'-0"	18"	15"	21"	18"	
55'-0"	20"	17"	23"	20"	
60'-0"	21"	18"	25"	22"	
FOR 4'-0" DECKING WIDTH					ASSUMES 2
10'-0"	12"	9"	12"	9"	
15'-0"	12"	9"	12"	9"	
20'-0"	12"	9"	12"	9"	
25'-0"	12"	9"	12"	9"	
30'-0"	13"	10"	14"	11"	
35'-0"	14"	11"	16"	12"	
40'-0"	15"	12"	17"	14"	
45'-0"	16"	13"	19"	16"	
50'-0"	18"	15"	21"	17"	
55'-0"	19"	16"	22"	19"	
60'-0"	21"	18"	25"	21"	


20'-0"
6-4X4 POSTS EQUALLY SPACED EACH SIDE
2X6 CAP
2X6 TOP RAIL
2X6 MID RAIL
1'-6"
1'-4"
4X4
2X4 BLOCK
3/8"X6" LAGS
4X4 POST (TYP.)
3/8"X 8" MACH. BOLT
6"
TYPICAL
6"
3/8"X 7" LAGS
2X6 BACKWALL PLANKS
TYP. RAMP FROM STONE DITCH MATERIAL 12"± THICK
GRADE
10
1
CCA 0.6 lbs./c.f. POLE 20' LONG, EACH MIN. TOP DIA.=7" MIN BUTT DIA.=11" ALTERNATE BUTTS
STREAM BED
SIDE ELEVATION
2:1 SLOPE DOWN
STONE DITCH MATERIAL
10:1 SLOPE DOWN
RAMP
BRIDGE DECK
2:1 SLOPE DOWN
RAMP PLAN
6'-0"
2X6's
2X6 LONGITUDINAL DECKING
2X6 CROSS DECKING
LAY 30 lb. FELT OVER EA POLE
3/8"X 6" LAG (SEE PLAN FOR LOCATION)
4X4
2X4 BLOCK 1'-4" LONG
3/8"X 8" GALV. MACH. BOLT W/ 2-1 1/2" H.D. GALV. WASHERS INSTALL NUT ON OUTSIDE
9"
9"
3/8"X 7" GALV. LAGS W/ 1 1/2" O.D. GALV. WASHERS (H.D.) TYP.
GRADE
4X4 BLOCK
6X6 MUD SILL 8'-lb" LONG
ASSUME 11" MIN. BUTT
ASSUME 7" MIN. TOP
5/8"X 18" REBAR THRU LOG & INTO MUD SILL TYP.
NOTE: USE 2-40' LONG POLES. CUT IN HALF & USE BUTT ENDS ON INSIDE
SECTION THROUGH
1'-6"
1'-10 1/2"
4'-6 1/2"
bridge.dwg
STATE OF MAINE
DEPARTMENT OF CONSERVATION
BUREAU OF PARKS AND RECREATION
STANDARD BRIDGE
DRAWN DLT
CHECKED
DATE 8/94
SCALE 1/2"=1'-0"


ANGLE IRON CROSS BRACE TO BE RUN DIAGONALLY BETWEEN LATERAL BRACES. USE L3X3X3/8 FOR W12'S AND LARGER AND L2X2X3/8 FOR W10'S AND SMALLER WELD TO BRIDGE BEAMS WITH 4 INCHES OF 1/4 INCH WELD ON BOTH SIDES OF ANGLE
W BEAM SEE BEAM TABLE
4'-0" FOR 5'-0" WIDE DECKS
7'-0" FOR 10'-0" WIDE DECKS
L3X3X3/8 ANGLE IRON CONNECTION FROM CHANNEL LATERAL BRACE TO BRIDGE BEAMS. ANGLE TO BE 10 INCHES LONG FOR W12'S AND LARGER AND 4 INCHES LONG FOR W10'S AND SMALLER. WELD ALL AROUND WITH 1/4 INCH WELD ON BOTH SIDES OF ANGLE AND TO BRIDGE BEAMS
C6 OR C10 LATERAL BRACING TYPICAL AT 1'-0" FROM ENDS OF W BEAMS AND SPACED PER BEAM TABLE "MAXIMUM UNBRACED LENGTH"
C6x13 FOR W10'S AND SMALLER C10x15.3 FOR W12'S AND LARGER
BRIDGE WITH TWO BEAM ARRANGEMENT 5' OR 10' WIDE BRIDGE
3'-6"
3'-6"
BRIDGE WITH THREE BEAM ARRANGEMENT 10' WIDE BRIDGE ONLY
2'-4"
2'-4"
2'-4"
BRIDGE WITH FOUR BEAM ARRANGEMENT 10' WIDE BRIDGE ONLY
FLANGE THICKNESS
BEAM DEPTH
BEAM WIDTH
LOCATIONS FOR MEASUREMENT OF BEAM DIMENSIONS
BRIDGE CROSS BRACING
BRIDGE LATERAL BRACING
1'-6"
MAXIMUM UNBRACED LENGTH (VARIES)
MAIN BRIDGE BEAM
TYPICAL BRIDGE STRUCTURAL LAYOUT (3 BEAM BRIDGE SHOWN)
NOTES:
1.) ALL STEEL TO BE ASTM A36 OR HIGHER YIELD STRENGTH
2.) BRIDGE DECK TO BE TRUE HORIZONTAL WITH STRUCTURAL STEEL PERPENDICULAR TO DECK
3.) WELD - PER AWS1.1 USING E70XX ELECTRODE
4.) THIS DRAWING IS NOT TO SCALE
05-24-05 CHANGED TITLE
05-19-05 ADDED BEAM DIMENSIONS
Kleinschmidt
STATE OF MAINE
DEPARTMENT OF CONSERVATION
BUREAU OF PARKS AND LANDS
DRAWN BY: PSB
CHECKED BY: PSB
DATE: 4-28-05
SCALE: NOT TO SCALE
PROJECT NO: 314-038
FILENAME: 314-038 BEAM SKTCH
DOC ATV BRIDGES MAINE
GENERAL BEAM AND BRACING DETAIL

Ten-Foot-Wide, Four Beam Bridge
Max 15,000 Pounds
Beam Dimensions and Unbraced Length

Span (Ft)		Depth (In.)	Flange Width (In.)	Flange Thicknes s (In.)	Max unbraced Length (feet)
W10					
30	W10x77	10 5/8	10 1/4	7/8	5' - 1"
W12					
30	W12x58	12 1/4	10	5/8	10'-7"
W14					
30	W14x48	13 3/4	8	5/8	8'-6"
40	W14x90	14	14 1/2	11/16	15'-3"
W16					
30	W16x40	16	7	1/2	7'-4"
40	W16x77	16 1/2	10 1/4	3/4	10'-10"
W18					
30	W18x35	17 3/4	6	7/16	6'-3"
40	W18x65	18 3/8	7 5/8	3/4	8'-0"
50	W18x106	18 3/4	11 1/4	15/16	11'-9"
W21					
30	W21x44	20 5/8	6 1/2	7/16	6'-7"
40	W21x57	21	6 1/2	5/8	6'-10"
50	W21x83	21 3/8	8 3/8	13/16	8'-8"
W24					
30	W24x55	23 5/8	7	1/2	7'-0"
40	W24x55	23 5/8	7	1/2	7'-0"
50	W24x68	23 3/4	9	9/16	9'-6"

Ten-Foot-Wide, Three Beam Bridge
Max 15,000 Pounds
Beam Dimensions and Unbraced Length

Span (ft)		Depth (In.)	Flange Width (In.)	Flange Thicknes s (In.)	Max unbraced Length (feet)
W12					
30	W12x96	12 3/4	12 1/8	7/8	12'-10"
W14					
30	W14x82	14 1/4	10 1/8	7/8	10'-8"
W16					
30	W16x67	16 3/8	10.25	11/16	10'-9"
W18					
30	W18x55	18 1/8	7 1/2	5/8	10'-10"
40	W18x97	18 5/8	11 1/8	7/8	11'-9"
W21					
30	W21x44	20 5/8	6 1/2	7/16	6'-7"
40	W21x83	21 3/8	8.375	13/16	8'-9"
W24					
30	W24x55	23 5/8	7	1/2	7'-0"
40	W24x68	23 3/4	9	9/16	9'-6"
50	W24x103	24 1/2	9	1	9'-6"

Ten-Foot-Wide, Two Beam Bridge
Max 15,000 Pounds
Beam Dimensions and Unbraced Length

Span (Ft)		Depth (In.)	Flange Width (In.)	Flange Thickness (In.)	Max unbraced Length (feet)
W12					
30	W12x87	12 1/2	12 1/8	13/16	12’-9”
W14					
30	W14x74	14 1/8	10 1/8	13/16	10’-7”
W16					
30	W16x57	16 3/8	7 1/8	11/16	7’-6”
40	W16x100	17	10 3/8	1	11’-0”
W18					
30	W18x50	18	7 1/2	9/16	7’-10”
40	W18x86	18 3/8	11 1/8	3/4	11’-8”
W21					
30	W21x44	20 5/8	6 1/2	7/16	6’-6”
40	W21x73	21 1/4	8 1/4	3/4	8’-9”
W24					
30	W24x55	23 5/8	7	1/2	7’-0”
40	W24x62	23 1/4	7	9/16	7’-4”
50	W24x94	24 1/4	9 1/8	7/8	9’-7”
W30					
30	W30x90	29 1/2	10 3/8	9/16	10’-0”
40	W30x90	29 1/2	10 3/8	9/16	10’-0”
50	W30x90	29 1/2	10 3/8	9/16	10’-0”

Six-Foot-Wide, Two Beam Bridge
Max 5000 Pounds
Beam Dimensions and Unbraced Length

Span (Ft)		Depth (In.)	Flange Width (In.)	Flange Thickness (In.)	Max unbraced Length (ft)
W8					
30	W8X58	8 3/4	8 1/4	15/16	8’-8”
W10					
30	W10X45	10 1/8	8	5/8	8’-6”
40	W10X100	11 1/8	10 3/8	1 1/8	10’-10”
W12					
30	W12X30	12 3/8	6 1/2	7/16	6’-10”
40	W12X79	12 3/8	12 1/8	3/4	12’-9”
W14					
30	W14X26	13 7/8	5	7/16	5’-3”
40	W14X61	13 7/8	10	5/8	10’-7”
W16					
30	W16X26	15 3/4	5 1/2	3/8	5’-7”
40	W16X50	16 3/4	7 1/8	5/8	7’-6”
50	W16X89	16 3/4	10 3/8	7/8	10’-10”
W18					
30	W18X35	17 3/4	6	7/16	6’-4”
40	W18X46	18	6	5/8	6’-4”
50	W18X76	18 1/4	11	11/16	11’-7”
W21					
30	W21X44	20 5/8	6 1/2	7/16	6’-7”
40	W21X44	20 5/8	6 1/2	7/16	6’-7”
50	W21X62	21	8 1/4	5/8	8-‘8”
W24					
30	W24X55	23 5/8	7	1/2	7’-0”
40	W24X55	23 5/8	7	1/2	7’-0”
50	W24X55	23 5/8	7	1/2	7’-0”
W30					
30	W30X90	29 1/2	10 3/8	9/16	10’-0”
40	W30X90	29 1/2	10 3/8	9/16	10’-0”
50	W30X90	29 1/2	10 3/8	9/16	10’-0”

Decking

Most trail bridge decks are built from planking 2 to 4 inches thick and 6 to 10 inches wide. (Equestrian use requires thicker decking and snowmobile use requires wear strips.) Pressure-treated wood, hemlock or tamarack are all good choices. Decking should be placed with tree growth rings curving down. This encourages water to run off rather than soak in and helps to prevent cupping.

Costs of decking can sometimes be reduced by using running boards on top, and perpendicular to, the base layer of deck planking. Running boards help distribute the impact of heavy loads thereby reducing the need to depend on deck planking alone for weight-bearing support.

Railings

Railings should be strong and high enough to protect users. Inadequate railings become an attractive nuisance and are a safety hazard. Wood railing should be made from at least 2x6's or larger material. They should be bolted or screwed together rather than nailed. If possible, braces should also be installed.

The railings on a high bridge in urban areas may need to be designed to prevent small children from falling through openings. Smaller more remote bridges may just need bumpers. Railings should always be at least 30 inches high and designed so they don't attract people to sit or walk on them.

Bridge Maintenance Tips (annually)

- Thoroughly inspect stringers, ramps, decking, railings and abutments.
- Check for rot, splits, and insect damage.
- Replace loose screws, nails, and bolts.
- Maintain approaches so water and sedimentation don't drain onto the bridge or into the stream.
- Look for erosion, as well as displaced logs or rocks that could cause problems.

Any of the following problems require immediate attention to determine whether the bridge should remain open to traffic:

- Rotten, missing or broken materials.
- Large areas of damage from storms, accidents, rust, or insects.
- Broken, eroded, or rusted supports.

Trail Maintenance

Maintaining the trail involves the removal of brush, blow downs and other encroaching plants such as thorns or berry bushes which may block the trail or restrict travel. It also involves filling ruts, holes, and low spots and removing or covering over obstacles such as protruding roots and rocks. You also need to repair eroded sections due to significant use, or major storm damage such as landslides or washouts.

Proper tread maintenance aims for a solid, out-sloped or crowned surface. Remove all debris that has fallen on the trail. Pull the lower edge berm back onto the tread surface and use it to restore the crown or out-slope of the trail.

Diverting surface water off the trail should be at the top of your list of priorities. An insufficient crown will allow water to puddle on the surface; this will create potholes or erode the trail. Potholes will continue to grow each time a vehicle splash through them. Standing water will also seep into the trail weakening it and making it susceptible to rutting.

A general rule for gently sloping gravel trails is ¼-inch of crown per foot of total width. A crown of ½ inch per foot of trail width may be necessary for steeper sections to counteract the tendency of water to collect and travel downhill. Out-sloped trails should also be between ¼ and ½ inch per foot of width. Annual maintenance is required to maintain the correct amount of out-slope or crown and prevent erosion.

Grading

Grading is the process of smoothing and crowning a trail. This involves using a **tractor, grader, or bulldozer** with a steel cutting blade to redistribute soil material. Generally **large graders** are only used on large gravel trails like rail beds or forest management roads.

Regular grading or raking is an effective means of redistributing material that has either been washed or pushed to the edge by vehicle traffic. Over time, as the soil compacts, a berm will often form at the downhill edge of the trail. These little ridges defeat the purpose of crowning by preventing water from draining off.

Always make sure that water can get off the trail by smoothing the edge with the grading blade or rock rake. Usually, trails are graded by scraping and pulling the material from the outer edge back into the center.

Proper grading is also the most effective means of removing potholes. The grader should cut to the full depth of the potholes. Otherwise, they will tend to reform very quickly.

The best time to grade is when the ground is moist (in the spring after the frost has gone, or after a rain). Water helps to loosen the gravel and makes the road easier to reshape.

A word of caution – job performance is as good as the equipment operator! A trained and experienced contractor may be more expensive, but the job he does may be better, and last longer. Check references, and make sure they understand the work you need done.

A Steel tine rake, commonly called a York rake is another affordable and effective piece of maintenance equipment**.** This device consists of a row of strong metal tines that work in much the same manner as a grader blade. They can be towed behind or mounted on the front of an ATV, tractor, or truck.

Steel tine rakes can be used to:

- ❑ remove small potholes and wash-boarding.
- ❑ establish and maintain proper crown.
- ❑ remove ridges of material from the shoulder to allow for better drainage.

Advantages of this type of device include:

- ❑ Less expensive than graders.
- ❑ Ease of use, less time to grade.

Disadvantages include:

- ❑ Won't cut like a grader blade.
- ❑ Takes more passes for some tasks.

Mud Holes

Mud puddles will result in tread damage, but mud holes can have a more significant impact on the environment. Every attempt should be made to keep all trails high and dry.

Standing water usually weakens the tread and can cause a muddy/boggy area to develop. Usually these areas get wider and deeper as the existing trail gets harder to negotiate. Eventually a small muddy section will turn into a wide, nearly impassable, trail if the problem isn't quickly and effectively addressed.

It is important that natural wetlands and sensitive areas such as vernal pools not be damaged by ATV use. Many muddy sections of trail are in problem areas. In most cases the best option is to relocate trails to more appropriate and easier maintained locations or use trail hardening and stabilization techniques. Failure to properly address muddy areas will result in trail closure and possible violations.

Closing Trails

Discontinued trails should be blocked and/or gated to prevent unauthorized use and damage. When the trail is closed, measures should be taken to discontinue use by removing all signs and structures, including pulling culverts/bridges, and installing water bars, or other effective stabilizing measures.

Past practices of trail abandonment have left safety issues and permanent scars on the land. You probably know of abandoned trails that had a few logs and rocks dragged into the tread and trenches. Years later they are still visible, ugly and in many cases still eroding.

There are no cookbook answers for returning abandoned trails to their natural condition. Each site should be evaluated for its potential to regenerate and heal.

Revegetation can be accomplished passively or actively. Passive revegetation allows surrounding vegetation to naturally overtake the abandoned trail. Active revegetation ranges from spreading appropriate mulch, seed or transplanting onsite vegetation.

Simple restoration may consist of blocking new shortcuts and allowing the vegetation to recover. Complex restoration projects include reshaping the trail and replanting genetically appropriate species. Careful monitoring and follow up may be necessary to ensure that almost all evidence of the trail is gone. Thus, restoration can range from simple and inexpensive to complex and costly.

Definitions

Abutments The structures designed to support bridges or boardwalks.

Back-slope is the excavated, exposed area on the hillside above the trail.

Best Management Practices (BMP's) the most effective, practical, and economically feasible means of preventing water pollution.

Borrow Pit the area from which soil is excavated.

Boardwalk a planked bridge like structure erected across wetlands.

Clearing limit the area from which vegetation and other obstacles are removed to allow safe passage.

Clinometer a tool used to measure grade or slope.

Climbing Turn less than 180-degree turn used to go up hill, while maintaining the existing trail grade.

Corduroy a primitive type of puncheon made by laying logs on the ground side by side.

Cribwall is a retaining structure made of wood and rocks designed to keep dirt in place.

Culvert is a wood, metal, plastic, or concrete structure under the trail to allow water to cross.

Down-slope is the down hill side of the trail.

Drainage Dip A change in trail slope designed to drain water off the trail surface.

Erosion is the process by which soil particles are detached and transported by water down-slope.

Fall line is the direction a ball would generally roll down a steep slope.

Fill-slope is the downhill side of the trail built from material excavated from above.

Filter Strip is an undisturbed area of ground located between the trail and a water body which acts as a trap to filter out sediments.

Full Bench is a trail constructed entirely into the side of the hill using no fill for trail support.

Geotextiles sometimes called construction fabrics are the most commonly used Geosynthetic material.

Geo Grids are honey combed panels designed to support heavy loads when connected together.

Groundwater is (subsurface water) under the earth's surface.

High Water Mark is the highest place water typically reaches during a flood.

In-sloping is when the trail slopes in against the natural slope of the hill side. This requires more ditches and cross drain culvert installation.

Out-sloping is when the trail is sloped out in the same direction as the natural slope of the hill. This is done to allow water to naturally run off the trail.

Open-top Culverts are box-like structure designed to collect and divert trail and surface water runoff.

Mulching is providing any loose covering such as hay or bark mulch over exposed soils.

Natural Resources can mean a lot of different things, but in the trail world, it generally refers to soil, wildlife, vegetation and water quality.

Non-Point Source Pollution enters a water body from an ill-defined or diffuse origin.

Puncheon is a boardwalk type of structure designed to provide a dry tread on fragile wet terrain.

Revegetation is planting grass, shrubs or trees to stabilize disturbed soils.

Rip Rap is a layer of angular rock fragments placed to stabilize the soil from erosion.

Rubber Waterbar is a water bar made of rubber belting sandwiched between wood.

Sedimentation is deposition of soil particles which is the result of soils being washed off-site.

Sheet Flow is the normal non-concentrated flow of water over the land.

Silt Fence is a geotextile product designed and installed to prevent off-site movement of soils.

Streams are natural water channels that may flow year-round or only part of the year.

Stringers are the primary support devices for a bridge decking.

Surface Water is water that is flowing or standing on the top of the ground.

Switchback is a sharp 180-degree hillside turn to reduce the trail grade on steep slopes.

Trail Grooming is generally known as moving snow, cutting snow moguls and packing a smooth snow surface.

Trail Tread is where the rubber meets the ground.

Trail Corridor is the zone including the trail tread and the area to the sides of it.

Turnpike is a raised section of trail consisting of ditches on both sides to improve drainage.

Turnouts used in conjunction with ditching to direct water away from the trail into a filter strip.

Waterbar is a water deflector installed at a 45-degree angle across the trail.

Watershed is the surrounding land area that drains into a lake or river system.

Wetland is an area where soils are flooded or saturated a significant part of the year.

Wire gabion is a wire basket filled with rocks and stacked as a retaining wall.

Vernal Pools are a special type of forested wetland deserving special consideration because they are the primary breeding grounds for certain species of wildlife.

Notes