Shuswap Trail
Trail Design Standards

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Overview

Purpose

The purpose of these trail design standards is to provide a consistent level of quality while creating a variety of options based on user needs. The Shuswap Trail project will cover over 400kms of trails in the region. These standards have been developed through consultation with various user groups and trail construction experts.

Sources

Several sources were used to create these standards, including:

- The Whistler Trail Design Standards
- Trail Solutions (International Mountain Bike Association)
- Natural Surface Trails by Design (Troy Scott Parker)
- Managing Mountain Biking (IMBA)
- Lightly on the Land (Student Conservancy Association)
- Fromme Mountain Sustainable Trail Use and Classification Plan

General Design Guidelines

There are some general guidelines to follow when designing new trail or assessing existing trails. Including each of these guidelines will ensure sustainability, which is the key to any successful trail system. The key is to minimize maintenance costs, and maximize user enjoyment.

These general guidelines are:

- **The 10% Rule**
- **The Half Rule**
- **Grade Reversals**
- **Outslope/Backslope**
- **Maximum Sustainable Grades**

The 10% Rule

Trail slope should run at a maximum average grade of no more than 10%. This helps create an easy to use trail that helps prevent erosion. There can be short sections of trail that exceed the 10% average, as long as the soil type is such that it can sustain steeper slopes. These sections should be no more than 10-15 metres, and should not exceed 20%. Average slope is calculated by selecting a longer section of trail, and determining the rise to run ratio. (see figure 1.1)

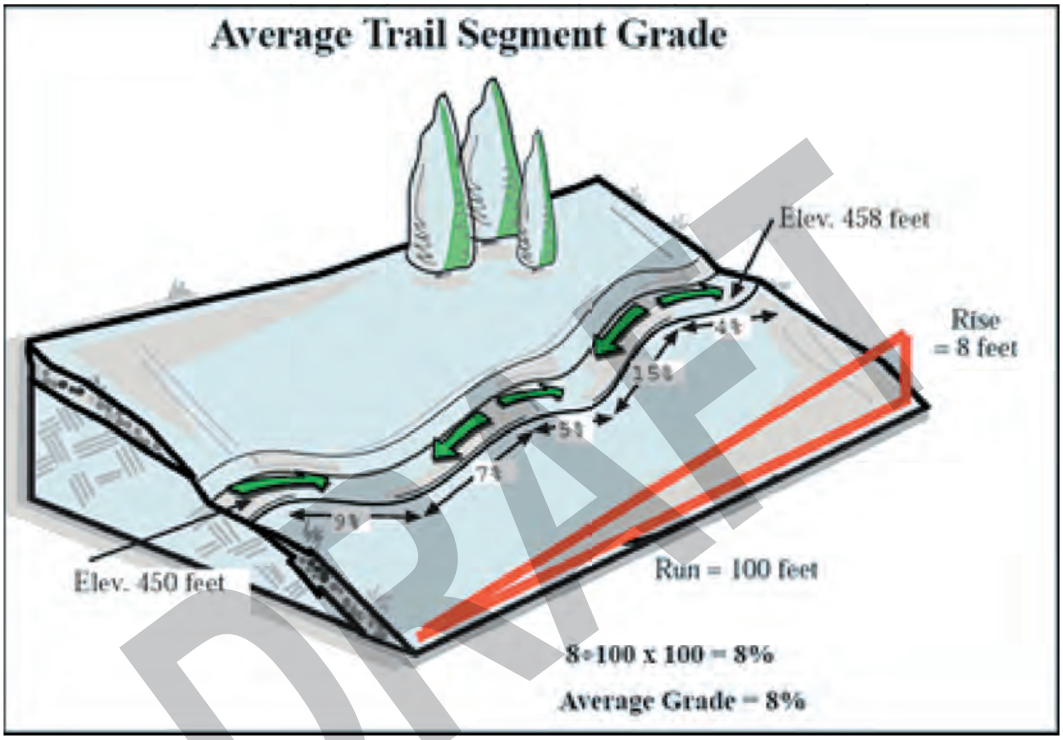


Figure 1.1 - Average Slope - IMBA (2004). pg

The Half Rule

The half rule states that the grade of the trail alignment should be half (or less) of the side slope. In figure 1.2 you can see that water is encouraged to follow the trail, due to the high trail slope relative to the side slope. In figure 1.3, you can see that the trail slope is less that the side slope, thus the water is encouraged to flow down the side slope.

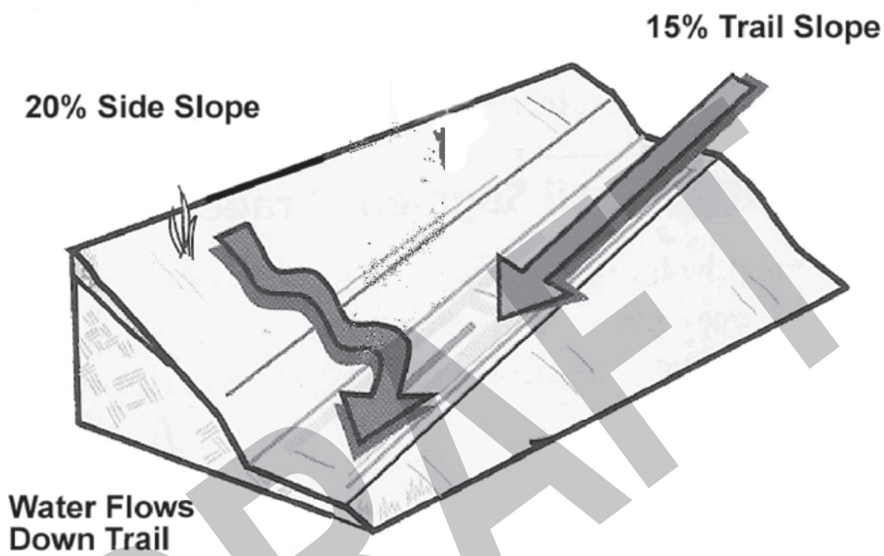


Figure 1.2 - Bad trail slope - IMBA 2004

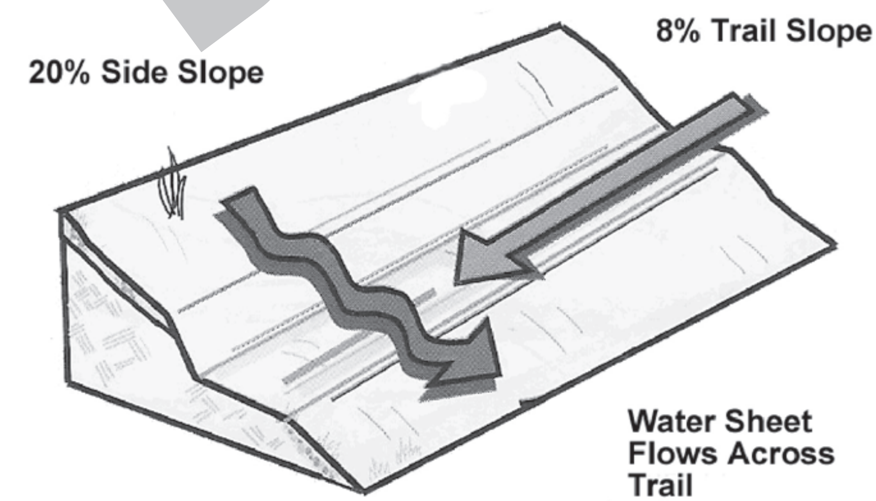


Figure 1.2 - Good trail slope - IMBA 2004

Grade Reversals

A grade reversal is essentially a dip in the trail that prevents water from flowing any further. (see fig1.4) The grade reversal replaces old erosion controls like water bars, that break down over time. A properly constructed grade reversal will last as long as any other part of the trail. The size of the grade reversal is determined by the grade of the trail. A gentle grade (1-5%) can have a longer more gentle reversal (50-80m) versus a steeper trail (>20%) will require a more dramatic reversal (15m). See figure 1.5 for the recommended spacing.

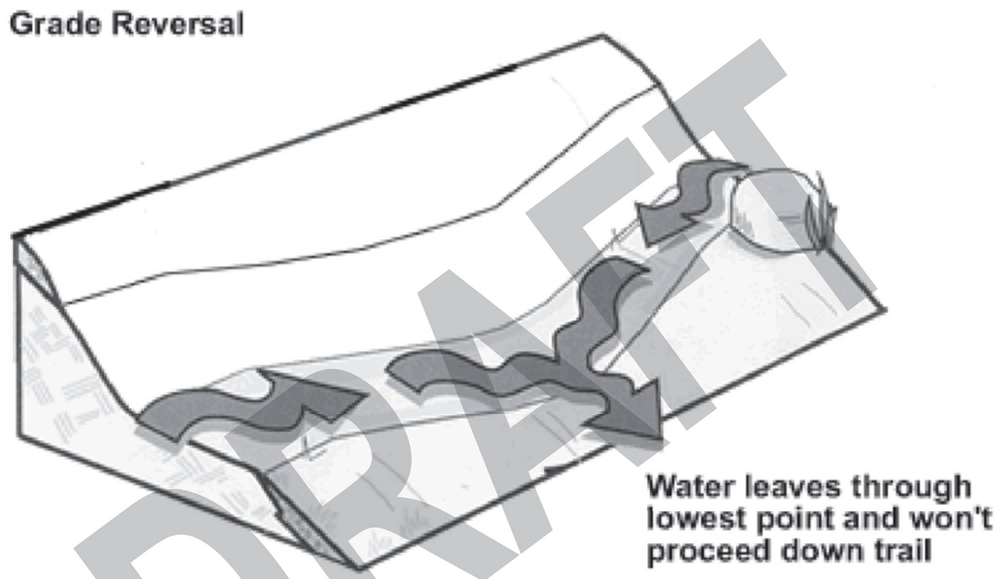


Figure 1.4 - Grade Reversal - IMBA 2004

Trail Grade	Drainage Spacing
>20%	<15m
15-20%	15m
10-15%	30m
3-10%	50-80m

Figure 1.5 - Grade Reversal Spacing

Outslope/Backslope

By creating outslope and backslope, any water running down the fall line will run across the trail instead of along it. First create the tread shape by removing the organic and mineral soil from the tread area. It is a good idea to save the organic materials for the final finishing step. Once this is done, tapering the tread to the downhill side by 5-8% will ensure water runoff. To prevent splash erosion, or mini-waterfalls, a backslope of 35-45% is then created on the uphill side of the tread. (see figure 1.6)

The last step is to pack the tread and backslope to prevent loose mineral soil from being removed due to water movement. When the tailings from creating the tread, outslope and backslope are removed, it should be spread out below the tread to create a smooth surface. At this point, the leaf litter and organic materials collected from the top of the tread area should be spread over the organic an mineral soil waste materials to create a finished look. Be sure to prevent packing of the discarded material, as it will prevent regrowth.

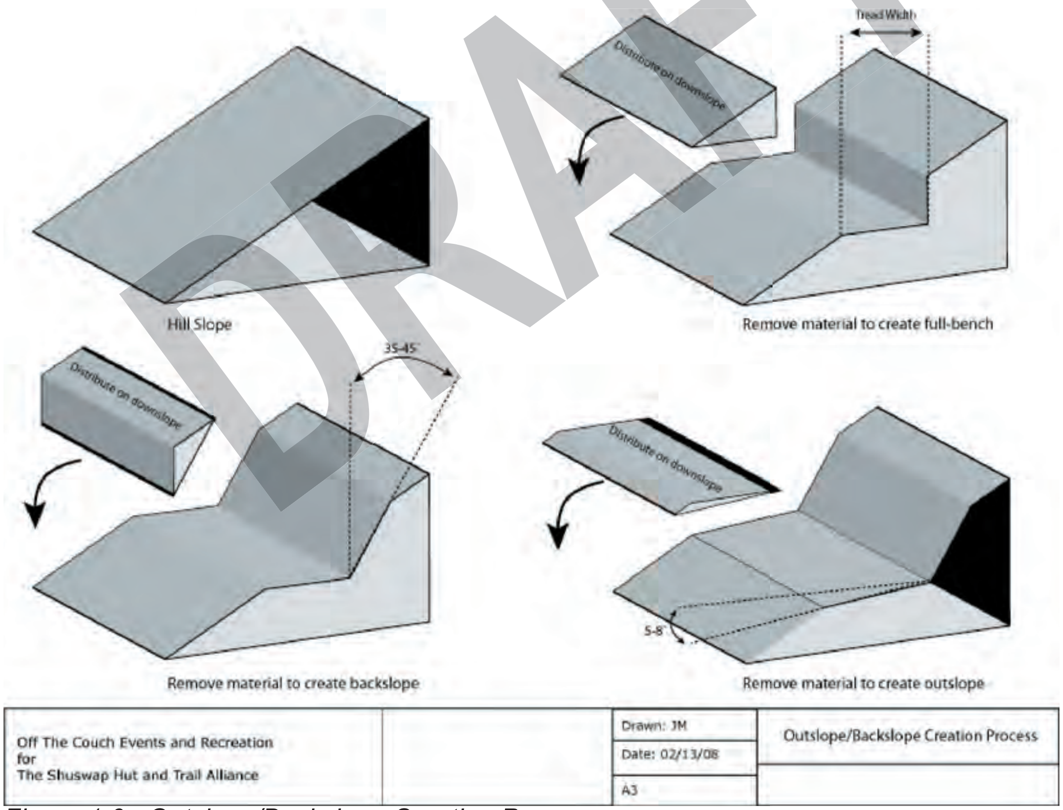


Figure 1.6 - Outslope/Backslope Creation Process

Maximum Sustainable Slopes

The maximum sustainable grade on a trail is subject to several variables:

Soil type

Sandy soils should not exceed 10%, but sandy loams, or clays, may be able to sustain 15-20% grades. Rock can obviously sustain any degree of slope, but the effects on the user must also be considered, such as slippery surfaces when wet.

Half Rule

Despite what the soil can handle, the half rule still needs to be considered to avoid water running down the tread. Consider the whole watershed, and what effects water running down a steep rocky upper section will have on a steep sandy lower section.

Rainfall

If an area is particularly dry, water erosion on steep grades will be less of an issue. Very wet areas will need to be more sensitive to the effects of water and trail grade.

Grade Reversals

see #4 – Grade Reversal

Types of Users

Horses and OHV users should not exceed trail grades of 10%, as they disrupt to much tread material when grades get steeper. Mountain bikes can use tread slope of 15 – 25% provided the users avoid skidding on descents.

Number of Users

A high volume trail will have a harder time sustaining steeper grades, compared to a low

Trail Psychology

Trail psychology refers to the emotional effects trail design can have on users. The desire of any trail designer is to create a positive experience for the user. A positive trail experience can be created by a design that respects its surroundings, brings it users to a single, or multiple destinations, minimizes impact, and invites the user in.

There are a few methods that trail designers can use to enhance the user experience. These methods involve how the trail is integrated into its environment.

These methods include:

•Gateways
•Anchors
•Contour Reversals
•Edges

Gateway

A gateway is one of the first things a trail user will experience. A gateway sets the tone for the trail, and draws users into it. People are naturally drawn to openings. By creating openings along the trail, you draw users further into the system, and keep them on the trail. A gateway can be a hole in a fence, an opening into a field, or a portion of a log cut out to pass through. Gateways are one of the easiest methods to create or find, in an area where a trail is being planned.

By altering the look and feel of the gateway, you can filter the type of user. A wide opening with a smooth tread will tell people that this an easy trail. A narrow opening with steps or rocks will create a more difficult feel. This is important when you are trying to prevent a particular user group from using a trail. See figure 1.7a-c for gateway examples

Figure 1.7a - Gateway through trees

Figure 1.7b - Gateway at trail head - Easy

Figure 1.7c - Gateway used as filter for expert users

Anchors

Anchors are points of interest along the trail. These points of interest can be as small as flowers, and as large as a mountain top view. Anything that interests people is a draw that will cause people to use the trail as a tool for their experience. Some examples of anchors are large rocks, character trees, unique flora, viewpoints, open areas, historical sites, unique land forms, campsites, huts, lakes, swamps, bogs, and so on.

By locating and spacing the anchors along a trail, you will help draw users into the trail, and encourage use. It is useful to point out less obvious anchors to users at the trail head in the description, especially if you are building a trail that will see a good number of beginner users. Another use for an anchor is to discourage trail users from straying off of the trail. One of the key areas this is a problem is switchbacks. Trail users tend to cut corners to save time. By building a switchback around a large tree, you draw the user to the corner and reduce corner-cutting. See the images below for examples.

Anchors - Viewpoint

Anchors - Large Tree in switchback

Anchors - Unique Landforms

Anchors - Flora

Anchors - Huts

Contour Reversals

A contour reversal is essentially a grade reversal. The advantage that a contour reversal has in trail psychology is two-fold. First, it provides a changing aspect to the surroundings. Because the trail wanders, it makes it very difficult to put your head down and trudge away. You are forced to look where you are going. As a contour reversal changes direction so does your view from the trail. It is one of the key pieces to keeping trail users engaged in their surroundings.

Second, the shape of a curve-linear trail is that it is pleasing to the eye and more “natural” in shape. There are no straight lines in the universe, and so trails should not be straight either. Figure 1.8 shows the difference between a straight trail and a trail with contour reversals.

Figure 1.8 - Straight versus Curvilinear Trail

Edges

Edges are essentially an extended anchor. The edge of a tree line in a field, or the edge of a stream through the forest are examples of using edges to enhance the natural feel of the trail. An edge can also be used as a gateway between two different types of terrain when the edge is crossed. (i.e.. forest to field)

Figure 1.9 - Trail follows rivers edge

Trail Types

There are several ways to construct a trail, utilizing various materials and tread sizes. There are two main purposes to creating a set of trail standards. First is to create a level of consistency in terms of look and feel throughout a system. The second is to have a simple means to convey detailed technical information to work crew and volunteers.

We have based our trail design standards on the Whistler Standards and the IMBA system. The Whistler Standards list five trail types that cover anything from paved surface trails to skinny singletrack routes. The Shuswap Trail alliance has chosen to follow these standards, as they encompass the requirements of the user groups that will be using our trail systems.

The Trail Types provide all of the measurements and technical information required to construct a trail to standard. This information includes: tread width, surface material, corridor width, corridor height, outslope, backslope, crown, base, and tread surface make-up.

The following are the five different trail types:

- **Type 1 Trail**
- **Type 2 Trail**
- **Type 3 Trail**
- **Type 4 Trail**
- **Type 5 Trail**

Trail Corridor

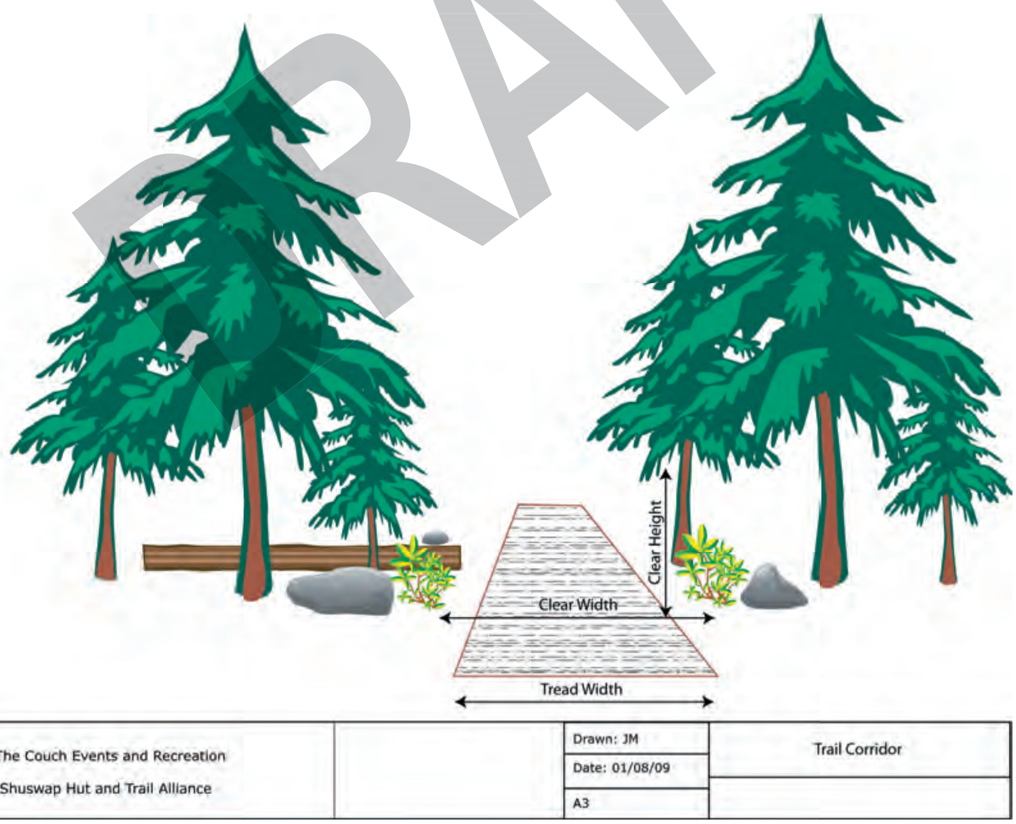
The trail corridor is the area surrounding the trail tread. A properly constructed and maintained corridor is the key to a successful trail. Branches hitting your face, logs scratching you legs, and trail so grown in you can't see where you are going all result in negative trail experiences.

When clearing the corridor, it is important to ensure that all brush is removed at ground level. It is also important to trim branches from trees and shrubs about 5cm from the trunk.

All clippings should be moved well away from the corridor so that they can't be seen, especially after the leaves have fallen. Brush should not be piled, but laid flat on the ground, to increase the rate of decomposition, and reduce visibility.

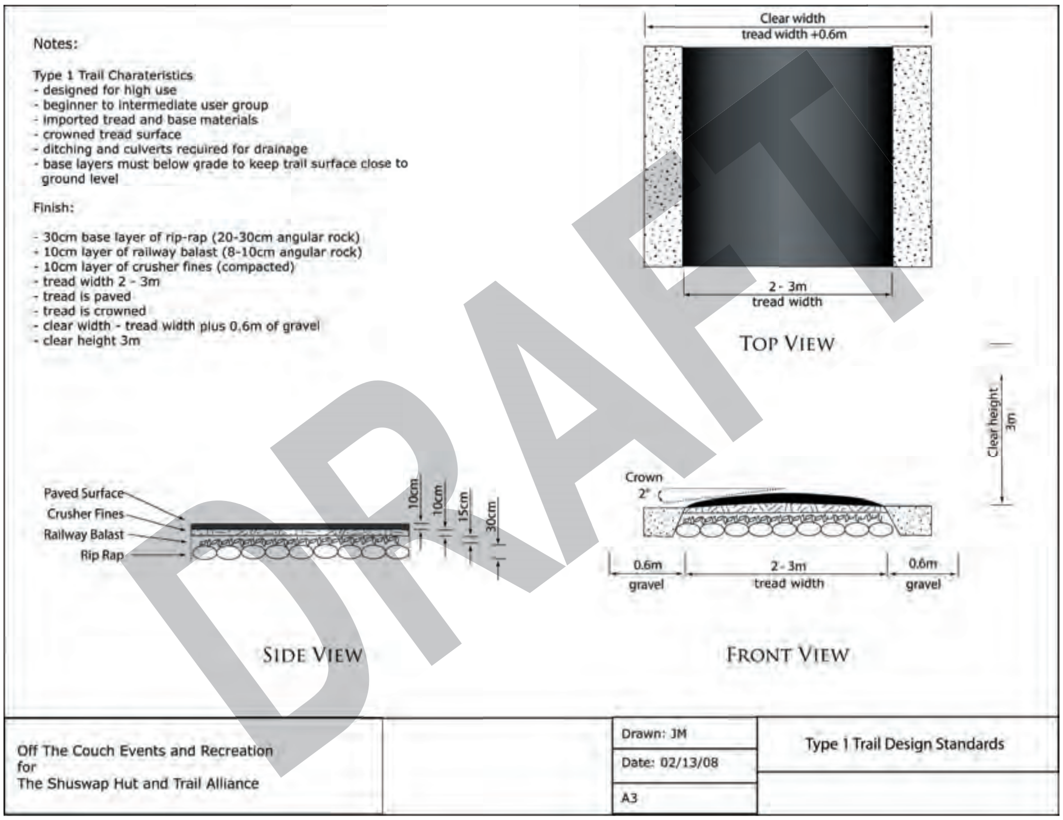
The trail should be laid out to reduce the need for tree removal, but occasionally one or two will need to be cut down. In these cases, if a tree is removed, the stump should also be removed if it is in or near the proposed tread area.

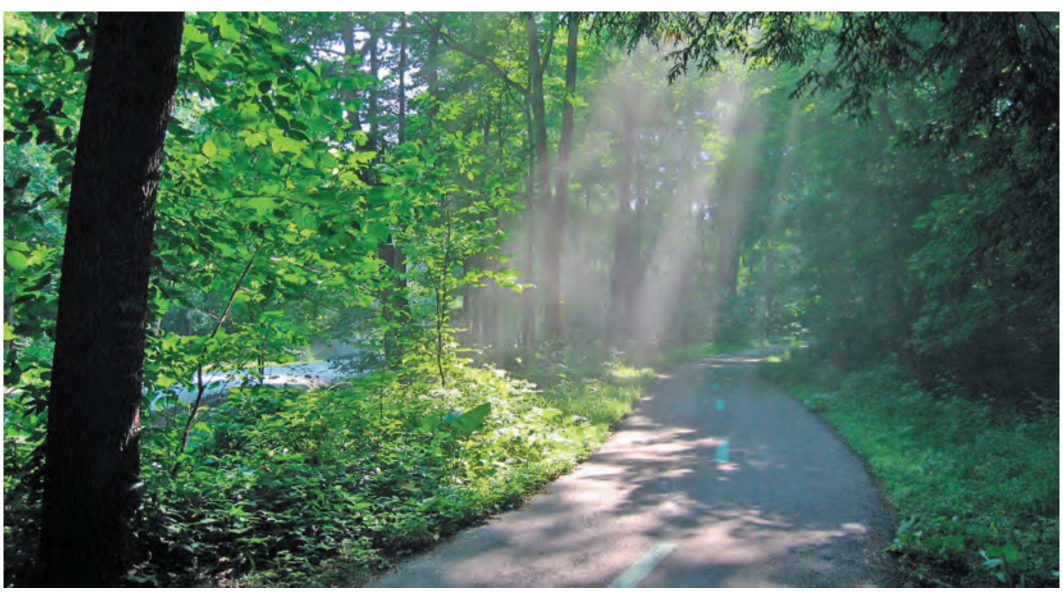
When removing smaller trees (5-10cm diameter), cut them around 1 metre above ground level. This creates a lever to help remove the stump and root ball at ground level.



Type 1 Trail

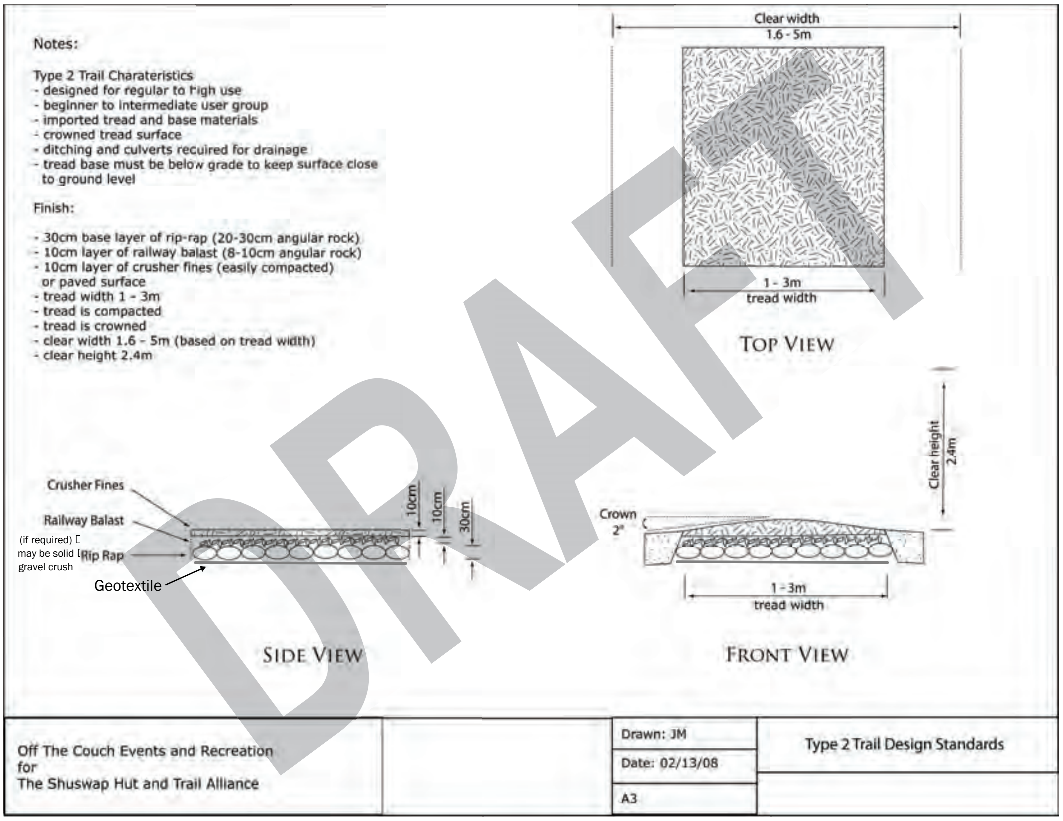
• paved double-track trail for smooth, all weather use
• use asphalt or chip-seal coat surfacing
• clear width to tread width plus 0.6m gravel shoulder and adequate drainage on each side
• clear height to 3.0m
• provide 2-3m tread width
• provide illumination for night use if appropriate
• provide interpretive and directional signs,benches, viewing areas where appropriate

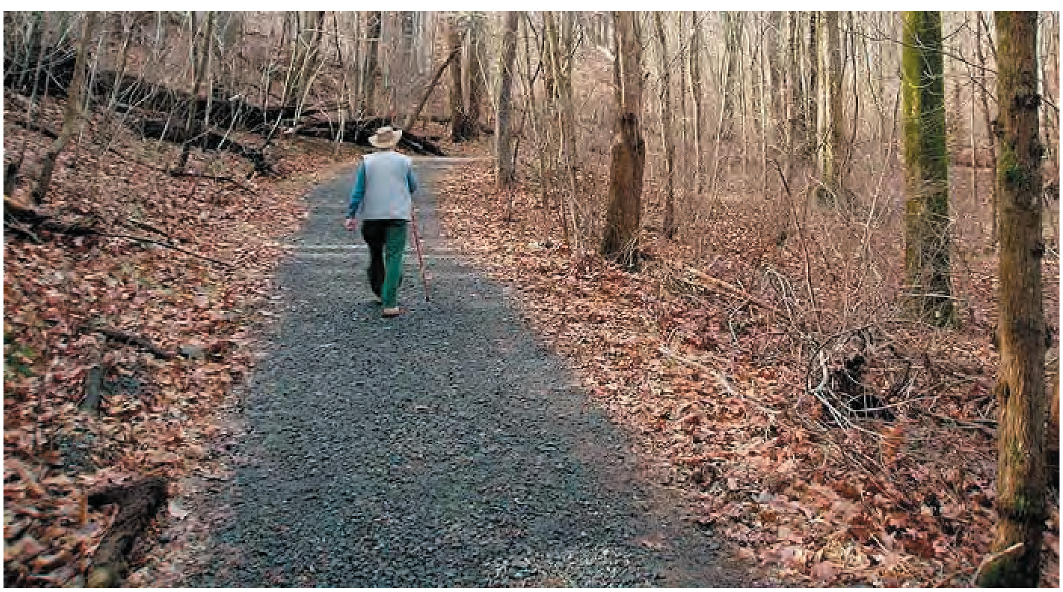




Type 2 Trail

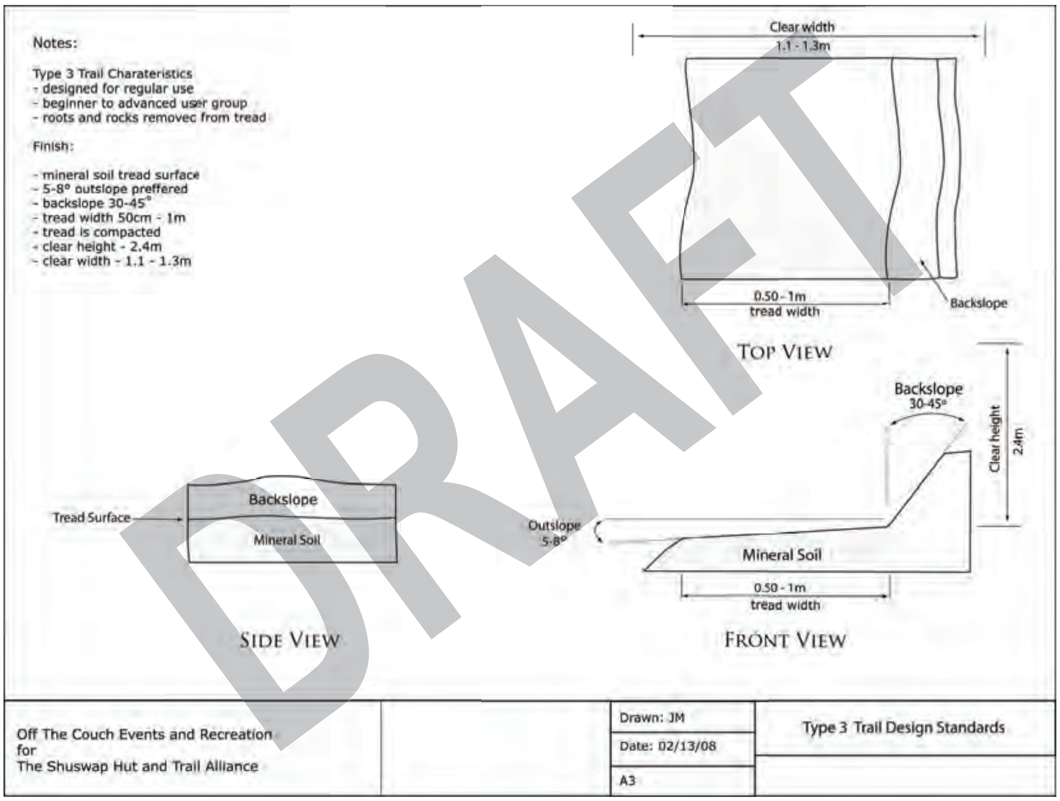
- plan as surfaced double-track or single-track trail
- machine built
- remove all embedded trail obstacles
- use crushed limestone with fines, well-compacted gravel, or existing old roadbeds
- clear width to 5.0m for double-track and 1.6m for single-track trails
- clear height to 2.4m
- provide 2-3m tread width for double-track trails, 1m for single-track trails
- provide illumination for night use if appropriate





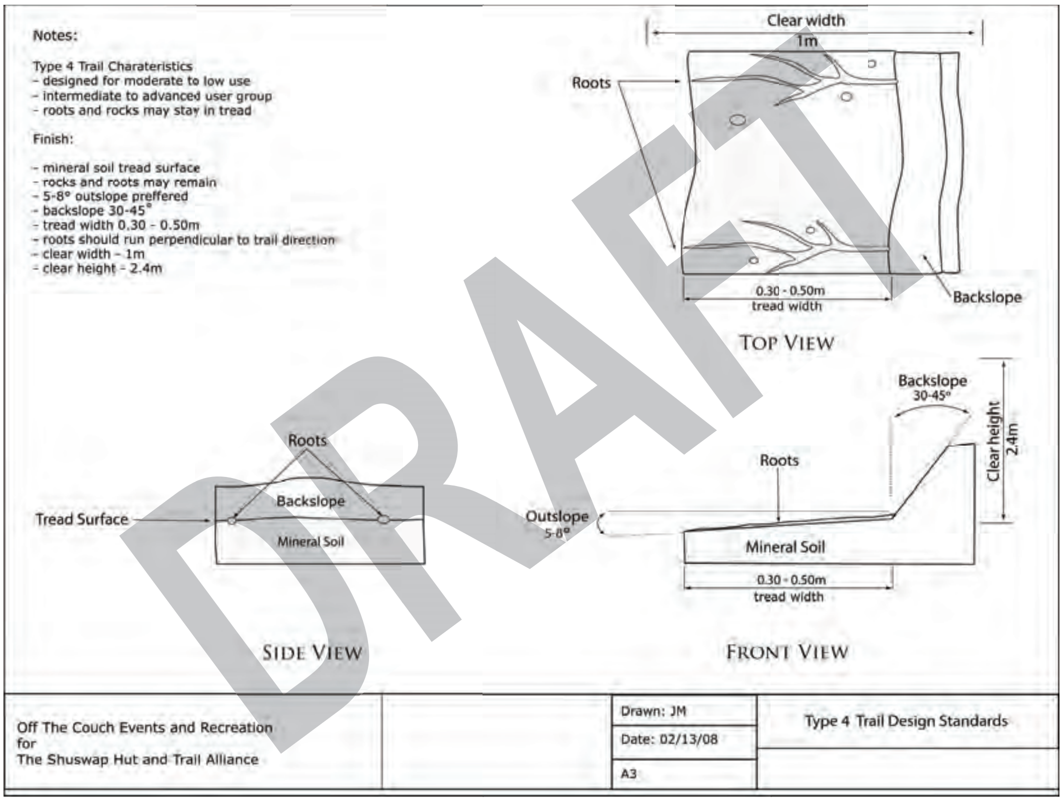
Type 3 Trail

- plan as natural surface single-track trail
- may be machine built
- clear width to 1.1-1.3m
- clear height to 2.4m
- provide 50-70cm tread width on native soil



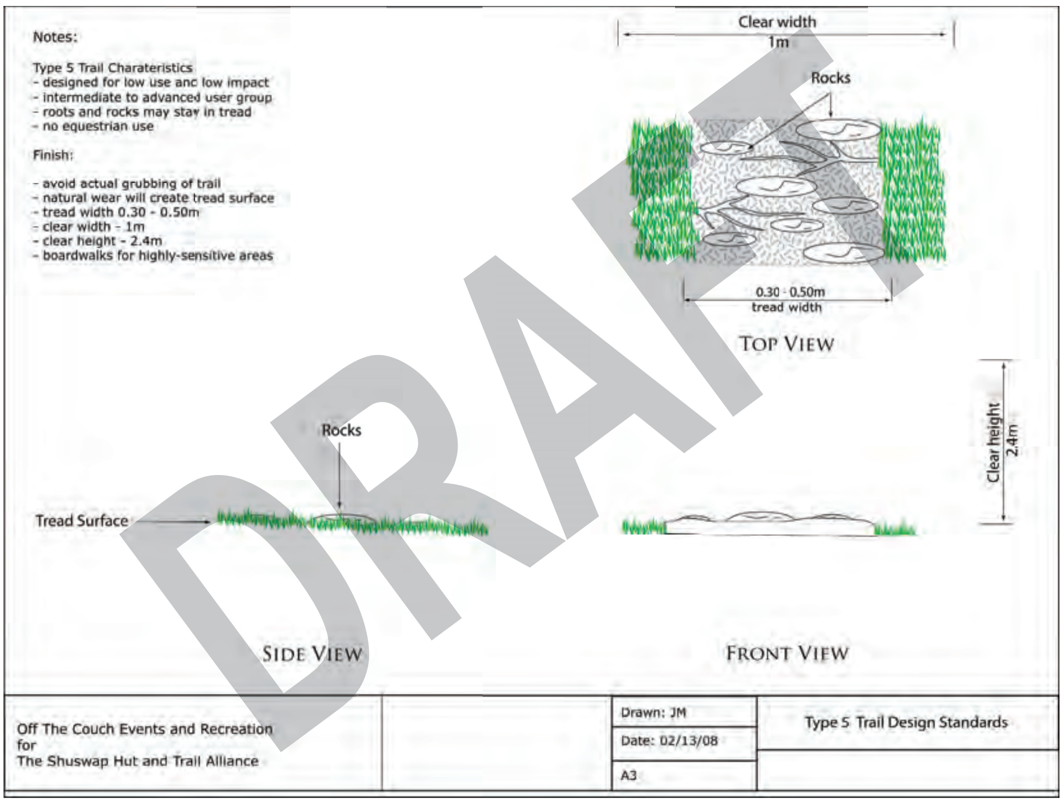
Type 4 Trail

- plan as unsurfaced single-track trail
- clear width to 1m
- clear height to 2.4m
- provide 30-50cm width tread on native soil
- rocks or roots may be left in tread surface
- rocks should be smooth and rounded and only left in tread if necessary
- roots should be perpendicular to direction of travel
- large roots should be covered to protect them



Type 5 Trail

- plan as low-impact nature trail or lightly used wilderness trail
- no high impact users, such as motorized vehicles or horses
- clear height to 2.4m
- provide 30-50cm tread maximum, avoid tread grubbing, sections of very rough terrain
- in the case of low-impact nature trails use boardwalks to traverse sensitive areas



Trail Infrastructure

Trail infrastructure refers to the parts of the trail that require engineered solutions to terrain issues. These issues include water crossings, switchbacks, wet areas, and technical trail features (TTF). It also includes structures that restrict access, such as fences, gates and stiles.

In order to provide a consistent look and feel, as well as provide safety and durability, all trail infrastructure should be built to the standards provided in this guide.

The following structures will be covered:

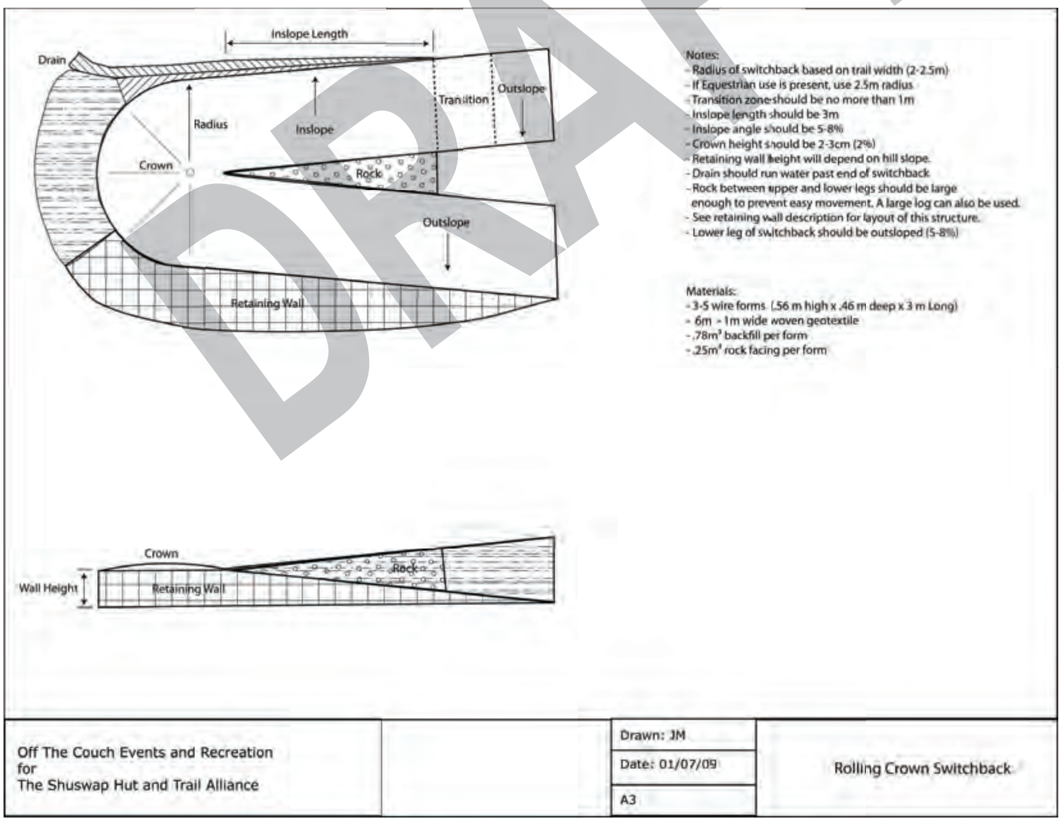
- **Switchbacks**
- **Water crossings**
- **Wet areas**
- **Fences**
- **Stiles**
- **Retaining walls**
- **TTFs**

Switchbacks

A switchback is a type of corner that is used when the side slope is greater than 10%. It is a 180° turn that connects an upper and lower leg together with a turning platform. A regular switchback will have a flat turning platform, which can lead to drainage issues on wider trails (over 70cm). The best solution for wider trails is the rolling crown switchback, which is what will be described here.

The rolling crown switchback has a few unique characteristics. First, the upper leg of the switchback has an inslope for the last 5 metres. It also has a drain that runs out the end of the switchback from the inslope. This directs the water away from the turning platform and lower leg. The turning platform itself has a crowned shape (hence the name). This prevents water from lying on the corner. It also has a very round shape to the turning platform to allow ease of use for cyclists and equestrians. (see Figure 1.9)

If the trail will be used by mountain bikes, a speed control above the switchback is a good idea. By placing a pinch above the switchback, ift forces the mountain biker to brake before the corner, which will reduce maintenance.



Water Crossings

Because there are environmental effects possible with any type of stream crossing, it must be thoroughly investigated, and environmental approvals are a must before any work is done.

There are five main ways to deal with water crossings. The first is an engineered bridge. The engineered bridge is a wooden, metal, or wood/metal combination structure that is designed for wider crossings, large amounts of traffic, and equestrian users. In these cases the load on the bridge can be quite high, and thus requires an engineered (read safe) structure. In an engineered structure, all parts are designed to handle a measured load, which is certified by an engineer as safe and sound.

The second type of water crossing is used where the span is smaller, or use is limited to single lane traffic from hikers or cyclists. A bridge using dimensional lumber or log stringers is will work for shorter spans and light use. The maximum span for this type of structure is limited by the size and type of stringer available (see figure 2.?).

The third type of water crossing is a culvert. Culverts can be used when there is a low volume of water flow through the season, there is a formed channel that the water is flowing in, and importing of bridge materials is impractical. Care must be taken to select the right size of culvert for the stream.

The fourth type of water crossing is the french drain. This can be used with very low flow streams, or small seasonal streams. Rocks are layered from large to small, with a final layer of mineral soil on top. The large rocks on the bottom alllow water to flow through, preventing a washout.

The fifth type of crossing is the in-stream crossing. This type of crossing is created by hardening the stream bed where the trail crosses, to prevent in-stream erosion. The entrance into and out of the stream bed must be a gentle angle, and also must be hardened.

For Bridges using stringers, the length of stringer is determined by the width of the stream at high water, plus 36” (1m) to clear the edge of the stream bank on either side, and an additional 24” (.6m) for the cribbing on both sides.

As far as using raw logs as stringers, using Hemlock, Douglas Fir, or Cedar work very well. Try to find logs with minimal taper, minimal bend, and no centre rot. As Cedar tends to be softer than the other types of woodit needs to be thicker to work as well. It is recommended to go up 2” in diameter for the same length when using Cedar stringers.

Log Diameter	Maximum Span
4”	8ft
5”	12ft
6”	14ft
7”	18ft
8”	22ft
9”	25ft
10”	29ft
12	37ft
14”	45ft
16”	54ft
18”	63ft

Figure 2.0 - Log Diameter for bridge stringers - Bruce Trail - Guide for Trail Workers, 2001

Bridge Span	Lumber Dimension	# of laminates	Length Combinations (ft)
20ft (6.5m)	2”x10”	2	4 | 16 16 | 4
24ft (7.8m)	2”x10”	3	16 | 8 4 |16 |4 8 | 16
28ft (9.2m)	2”x10”	4	16 | 12 8 |12 | 8 6 | 16 | 6 12 | 16
32ft (10.5m)	2”x10”	5	16 | 16 4 | 16 | 12 8 | 16 | 8 12 | 16 | 4 16 | 16

Figure 2.1 - Dimensional lumber rquirements for bridge spans - Bruce Trail - Guide for Trail Workers, 2001

Beam Dimension (using two stringers)	Maximum Span
4” x 4”	8ft
4” x 6”	15ft
4” x 8”	20ft
6” x 6”	17ft
6” x 8”	23ft
6” x1 0”	29ft
6” x 12”	35ft
8” x 8”	25ft
10” x 4”	14ft
10” x 10”	34ft
10” x 12”	41ft

Figure 2.2 - Wooden beam requirements for bridge spans - Bruce Trail - Guide for Trail Workers, 2001

Wet Areas

A wet area is a section of trail that remains wet throughout the season, or a good portion of the season. Wet areas pose several challenges, such as increases risk of erosion, falling hazards, and social trails that avoid the wet area. Ultimately, if a wet area can be avoided, it should. In some cases, it is not possible to avoid, so creating a sustainable trail in the wet area is necessary.

The first step to dealing with a wet area is to find mineral soil. A lot of times wet areas fill up with organic soil, which is a poor foundation for any trail. Once mineral soil is found, the hollow will need to be filled with rock. 30cm rip-rap (angular rock) is the best for the base. Then add a layer of smaller rock (10cm angular rock) over top. Next, a layer of geo-textile is laid down over top of the smaller rock to prevent mixing of layers. Next, a layer of geocell (synthetic webbing) is laid over top of the geotextile. The pockets of the geocell are then filled with the tread surface material, which is typically a 3/8” minus gravel with crusher fines. This surface is then compacted.

The geo cell will hold the surface material in place, and the geotextile will prevent it from washing through the underlying rock. See figure 2.1 for details

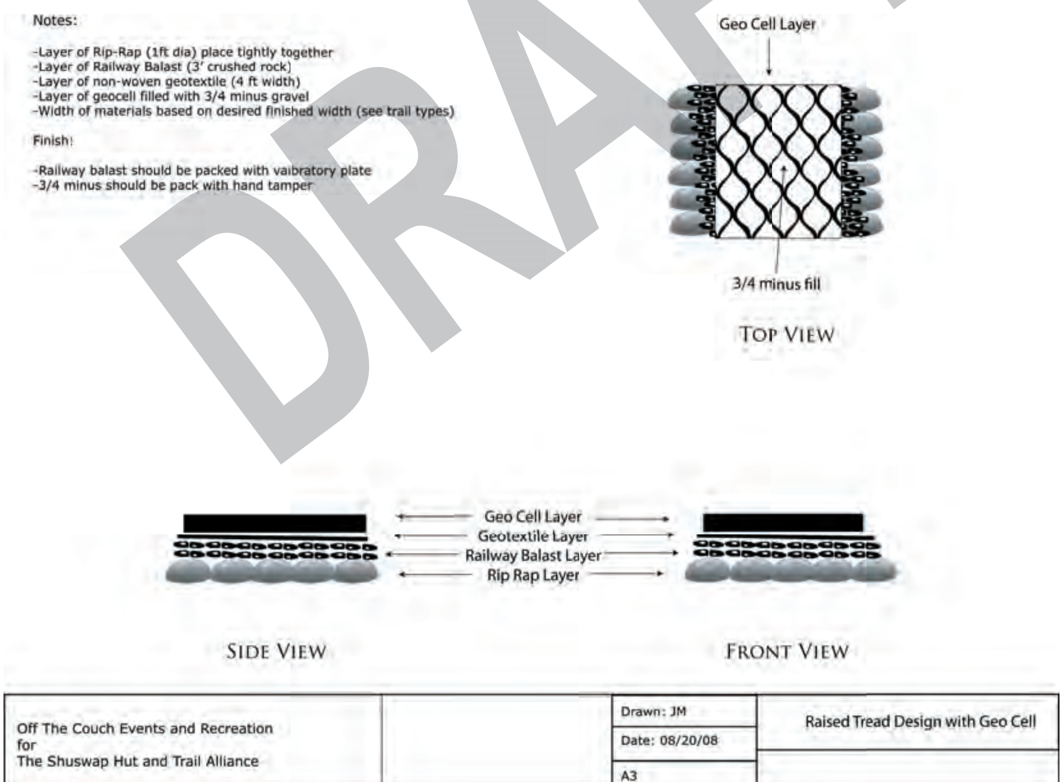


Figure 2.1 - Foundation for trails in wet areas

Fences

Fences are used to create a barrier near a trail entrance or along private property. The fence must be functional (keep out undesired traffic) and appropriate for the surroundings.

In most cases, the fence design shown below will prevent unwanted traffic and blend in to most environments. In some cases, where a fence is needed near a steep edge, wire mash may be added to this design to prevent small children from crawling through.

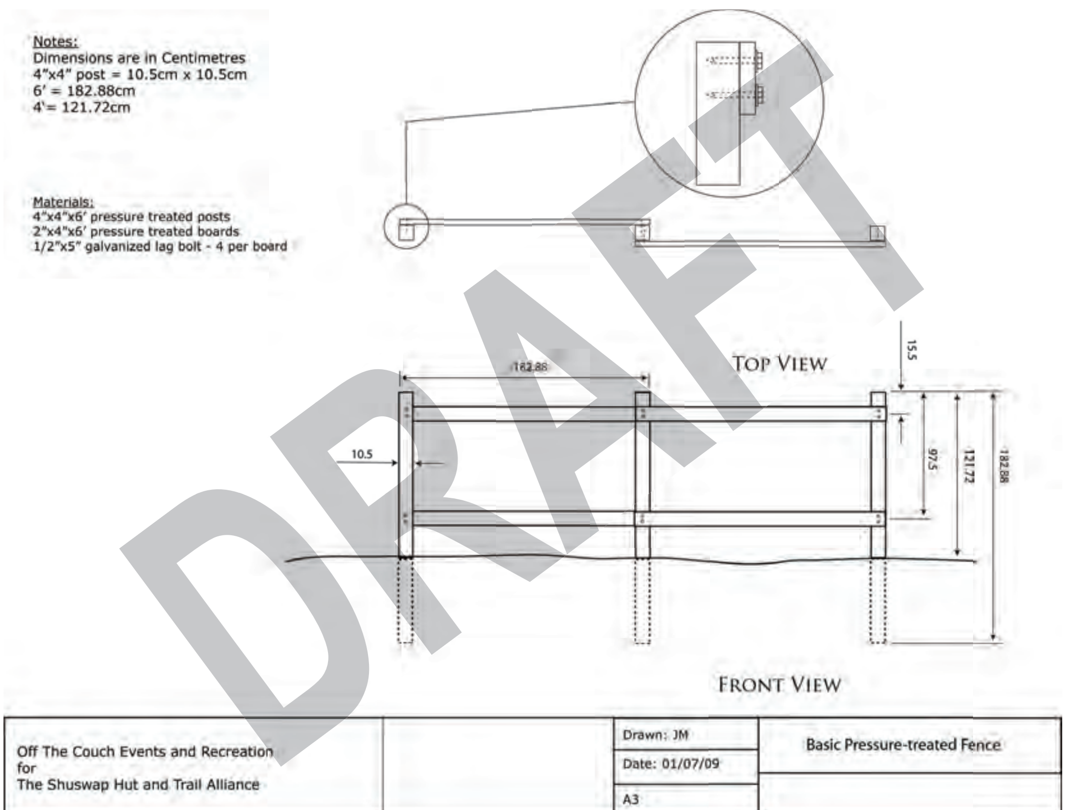


Figure 2.2 - Fence

Stiles

A stile is a type of gate that allows certain types of users to pass through easily. There are two main types of stiles that the Shuswap Trail Alliance will make use of. The first is a restrictor for equestrian and motorized users. The Type 1 Stile is too narrow for a horse, motorcycle, or ATV to get through, but a hiker or cyclist can pass through easily.

The second type is the Type 2 Stile. This stile allows horse, hike and bike users, but prevents motorized users.

Location of the stile is important, as minimizing the amount of fencing needed brings economic benefits. Try to find a spot where there is dense underbrush, large rocks or dense forest to help limit access.

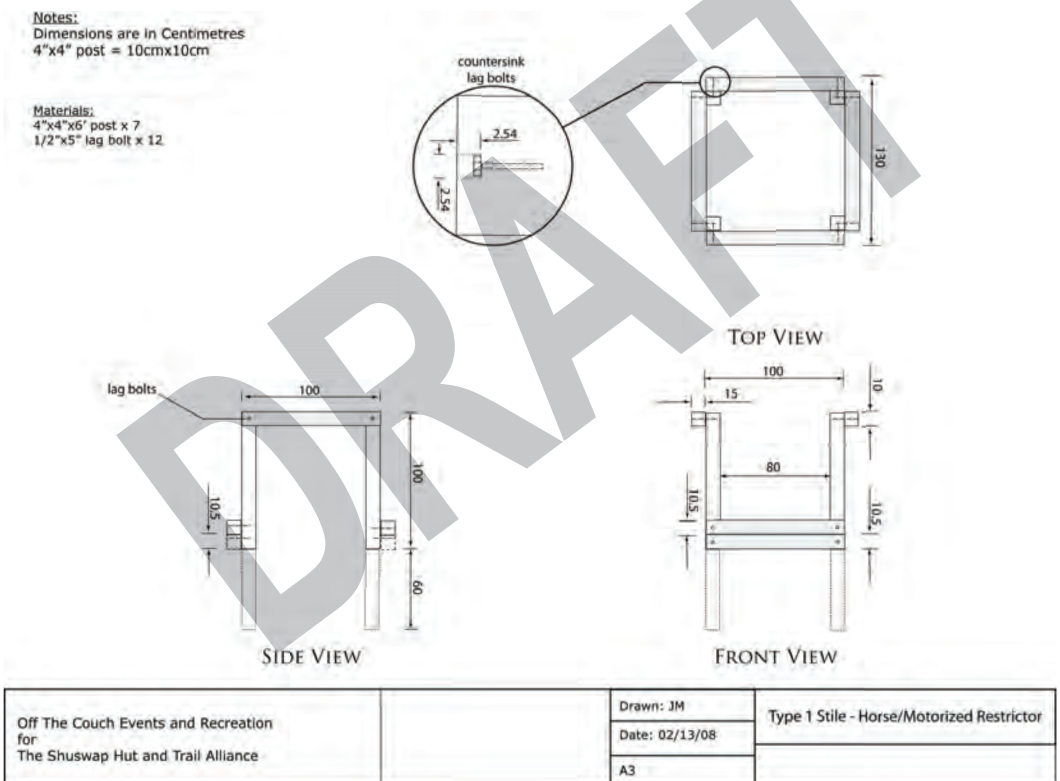


Figure 2.3 - Type 1 Stile - No equestrian or motorized

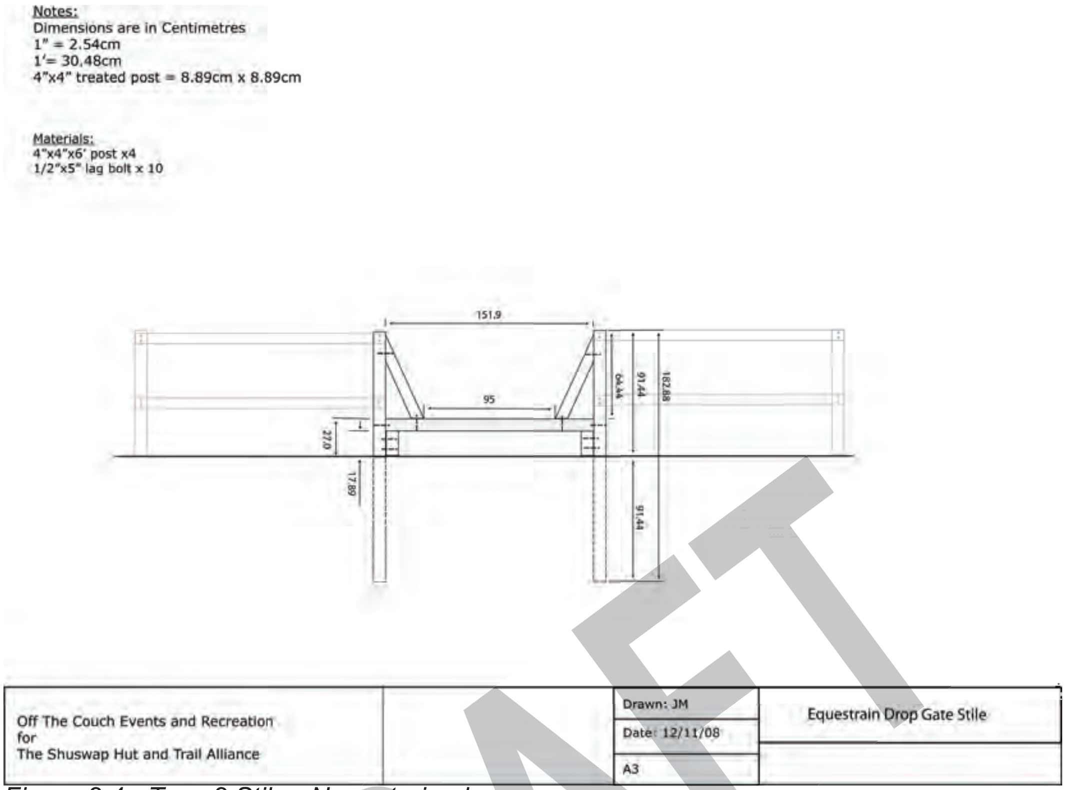


Figure 2.4 - Type 2 Stile - No motorized

Retaining Walls

Retaining wall are used to create material retention in areas where the terrain cannot support a trail tread, or where a hollow, or dip in the terrain is too extreme to follow with a contour. It will also be used when building a switchback, for the lower part of the turning surface.

Any time a retaining wall is installed, the amount of backfill material needed, and where it will be found are key questions to installation time. Borrow pits will be sizable for a retaining wall in a switchback, so make sure the pit will be close to the wall site.

There are a few methods to constructing a durable and solid retaining wall. We will focus on two types, the 6x6 post retaining wall and the metal form retaining wall.

Due to its ease of installation, and transportation, to metal form retaining wall (see figure 2.5) is the method of choice. The metal forms are light, as is the geotextile. In most cases enough rock can be found on site to provide a facing, but if not, backfill is the only material that is necessary. Another upside to the metal form walls is that there are only three very portable tools required to install them; a wire bender, bolt cutters and an exacto knife.

The 6x6 retaining wall (see figure 2.6) is preferred in situations where a more subtle approach is required. This type of wall tends to blend in the environment much better. It does have drawbacks, though. Because if the amount of materials required, and the weight of these materials, transportation becomes a challenge. Thus it is important to make sure the site for the wall is easily accessible. Even though treated wood is used for the wall, it will eventually break down and rot, creating the need to rebuild it. It will also require some larger tools, such as a generator, 1/2” drill, and sledge-hammer.

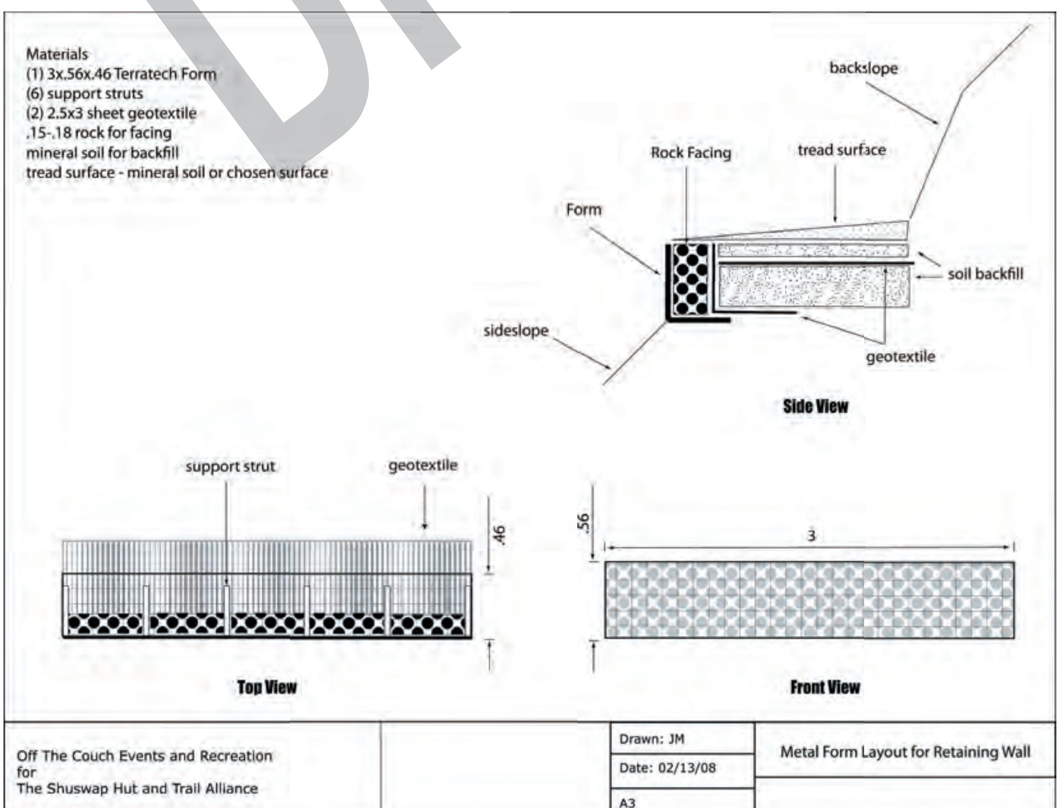


Figure 2.5 - Metal form retaining wall

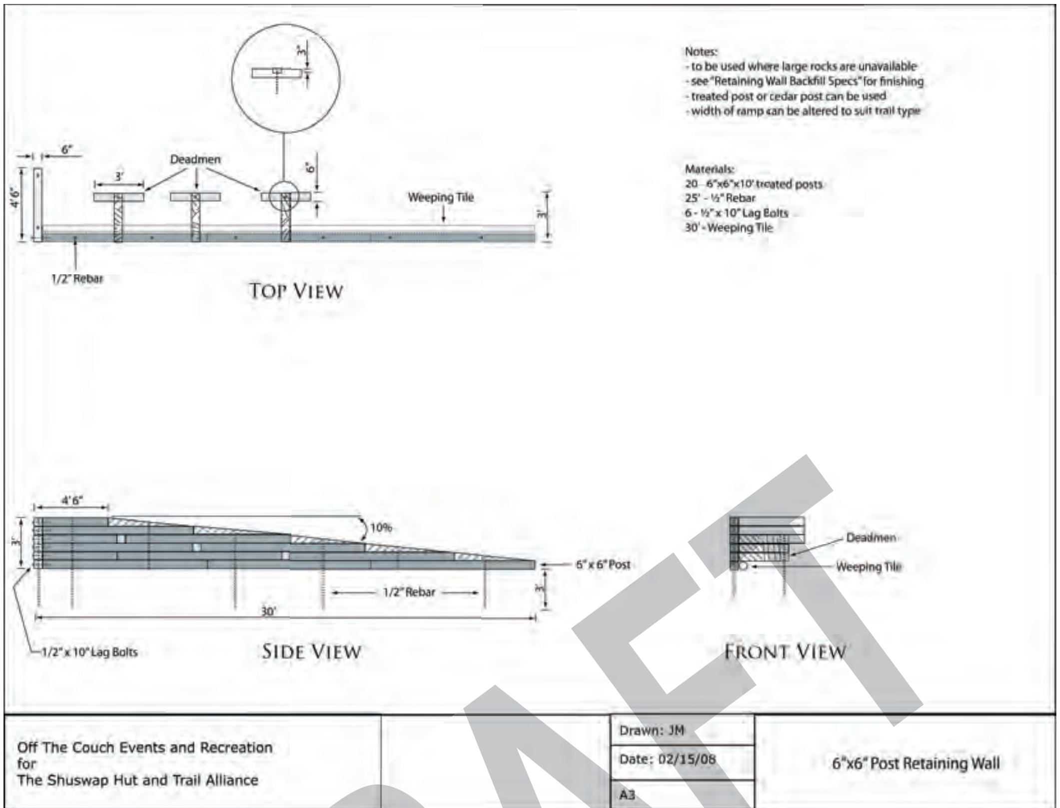


Figure 2.6 - 6x6 Post retaining wall

Technical Trail Features (TTFs)

A technical trail feature is a structure placed on a trail to increase the level of challenge for the user. TTFs are only used on mountain bike specific trails, as they are un-navigable for hikers or equestrians. Most of these structures are either natural wood, milled lumber or a combination of the two. These structures include: log rides, skinnies, ramps, drops, ladder bridges, transitions, landing ramps, and teeter-totters. The following information was taken from the Fromme Mountain Sustainable Trail Use and Classification Plan (Lees + Associates - 2007)

Safety

Design Philosophy

The following design philosophies are used to reduce the likelihood of a rider's exposure to a TTF's inherent risk in situations that exceed the skill level of the rider.

Gateways:

The objective of a Gateway (aka Filter) is to make riders fall early before being exposed to a higher consequence situation. This is achieved by placing a narrow section or difficult turn early while the TTF is still close to the ground (known as a gateway). Inexperienced riders will dismount prior to being exposed to a higher risk element beyond their skill level.

Intuitive Design:

The maximum skill level required for a TTF should be intuitive and visible from the entry. Situate the most difficult section in view so the rider can make an informed decision before they may experience difficulty with a TTF that exceeds their skill level.

Difficulty Level Signage:

• Where the skill level required to successfully complete a TTF exceeds that required for the trail itself, a less difficult alternative TTF or a ride-around should be provided as the primary route.

Fall Hazard:

The structure should be built and finished to minimize potential injury to a falling rider colliding with the structure or supports.

Strength and Stability

The TTF must be capable of supporting the greatest anticipated force and weight, and should be tested using dynamic body weight(s) for the capacity to resist vertical and lateral loading under dynamic conditions.

Fall Zone Guidelines

The Fall Zone is the area adjacent to a TTF into which a rider might conceivably fall if they are unsuccessful in negotiating the feature. Falls should be anticipated, and any objects that endanger a falling rider (sharp objects, large rocks, stumps etc.) should be removed to a minimum of 1.5 m in any direction. Vegetation that poses no danger to the rider need not be removed. Planting of durable native species within Fall Zones is encouraged. Management of risks associated with Fall Zones should be relative to the trail difficulty level, with a focus on intermediate and advanced trails.

TTF Construction Practices

The following guidelines are provided to increase the stability and durability of wooden TTF structures while maintaining the traditional TTF style that is synonymous with the North Shore. TTFs should be designed and built by or with the assistance of individuals experienced in conventional carpentry techniques.

Design Philosophy

Maximizing the size of wood used and minimizing the number of fasteners often achieves a more durable structure requiring less maintenance. This is particularly the case for areas of high impact and breaking.

Sighting

The approach to the TTF should be on dry ground to limit the mud and moisture transported onto the structure. Potholes are symptomatic at the transitions of a TTF due to the increased forces realized there; construction of adequate transitions (preferably from rock) onto and off of the TTF will prolong the life of the structure and increase riding enjoyment. Structural elements of the TTF should not contact the ground directly. Use separate pieces as a foundation.

TTFs should not be mounted to living trees for the following reasons:

1. The tree will continue to grow, compromising the integrity of the TTF.
2. The tree may sway due to wind, weakening the TTF.
3. Most attachment methods are harmful to the tree.
4. Fasteners within the tree represent a future hazard for tree falling.

Wood Dimensions

These specifications are not engineered or to building code, rather they constitute common overbuild practice.

Dimensional Lumber Construction:

- Stringers: 2”x 6”or 4” x 4” cedar for bridge spans up to 3m.
- Decking: 2”x 4” cedar.
- Cross-bracing: 2”x 4” cedar.
- Ramps: 2”x 6”, 2”x 10” or 2”x 12” cedar for spans up to 1.5m
- Ramps: 4”x 6”, 4”x 10” or 4”x 12” cedar for spans up to 3.0m

Native Wood Construction:

- Stringers: 20cm diameter intact (peel off the bark) cedar logs for spans up to 3m.
- Decking: 9cm by 5cm split cedar.
- Cross Bracing: 9cm x 5cm split cedar.
- Ramps: 5cm thick cedar for spans up to 1.5m
- Ramps: 9cm thick cedar for spans up to 3.0m
- Native cedar strings and other structural elements should be squared at point of contact with other timbers and decking.

Wood Sourcing

Untreated cedar contains natural preservatives and so is the best choice for durable technical trail features. Concentration of this natural preservative increases with the age of the tree. Wood sourced from the forest or rough-cut lumber has higher aesthetic value than commercial lumber. Rough-cut dimensional cedar transported to the site should be used for TTF construction where practical. Dimensional wood is strongly recommended for all structural components of TTFs. Split cedar is strongly recommended for all decking of TTFs for traction and aesthetic purposes.

Wood Sourcing - cont'd

Authorized individuals may selectively harvest living cedar trees for use on-site, subject to the land manager's forest management policies. Use of treated wood is discouraged and prohibited where in contact with streams or wetlands.

Bridge Rung Spacing

Spacing of approximately 2cm between rungs promotes drainage of water and mud and will ensure that humans and dogs will not catch their feet between rungs. Rungs should not overhang stringers by more than 5cm (2in) to ensure that they do not cantilever off when weight is applied to the outside.

Fasteners

The usual method of joining pieces of wood together is galvanized ardox (spiral) spikes and nails. Deck screws may also be used as they have the advantage of ease of future maintenance. Ensure two-thirds of the nail or screw length penetrates the stringer. (5"nail require for 2"x4"decking)

Galvanized nuts and bolts or lag bolts or are recommended over screws and nails for joining main structural supports. The strength of the TTF should not rely on the shear strength of the fasteners. Use cross and diagonal bracing.

Log Rides

Logs from native tree species may be incorporated in TTFs. Logs may be of any native tree species, however, most native wood can be expected to have a reduced life span compared to cedar. Furthermore, stability and durability is relative to the log thickness and state of decay.

Minimum log diameter is 20cm. The riding surface of the log may be squared or not depending on the targeted skill level. Logs should be stabilized with supports to eliminate unwanted movement.

Anti-slip Surfacing

The use of split or rough cut dimensional lumber as decking will provide sufficient traction in most situations. Where angles exceed 10°, application of an anti-slip surface is recommended. Various anti-slip surfaces have been experimented over the years with varying results. The recommended anti-slip surface material is rubber conveyer track given its effective traction, durability, ease of application. Furthermore rubber conveyor track does not present a fall hazard. The following alternative traction applications are not recommended:

- Perpendicular saw cuts (traps mud, promotes decay)
- Steel lath or mesh (fall hazard, poor durability)
- Asphalt shingle roofing (poor durability, toxins)

References

International Mountain Bike Association, (2004). Trail Solutions: *IMBA's guide to building sweet singletrack.* Boulder, Colorado: International Mountain Bike Association.

International Mountain Bike Association, (2007). Managing Mountain Biking: *IMBA's Guide to providing great riding.* Boulder, Colorado: International Mountain Bike Association.

Parker, T. S. (2004). Natural Surface Trails by Design, Boulder, Colorado: Natureshape LLC.

Lees and Associates. (2007).Fromme Mountain Sustainable Trail Use and Classification Plan. Vancouver, BC

The Bruce Trail Association. (2001). Guide for Trail Workers. (3rd Ed) Hamilton, ON: The Bruce Trail Association.

Whistler Cycling Committee. (2003) Whistler Trail Standards. *Environmental and technical trail features*. Whistler, BC. DeBoer, A.

Student Conservation Association (2006). Lightly on the Land, *The SCA Trail Building and Maintenance Manual. Seattle, WA. Birkby, R.*