Erosion Control for Recreational Trails

This guide is intended for volunteers or contractors performing erosion control as a part of a trail maintenance program.

The methods in this guide require only the use of hand tools. Machinery is not required but could be used if available.

The materials used are site-sourced when possible. When non-site sourced materials are required, effort has been made to specify lightweight, low cost and widely available items.

There are many variations of the methods indicated and not all variations are shown. Local conditions may dictate an alternate method.

General Guidelines

1. Trails should not have water running down the trail as a result of rain, seepage or snow melt subject to the following:
   a. It is permissible to allow water to flow on trails provided that the amount of water flow will not cause erosion.
   b. The water flow is controlled by suitable erosion control works or methods.

2. No trail should have standing water (puddles) on it subject to the following:
   a. Standing water that forms an area less than 900 sq cm (1 sq ft) is permitted following rain or snow melt provided that the water will drain or soak away within a reasonable time period.
Erosion Control Methods

**Out-Slope**

The trail bed should have a 5 percent slope so that sheet flow water will travel across the trail and continue down the slope.

Remove slough and berm and use this material to create a sloping trail tread.
**Grade Reversals and Rolling Drain Dips**

The down slope of a trail is interrupted by a section of up slope so that water is forced off the trail at the point where the trail changes from a down slope to an up slope.

The differences between a grade reversal and a rolling drain dip are illustrated:

- **Lower Ramp**: 2x as long as Upper Ramp
- **Upper Ramp**: Top ¼ of ramp flattened.
- **Drain Dip**: Longer than a bicycle. Outslope at least 10%

A grade reversal consists of a short dip followed by a slight rise every 8 to 20 meters and are built during trail construction.

Water is diverted off the trail here.

Rolling drain dips are added to trails that do not have adequate grade reversals to control erosion.

Water is diverted off trail and into drain here.
**Water Bar**

A water bar can be constructed by several means. They can be constructed of rock, granular material/soil, wood, rubber or other materials.

The water bar should be constructed at an angle of 45 degrees relative to the trail so that water is diverted off the trail. The depth of the drainage channel and the height of the top of the water bar can be adjusted for the expected water flow.

A water bar is a more compact structure than a grade reversal or rolling drain dip.
**Knick**

A knick is the removal of material from the lower side of a trail so that water may flow off the trail. A knick requires the less effort to install when compared to a grade reversal, rolling drain dip or water bar.

The trail tread is sloped to 15% at the center and transitions to 5% where it meets the existing trail tread. It is 2-3 meters wide.

**Swales, Rock Drains, Drainage Pipe & Culverts**

Swales, rock drains, drainage pipes and culverts are used allow water to cross a trail. The right method to use depends on the amount of water flow and amount of trail use.

**Swale**

A swale is simply a shallow ditch that allows water to flow across the trail.

The width and depth can be altered as required to accommodate the water flow. As the depth increases, the width should also increase.

The discharge side should be cleared periodically. Sediment may form and create a puddle if not maintained.

The swale can be hardened by placing stones or rocks level with the bottom.
**Drainage Pipe**

Drainage pipes allow for water flow under a trail. One or more pipes can be used.

A good choice for drainage pipe is 4 inch diameter non-perforated weeping tile. It is lightweight, low cost, easy to transport and can be cut with a utility knife.

The inlets of drainage pipes should be cleared of obstructions periodically.

![Drainage Pipe](image)

**Rock Drains**

A rock drain is suitable for low water flow rates. It will also drain surface water flowing on the trail.

A 4-inch diameter perforated weeping tile placed at the bottom improves performance.

An alternative design uses landscape fabric placed on the top of the rock drain with a covering of 5 – 10 cm of backfill. This reduces clogging from surface runoff sediments.

![Rock Drain](image)
**Culverts**

Culverts are used when larger water flow rates are encountered. The maximum flow rate must be estimated when selecting culvert size. Culvert installation may require the approval of the land manager/authority.

Culvert selection and installation is beyond the scope of this guide.

**Maintenance**

Culverts require clearing periodically to remove obstructions. Check for erosion around inlet and discharge. Repair erosion damage by hardening inlets and discharges with rocks or stones.

**Bridges**

Bridge design and installation are beyond the scope of this guide.

**Maintenance**

Bridge maintenance involves the inspection of the bridge for the following:

- Rotted, split or warped stringers.
- Loose or rotted decking or handrails.
- Erosion of the soil or soil surrounding the structure that supports the stringers (abutments).

Report any deficiencies found to the land manager/authority.

The stream bed should be kept as clear as possible 10 meters before and after the bridge. This involves removal of logs and large rocks. The goal is to prevent obstacles from raising the water level under the bridge during high flow periods. High water levels may erode the abutments.
**Turnpikes**

Turnpikes are used to raise the trail bed above wet ground.

A ditch is created on each side of the trail and the material from the ditches is used to raise the trail bed.

A 4” drainage pipe installed every 5 meters (or closer) allows for water to flow from one side to the other and prevents a dam effect.

Turnpikes can be earthen only or logs can be used to retain the sides of the trail bed. Stakes or galvanized tie wire can hold the logs in place. Landscape fabric can be added 5-10cm below the trail bed surface for additional soil stability.

If installed on sloping ground, the lower ditch should have additional drainage channels (installed at 90 degrees to the ditch) so that only a minimal amount of water will stay in the ditch.

The drainage of the trail bed can be further improved by placing gravel or crushed rock in the top 2/3 to 1/2 of the trail bed.
**Causeway**

A causeway is a turnpike without the ditches. When constructed for erosion control purposes, it is used to raise the trail above a wet area.

To allow water flow through the causeway, it should be constructed as much as possible of rock and stones.

A layer of landscape fabric is placed above the base of rock and stones. On top of the landscape fabric, a trail bed of 5-10cm of material is placed. The material used for the trail bed above the fabric depends of what is readily available.

If available, larger rocks and stones can be used to form the trail bed surface with ideally a sand & soil mixture used to fill the gaps between the rocks or stones.
Boardwalk

A boardwalk is a wood sidewalk that is used to protect the soil when traversing wet or unstable soils.

If the boardwalk will be used by horse riders, the construction would be of a wider and stronger design than a boardwalk intended only for hikers, runners or mountain bikers.

In some areas there is a high level of hiker, runner and mountain bike traffic and a low level of horse rider use. In this case, a narrow, lighter boardwalk can be constructed for the hikers, runners and mountain bikers and room provided on the trail to allow a horse rider to proceed beside the boardwalk. This arrangement works only when horse rider trial use is low enough not to cause significant erosion.

There are numerous ways to construct a boardwalk. In general a boardwalk constructed of site-sourced materials will have the benefits of low cost and ease of construction since fewer materials need to be transported to the work location however the trade off is likely to be rapid decay due to wood rot.

A boardwalk constructed of rot resistant materials will provide the benefit of a longer service life however the material cost and effort to transport the materials to the work location will be greater.

Notes:
1. Width is 45 cm but can be changed as required.
2. Sleepers are buried 1/2 to 2/3 into ground.
3. Decking is fastened using 3" decking screws.
5. Face decking end grain downward before fastening.

The rot resistance of sleepers can be improved by applying a waterproof membrane around it. The membrane is wrapped around the sleeper with an overlapping joint. Roofing nails are used to keep the joint from opening. The 2x6 ends are sealed with roofing cement/patching compound.
Selecting Wood for Boardwalks

Rough Cut or Milled Lumber
Rough cut lumber is un-milled lumber. It is slightly larger than milled lumber in both width and thickness. As the name implies, rough cut lumber has a rougher finish. The larger size and better traction provided by rough cut lumber is generally better for trail use. Lumber yards and home improvement stores usually only stock milled lumber.

Pressure Treated Lumber
Pressure treated lumber is a good choice for trail use. It is usually only available as milled lumber.

The amount of preservative in the wood after treatment is called the retention level. Wood that will be exposed to the elements, but is not in contact with the ground should have a 0.25 (lb/ft$^3$) retention. Wood in ground contact will require a minimum retention of 0.40 (lb/ft$^3$). The preservative retention levels are printed on the quality mark tag that is stapled to the end of the board.

Cedar
Cedar is also a good choice when in rough cut form. It is often available through lumber yards that specialize in cedar. If rough cut cedar is not available in your area, use pressure treated lumber instead.

Spruce & Pine
Untreated spruce and pine lumber when in contact with soil can be expected to have a high rate of deterioration due to rot. These wood types are what most lumber yards and home improvement stores have in stock for general purpose use.

Site Sourced Logs & Lumber
A common practise is to use site sourced logs as the purchase cost and difficulty in transporting dimensional lumber to the work location can be a deterrent. A high rate of deterioration can be expected as the wood is untreated and the species may not be ideal for rot resistance. This is offset somewhat be using oversize logs as sleepers/mud sills. The larger size of the logs will take longer to decay.

Sited sourced lumber is produced by cutting site sourced logs into planks. As with site sourced logs, it often makes sense to cut logs into planks at the work location, however the skill and equipment required is such that this guide does not include site produced lumber in the design of boardwalks.