Table of Contents

The standards in this section are approved under the authority of the Director, Parks and Protected Areas Branch, and will apply to the maintenance and construction of all the BC Parks Building/Trails.

1.0 Introduction

The trail section includes a guide to field planning and design, construction, maintenance, rehabilitation and monitoring of all types of park trails. It should be used with Park Design Guidelines and Data.

This trail section is a synthesis of several previous publications. Many sources were reviewed, as listed in the Appendix. Key sources included the Parks Canada Trail Manual; BC Forest Service Recreation Manual; Kananaskis Park Guidelines for Trail Development and Maintenance; Hiking Trails Building and Maintenance Guidelines for Volunteers, Outdoor Recreation Council of BC; the Ontario Ski Council Cross-Country Ski Trail and Facility Design Manual, and the Cross Country Ski Trail Building and Maintenance Guidelines; BC Division Canadian Ski Association.

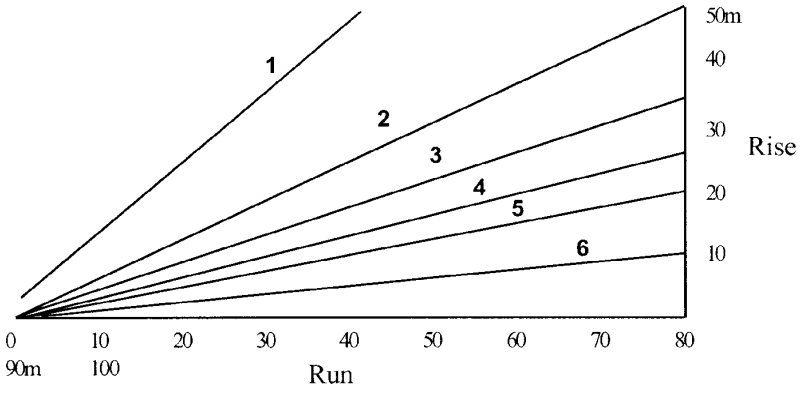
2.0 Construction

2.1 Trail Route Gradients

Ease of travel along a trail is affected by the degree of slope, the length of sustained grade and the proportion of uphill to downhill and level sections along the trail. Plan for a level trail section at the end of steep or sustained grades. Select variations in trail gradients with gentler sections in between steep climbs. Avoid long, sustained grades. Consider switchbacks, steps or ladders for small sections of very steep slopes. For most trails, plan for a 20% maximum grade over a distance of 30 m. If only a few steep areas occur along the route, allow for greater maximum grades as required.

Figure 1: Trail Gradients

1	1:1	100%	45°
2	1:2	50%	27°
3	1:3	33%	18°
4	1:4	25%	14°
5	1:5	20%	11°
6	1:10	10%	6°



2.2 Flagging the Trail Route

- Use both topographic maps and air photos to help locate the planned trail route and to pinpoint the trail location for later reference.
- Use a consistent colour or colour combination of plastic flagging to mark the route. Avoid the use of spray paint or tree blazes since adjustments to trail routing are inevitable during the design phase.
- Consider using colour codes to mark specific construction tasks such as boardwalks, bridges or varying clearing widths.
- Use a survey crew to stake high standard surfaced trails, for example near campgrounds, where grades and routing may have precise requirements.

- Mark the trail route on maps and air photos.
- Flag a rough route first, spacing flagging close enough so that they are just visible. When the route has been refined and is acceptable to the design team, hang enough flags to avoid misinterpretation of the route.
- Hang the route flagging along the proposed trail centre-line.
- When hanging flagging on the trail centre-line, consider ground conditions, slope, and the type of groundcover. Where possible, select the route to minimize tree cutting and damage to the roots of trees to remain.
- Measure the trail distances with a hip chain or other survey device. Label station markers if required for construction, (for example 0+100, to mark a bridge location 100 metres from the start of the trail).
- Remove all flagging tape after construction. Remove any tape from routes not used.
- Construct the trail within 2 years to ensure the flagging tape is still visible.

2.3 Techniques to Reduce Soil Erosion

Soil erosion reduces the visual quality of trails, affects the longevity of trails, increases maintenance costs, degrades plant and animal habitat, and may affect public safety. Effects of erosion include:

- loss of surface soil through sheet and/or gully erosion,
- root exposure resulting in physiological stress to plants and shrubs and, in the case of trees, susceptibility to windfall,
- stream sedimentation, resulting in damage to spawning beds, increased turbidity and adverse effects on flow regime and stream flora and fauna,
- contamination of water supplies,
- failing slopes through slides and slumping.

Soil erosion occurs where surface runoff is not controlled. Erosion results where trail grades are too steep or where adequate means are not provided for diverting surface water off the trail. Improper installation of bridges and culverts can also cause erosion. Trails located directly down a slope increase run-off and erosion.

- Locate trails in areas least sensitive to erosion. If this is not possible, use construction techniques that minimize erosion. Consider the use of bridges or trail surfacing.

- Use drainage controls on slopes. When surface runoff is low, direct it across the trail surface. When surface runoff is high, use a crowned tread with a ditch on the uphill side to lead water to grade dips, culverts or waterbars.

- Avoid steep sections susceptible to water erosion.

- Orient trails across slopes on the diagonal, or use switchbacks to climb steep slopes.

- Incorporate natural grade dips into the trail surface so that drainage is diverted at frequent intervals.
- Use steps or ladders on steep slopes, making sure drainage water is diverted from the top of steps.

- Slope the cross-section of the trail tread at approximately 2%, or 4 cm per 1 m of tread width to direct surface water off the trail.

- Use waterbars to direct water off the trail when using a cross slope on the trail tread and grade dips are not adequate to control runoff. Alternatively, construct water-bars out of stones 100 cm or greater in diameter. Place them across the trail in the same position as the log waterbar.

2.4 Suitable Culvert and Bridge Siting and Design

- Reduce the use of culverts and bridges by careful trail planning, selecting the optimum crossing points, and choosing less intrusive construction techniques where possible. For example drainage dips, cross-slopes, stepping stone crossings and other techniques may reduce or

- Provide for adequate drainage flow. Bridge specifications depend on peak flows and flood cycles.

- Locate bridge crossings to minimize disturbance to stream beds and banks. Locate bridges where channels are straight and where bank conditions are stable.

- Use bridges rather than culverts to cross large streams. Culverts may alter flow and cause downstream erosion or silting. They may also disturb fish habitat.

- Use culverts on small drainage ways. Select an adequate size and set at a level that will not interfere with drainage. (See detailed notes in Construction section).

2.5 Waste Disposal

- Plan a waste disposal strategy for the trail. Litter along the route, garbage associated with overnight camping, and horse and human excrement all detract from the visual quality of the trail. Bears habituated to human food can be a problem and may have to be relocated or killed. Broken glass, cans, bottle caps and plastic bags are also hazardous to wildlife.

- Educate users on waste and require a “pack in-pack out” policy as the most effective management practice.

- Avoid other types of trail use where horse traffic is expected to be heavy,

- Locate backcountry pit or other types of toilets in suitable soils.

2.6 Maintenance Requirements

Good design can reduce future trail maintenance costs. Following are three key ways to reduce maintenance:

- locate the trail on well-drained soils,
- traverse gentle slopes, avoid steep slopes and slopes prone to collecting rock or avalanche debris,
- cross streams at their narrowest point where banks are most stable and least susceptible to channel changes.

2.7 Trail Drawings

- Mark the location of the trail on a prepared topographic base map of the trail area. Use a scale of 1:50,000 minimum for longer backcountry trails, use scales of 1:5,000 if possible and use air photo enlargements to prepare trail design plans.
- Show specific recreation and landscape features on the plans to assist the construction team and to assist with interpretive planning when required.
- Show the specific location of all construction requirements, such as bridges, grade dips, right-of-way clearing and switchbacks. Match these to distance markers in the field.
- Show trail construction requirements as straight-line diagrams, log records, or notes on the plan.
- Include any notations on environmental conditions and limitations to trail use, to facilitate future route or construction changes.

Table 1 shows an example of a hypothetical construction log report.

Table 1: Construction Log - Black Tusk Trail

Km+m	Work Item	Remarks
0+00	begin project	
0+40+0+80	remove outslope	
1+50	sand and gravel site	see map for borrow
2+80+3+10	install log rounds	location use local logs
4+00	grade dip	

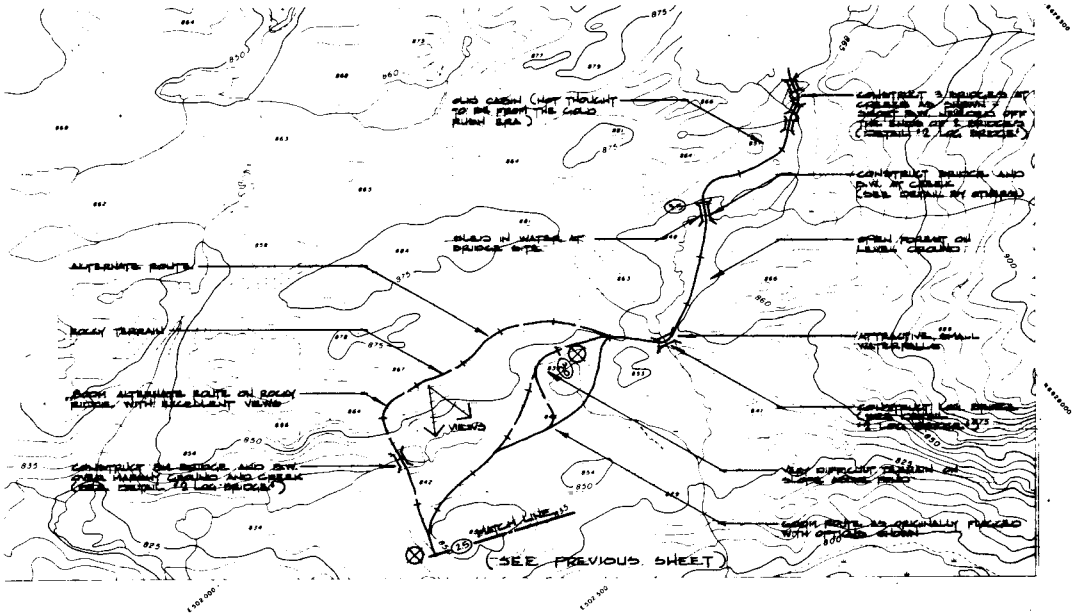


Figure 2 shows a trail drawing with construction notes from Chilkoot Trail National Historic park.

2.8 Cost Estimates

- Estimate the trail construction or renovation costs by determining the quantity and price of materials, labour, equipment, and administration.
- Calculate the total length and type of trail construction according to the different techniques required; e.g. some sections may need minimal clearing, while other require boardwalk construction.
- Estimate the total and unit costs of materials such as lumber, culverts, tread surfacing, signs and printed information.
- Modify the trail design details to reduce the cost of materials if required.
- Estimate the cost of labour for trail clearing and the construction of bridges, boardwalks and other trail elements. Allow for differences of terrain, weather, transportation time and other delays.
- Base labour estimates on a crew of 3 or 4, or as determined by the type of construction management planned. Assume one fore-person for each crew.
- Estimate the costs of equipment purchase or rental. Estimate the costs of construction start-up, transportation, food and accommodation, as well as administrative costs such as construction supervision and management.

2.9 Construction Specifications

- Prepare construction specifications that describe all the details of the work required.
- Include written descriptions and standard drawings showing dimensions, sizes and configuration of the various construction requirements.
- Follow the standard guidelines for individual trail types, where appropriate, as described in the following section.
- Where liability is a concern, for example in bridge design, consider using specialized expertise.

3.0 Classification

Summary:

- foot trails:
  - hiking
  - walking
  - interpretive trails
- horse trails
- bicycle trails
- cross-country skiing trails and ski touring
- snowshoe trails
- snowmobile trails
- special trails:
  - multi-use trails
  - interpretive and wildlife viewing trails
  - barrier free trails
  - portage trails

Trail standards are specific to the type of recreation use. Construction methods for specific trail types may vary between regions, depending on local site conditions and user requirements. For example, trail clearing and maintenance in forested coastal areas differs from dry interior sites. A flexible interpretation of the standards is required to suit the specific trail.

Consider user needs and safety on multiple-use trails. Generally, avoid motorized and non-motorized use on the same trail. Depending on the volume and season of use, hiking and equestrian or bicycle use on the same trail may not be compatible. Avoid planning for bicycle use on interpretive trails. In favorable terrain conditions, many trails may be used in both the summer and winter.

This section outlines a standard approach to classifying trail types, based on the system for hiking trails used by the BC Parks Branch since the 1960s. Trail types are classified from I to V depending on how many different types of trails are in each category. For example, hiking and walking trails have a wide range of characteristics, and are described using 5 different types. Snowmobile trails have 3 types shown. Type I trails are always the highest standard trails, with the lowest standard of trail or route shown by Type III, IV or V grading depending on what activity the trail is for. For example, Type V hiking trails and Type IV ski trails are routes only.

Table 2: BC Parks Trail Classification System

Type:	Type I	Type II	Type III	Type IV	Type V
Decreasing standards	highest standard maximum users may have highest environmental impact highest cost highest maintenance		lowest standard	may have lowest	minimum number of users environmental impact lowest cost lowest maintenance

Trail Type Summary

	Type I	Type II	Type III	Type IV	Type V
Foot	•	•	•	•	•
Horse	•	•	•		
Bicycle	•	•	•	•	
Ski	•	•	•	•	
Snowshoe	•	•	•	•	•
Snowmobile	•	•	•		
Interpretive	•	•	•		
Barrier-free	•				

3.1 Foot Trails

- Hiking (backcountry trails)
- Walking (surfaced frontcountry trails)
- Interpretive trails (See special section)

Apply Hiking Trails Standards

Use these guidelines to match park management zone objectives with the trail design, construction specifications and use. The guidelines for all other types of park trails, such as horse and bicycle trails, use a similar classification system.

Type I

- plan high standard short walks, 5 minutes to 30 minutes duration,
- design to accommodate a steady flow of two-way foot traffic during peak periods of use,
- provide base course and surfaced tread, 2 metres wide,
- set maximum 8% grades, preferred average grade no more than 5%,
- make accessible to wheel-chairs,
- provide interpretive signs, benches, viewing areas where appropriate,
- use in day use areas, viewpoints, campgrounds,
- use as ski trails in winter if criteria are met.
- Intensive Recreation Zone
- Natural Environment Zone
- Special Feature Zone (in some circumstances)

Type II

- plan as walking trails, 10 minutes to 2 hour duration,
- 1-6 km long,
- these trails often lead to higher elevation points of interest,
- design at 1.25m wide, may be surfaced, suitable for walking two abreast,
- set maximum 10% grades, preferred average grade no more than 5-8%,
- use in day use areas, viewpoints, campgrounds, interpretive areas, or as access to backcountry trails,
- consider as ski touring trails in winter if criteria are met.

  Intensive Recreation Zone
  Natural Environment Zone
  Special Feature Zone (in some circumstances)

Type III
- plan as hiking trails, single file, 1-7 hour day use to multi-day or overnight duration, 3-20km or more long,
- day use hiking trails often lead to higher elevation points of interest,
- provide .75m tread maximum, 15% maximum gradient,
- could have support facilities such as developed campsites and pit toilets,
- consider as ski touring trail if criteria are met.
- Natural Environment Zone
- Special Feature Zone (in some circumstances)
- Wilderness Zone

Type IV
- plan as lightly used wilderness hiking trails, overnight or multi-day duration,
- provide .50m tread maximum, gradients as required,
- avoid tread grubbing, place signs where required,
- would not normally have support facilities such as developed campsites, may have pit toilets as required.
- Wilderness Zone

Type V
- leave as wilderness hiking route, avoid trail development,
- overnight or multi-day duration,
- hikers may use wildlife trails, creeks or other natural features,
- routes may be over passes or snowfields,
- no signs, campsites or other facilities,
- may have restrictions on camping locations.
- Wilderness Zone

Layout and Length
- Design Type I and II trails as loops or stacked loops.
- Design Type III and IV trails to match the park topography and features, use loop routes where possible.

Grades
- Design grades to match the trail type, varying from gentle uniform grades of 5% for Type I trails to 15% for Type IV trails.

Clearing and Treads

- Design the clearing and tread width to match the trail type. Type I trails are the widest, with surfaced treads and Type IV trails the narrowest with no special tread surface treatment.
- Modify the clearing width if the trail will be used as a ski touring route.
- Select tread surface materials according to the class of trail and cost of construction.

Structures

- Design structures in accordance with the trail type. Type I trails may need engineered bridges, while Type IV trails may not use bridges at all, or use simple two-log crossings.
- Avoid all support facilities such as developed campsites on Type V routes. Minimize facility development on Type IV trails. Build suitable campsites and waste facilities on Type III trails.
- Consider winter use if the trail plans include cabins in remote areas. Plan for wood stove use, firewood storage, winter snowpack, winter entrances, and design and materials resistant to damage by wildlife.

Trail Signs and Related Facilities

- Provide trailhead signs and en route trail distance markers. Provide trail signs at all trail junctions, with directional arrows to show the way back to the trailhead.
- Provide trailhead registration boxes or other registration means on Type III, IV, and V trails and routes.
- Provide adequate parking, waste disposal, toilets, water supply and other services as appropriate for the type of trail.

3.2 Horse Trails

Type I

- plan 1-15 km routes for day use only,
- use a gentle uniform gradient and a well compacted surface,
- consider crushed stone surfacing unless soils are suitable for high use levels,
- plan as high use trails near campgrounds and major trailheads,
- consider designing to accommodate winter use,
- provide for short exploratory rides,
- design to accommodate a steady flow of two-way horse traffic during peak periods of use.
- Intensive Recreation Zone
- Natural Environment Zone

Type II

- plan 5-30 km trails for day use or overnight trips,
- design as moderate use trunk trails or day use trails,
- use existing soil surface, except where surfacing is required to cross wet or fine textured soils areas,
- not normally designed to accommodate winter use, except as snowmobile route
- Natural Environment Zone
- Wilderness Zone

Type III

- plan 30-50km trails in low use areas, multi-day duration trips,
- low standard routes beyond trunk trails,
- not normally designed to accommodate winter use,
- Wilderness Zone

Layout and Length

- Design the trail using criteria for day-use bridle paths or long distance routes used by pack and saddle stock.
- Design the trails for the safety of both riders and the horses.
- Use any trail layout form depending on the terrain conditions. Use additional loop or spur trails to increase the distance and provide a range of terrain conditions.
- In general, plan loop trails for day-use riding, and loop or linear trails for long-distance trails. Integrate day-use loops long-distance linear trails where appropriate. Use loops as alternate routes around wet areas in the spring or around sensitive wildlife areas in the fall.
- Design day-use trails to range from 5 to 15 km depending on the terrain and user ability. Long-distance trails may cover several hundred kilometres.
- Plan for campsites every 16 to 25 km along the route. Develop campsites to be consistent with the park management zone objectives.
- Provide access to drinking water at least every 15 km. Refer to Ministry of Health regulations on water sources.

Grades

- Plan trail routes with a desirable range of grades between 0-10%. Do not exceed a maximum sustained grade of 15%. Avoid grades steeper than 20% over a maximum distance of 30m.
- Design long climbing turns in preference to switchbacks. If switchbacks are used, design the curve radius to a minimum of 2 metres. Design grades of 10% to 15% leading to and from the curve to discourage shortcutting. Use rock or log barriers for a distance of 6 to 10 metres back from the turning point.

Clearing and Tread Width

- Clear vegetation to a height of 3 m above the tread surface, and a minimum width of 2.5 m.
- Match the tread width to the terrain conditions and type of equestrian use.
- Use a tread width of 45 cm to 1 m for average trail conditions.
- If the trail passes through hazardous side slope areas, use a tread width of at least 1.2 m to 1.5 m, to be safe for horse and rider.

Tread Surfacing

- Provide a fairly even surface free of rocks or roots that cannot be covered.
- Use additional surfacing materials in areas with fine textured soils or intensive use. Consider wood shreds in place of wood chips. Alternatively, use gravel or crushed stone mixed with the existing soils. On intensely used bridle paths, use crushed stone as the preferred surface material.
- On steep side slopes, place rocks or logs along the outer edge of the tread to prevent sloughing of the trail edge.

Structures

- Equestrian trail staging areas require circulation and parking for horse trailers, corrals, hitching posts and water supply.
- Provide a suitable size of horse corral depending on the type of staging areas and amount of use. Smaller corrals with separate stalls for small groups of animals are healthier for horses than large corrals that house many horses.
- Rely on stream fords rather than bridges for stream crossings, provided the velocity and depth of the water is acceptable during the normal use seasons. Water depths of not more than 60 cm are safest. Locate trails to cross acceptable natural fords.
- Improve the ford by constructing a minimum 1 m wide base from which large rocks have been removed and the stream bottom leveled to make a relatively smooth crossing.
- Design bridges to support the maximum number of loaded horses that may occupy the bridge at one time. Provide secure footing, for example with flattened logs.
- Cover culverts with a thick layer of soil or granular fill to prevent hollow sounds when horses are crossing. Cover corduroy with soil or other surfacing material to create an even tread.

Notes

- Horses can damage trails in wet areas. Once a trail becomes muddy, further damage occurs as horses detour to the sides of the trail. Wherever possible, locate routes in stable well-drained soils. Trails on side slopes require adequate drainage facilities. If wet areas must be crossed, use bridges or fill to prevent mudholes.
- Plant distribution and succession along trails and in grazing areas is disturbed by browsing and trampling. Imported feeds encourage the establishment of non-native plant species. Educate users and employ regulations if required to discourage grazing along trails and at campsites. Provide corrals at campsites and require users to pack in feed.
- Prohibit horse access to sensitive areas. Provide tethering places at the entrance to the foot trails.

3.3 Bicycle Trails

Bicycle trail standards include both mountain bicycle and standard road bicycle routes. Mountain bike use is increasing in many provincial parks and has evolved into a day use and overnight destination recreation activity. Bicycle use has also increased around heavily used campgrounds and day use areas. Tourists now often carry mountain bikes on their recreational vehicles as part of their standard camping equipment. Casual cyclists have different needs from those pursuing the activity as a challenging recreational sport.

Trails that were previously used only by hikers, horses or both, are now in demand by mountain bikers. This has led to impacts on other users, the environment, and trail maintenance. Apply appropriate trail planning and design principles to help manage the effects of mountain biking.

The trail types for bicycles include both mountain and road bicycles, with Types III and IV limited to mountain bike use only. Difficulty ratings for mountain bike trails are usually classed as easiest, more difficult, and most difficult. These ratings may be applied to the Type III (easiest) and IV (more difficult and most difficult) trail types. See Table 3 on mountain bicycle trail design guidelines.

Type I

- plan as paved two-way bicycle paths for smooth all weather riding,
- design for road and mountain bikes, suitable for all types of users,
- use asphalt or chip-seal coat surfacing,
- provide 2.5m tread width, gradient maximum of 10% on hills, 5%-8% average gradient over length of the trail,
- use Type I trails for groomed cross-country ski trails if criteria are met.
- Intensive Recreation Zone

Type II

- plan as surfaced two-way bicycle path,
- design for road and mountain bikes, suitable for most users,
- use crushed limestone with fines, well compacted gravel, or existing old roadbeds,
- provide 2m tread width for two way traffic, 1m for one-way or mountain bike trails,
- remove all trail obstacles,
- do not exceed a gradient maximum of 10-15% on hills,
- maintain a minimum 2.5m curve radius,
- use Type II trails for groomed cross-country ski trails if criteria are met.
- Intensive Recreation Zone
- Natural Environment Zone

Type III

- plan as unsurfaced one-way trail for mountain bicycles only, 10-20km,
- plan for easiest or more difficult trail ratings where appropriate,
- clear to 1-1.5m,
- provide .5-.7 m tread width on native soil, for easiest trails,
- provide .5-.7 m tread width on native soil for more difficult trails,
- allow for maximum slopes to 10% over 30m on easiest trails, 22% over 45m on more difficult trails,
- maintain a 2 m curve radius,
- leave trail obstacles up to 10cm high, if appropriate,
- consider using Type III trails for ski touring trails if criteria are met.
- Natural Environment Zone

Type IV

- plan as unsurfaced one-way trail mountain bicycle trail, 30-80 km,
- plan for more difficult to most difficult trail ratings,
- clear to 1m width,
- provide .3-.5 m width tread on native soil, sometimes rough ride,
- steep and challenging slopes, sometimes rough terrain,
- limit maximum grade to 25% over 90m, and maximum sustained grade to 15%,
- maintain a 1.2-1.5 m curve radius,
- leave trail obstacles up to 30 cm high.
- Natural Environment Zone
- Wilderness Zone (in some circumstances)

Minimum design standards will allow for adequate function of the trail, and optimum design standards will provide the most efficient bikeway. Select the appropriate standard based on anticipated use, cost, feasibility of construction and adaptability to the site.

Table 3: Design Standards for Road Bicycle Trails (from Kananaskis Country)

Design Standard	Width 1-way	Clearing 2-way vert.	Grades Curvature width		Cross-slope
Lowest 5% Standard	1.1m	2.5m	2.5m	3.5m	8-10%/46m by speed
Desirable by speed Standard	1.2m 2%	2.5m	3.0m	4-5m	5%/30m

Table 4: Design Guidelines for Mountain Bicycle Trails (after Backcountry Bicycle Trails Club, Washington)

Easiest (Type I and II)		
Curve radius	2.4 m	(8 ft)
Max. sustained grade	5%	
Max. grade	10%	
Slope length	30 m	(100 ft)
Tread width	60-90 cm	(24-26 inches)
Clearing width	121 cm	(48 inches)
Clearing height	2.4 m	(8 ft)
Length of trip	8-24km	(5-15 miles)
Obstacles	none or up to 10 cm	(4 inches)
More Difficult (Type III and IV)		
Curve radius	1.8 m	(6 ft)
Max. sustained grade	10%	
Max. grade	15-22%	
Slope length	150-45 m	(500-150 ft)
Tread width	30-60 cm	(12-24 inches)
Clearing width	91 cm	(36 inches)
Clearing height	2.4 m	(8 ft)
Length of trip	24-50km	(15-30 miles)
Obstacles	20 cm	(8 inches)
Most Difficult (Type IV)		
Curve radius	1.2 m	4 ft)
Max. sustained grade	15%	
Max. grade	25%	
Slope length	91 m	(300 ft)
Tread width	30 cm	(12 inches)
Clearing width	91 cm	(36 inches)
Clearing height	1.8 m	(6 ft)
Length of trip	50-80 km	(30-50 miles)
Obstacles	30 cm	12 inches)

Plan the Trail for the User

Different types of cyclists are:

Casual Day User/Family Cyclist

- primarily interested in recreational cycling in easy to moderate terrain,
- usually inexperienced riders, therefore lack of confidence,
- bicycle short distance; usually no more than 8 or l0 miles at an outing,
- wide age range of user.

Tourists (Travelling by Bicycle)

- average speeds 15 - 20 mph with distances of 50 to over l00 miles per day not uncommon,
- usually more experienced than the day-user and more willing to share the trail R.O.W. with other traffic if safety factor can be maintained,
- very interested in topographic information, location of accommodation and services for an area,
- may have special requirements for camping facilities other than bicycle security.

Mountain Bicyclists and Racers

- most experienced rider of the three,
- seek scenic and challenging routes if mountain biking,
- day use or overnight trips,
- may cycle long loop trails up to 60-80 km on a day use basis.

Layout and Length

- Use any form of trail layout, but remember that many long distance mountain bike trails use linear layouts along old roads, easements along highways, power lines, or abandoned railway grades.
- Plan curves to create a more interesting trail and avoid cutting large trees. Avoid sharp curves at the bottom of long or steep slopes. Use straight “run out” sections prior to sharp. Use curves to allow cyclists to reduce their speed. Ensure good visibility on slopes and curves.
- Use additional loop or spur trails to increase the distance and provide a range of terrain conditions.
- Trail loop lengths between 4 and 18 km are desirable. Most cyclists travel at an average speed of 18 km/hr on level ground with a range between 11 and 24 km/hr. Speed depends on terrain, wind, individual cyclist abilities.
- Plan for half-day day trip trail lengths of 30-40km for advanced cyclists, 24-30km for intermediate users and 8-16 km for less experienced cyclists.

- Plan for full day trail lengths of 65-80 km for advanced cyclists, 30-65 km for intermediates and 16-30 km for less experienced users.
- Avoid stream banks by at least 10 m.
- Note local wind characteristics. Avoid wind tunnel effects and locate the trail out of heavy prevailing winds. Note the sun orientation related to specified trail route and avoid, when possible, long tangent sections into the sun's glare or use vegetation as a relief.
- Minimize auto/bike contact where possible, especially in heavy bike zones (i.e. campgrounds). Provide pull-off (bypass) zones for bikers.
- Ensure adequate sight-lines when designing the route.

Grades

- Use maximum sustained grades of 15% for more difficult trails and 2-10% on easy and moderate difficulty trails. Optimum grades for easy road bike trails range between 2% and 5%, with the maximum gradient for short (20m) uphill sections not exceeding 15%.
- Use a maximum grade for short pitches of 25% over 90 m for the most difficult trails, 22% over 45 m for moderate difficulty trails and 10% over 30 m for easy trails.
- Modify the design grades to match soil conditions. In areas with finer textured soils, reduce trail gradients to help reduce erosion.
- Design long climbing turns in preference to switchbacks. If switchbacks are used, design the curve radius at a minimum of 2 metres. Design grades of 10% to 15% leading to and from the curve to discourage shortcutting. Use rock or log barriers for a distance of 6 to 10 metres back from the turning point.
- For Type I and II trails, use proven turning radii and super-elevation (sloping the curve inwards) on curves.

Table 5: Road Bicycle Radius Curvature

Design Speed	Radius (metres)
16 km/h	4.6
24 km/h	10.7
32 km/h	21.3
40 km/h	27.4
48 km/h	38.1

When trail widening is required on curves, it should be effected at the maximum point on the inside of the curve at a width of 1.2m. Curves which are widened generally require super-elevation (in addition to the standard 2% drainage cross fall), as follows.

Table 6: Super Elevation Curves

Super Elevate Curves Grades		
2%	when greater than 20m	Less than 5%
4%	when less than 20m	Greater than 5%

Use standard stopping site distance tables:

Table 7: Stopping Site Distances

Stopping Site Distance in Metres			
Design Speed	**Level**	**5%**	**10%**
6 km/h	15.2	15.2	18.3
24 km/h	26	27.4	30.5
32 km/h	39.6	42.7	48.8
40 km/h	53.3	60.9	70.1
48 km/h	70.1	79.2	94.5

Trail Clearing and Tread

- Note that bicycle handlebars are about 60 cm wide and about 75-100 cm above the ground. Rider's elbows may extend beyond the handlebar width.
- Clear a 3 m right-of-way for two-way surfaced bicycle trails. Clear a minimum 2m right-of-way for surfaced one-way bicycle trails in day use areas or campgrounds. Use a clearing width of 1m for more challenging one way Type IV trails, and 1-2 m for easier Type III trails.
- Clear to a height of 3.5 m on all types of road bicycle trails. Adjust the clearing height to allow for snow if the trails will be used for skiing in winter.
- Use a tread width of 30 cm for difficult mountain bike trails (Type IV), 30-60 cm for moderate difficulty trails and greater than 60 cm for easy one-way trails.

- Use a 1.5 m minimum tread width for surfaced one-way bicycle trails (eg. Type II) and 2.5 m for surfaced two-way trails (Type I) One-way surfaced bikeways are not recommended for most installations since they don't allow for passing.
- Increase the tread width by 15 cm on switchbacks or where side slopes exceed 60%.
- Provide a shoulder of 80 - 100 cm wide beside the surfaced tread.
- On paved Type I trails, apply a full depth asphalt surface of 100 mm on a 150 mm compacted gravel subgrade.
- Modify catch basin grates or change their direction if they will trap bicycle tires.
- Use pavement marking and/or striping to inform both the cyclists and the motorists as to their respective rights-of-way. Use changes in pavement or other surface texture to remind the cyclist of approaching obstacles.
- Clear the trail surface of most obstacles, particularly on the easiest trails.

Structures

- Use bridge decking with non-skid surfaces. Ensure that the trail surface and lip of the bridge decking are flush.
- Design bridges with railings 60 cm wider than the trail tread to allow for the overhang of handlebars. In heavy use areas provide an extra 60 cm to allow cyclists to stop on bridges without blocking traffic. A typical bridge width would be 3.0 m for Type I trails.
- Provide wheel stops on bridges without railings. Ensure wheel stops are 15 cm or less high to avoid hitting bike pedals. Do not locate bridges at the end of long or steep grades.
- Avoid peeled log water-bars on bicycle trails. The top surface may be slick and dangerous to bicyclists. Consider a gentle drainage dip as an alternative, or only expose the log water-bar on the lower side of the trail.
- Use steps on easy bike trails where grades exceed 10%. Build narrow paths or ramps on either side of the steps for users to wheel their bikes as they walk up or down. Provide landings on long climbs. Provide adequate warning signs and clear visibility to the steps, especially from the top approach.
- Provide lockable bicycle racks at heavily visited facilities. Provide leaning posts or rails at viewpoints on the trail.

Notes

- Consider camping facilities on long-distance trails. Consider terrain conditions, user ability and the number of interest points along the route to help decide on the best campsite locations.
- Prohibit motorized access to bike trails. Mark and block all road crossings, both on the trail and on the road.
- Provide access to drinking water at least every 10 km.
- Consider the potential capabilities of handicapped cyclists (i.e. tandem/tricycle rentals). While physical handicaps may limit user capabilities, they should not be automatic barriers.

3.4 Cross Country Trails and Ski Touring

This section includes ski touring, cross-country skiing, and racing trails. Ski trail design has evolved into a sophisticated art in the last decade, with specific requirements for a variety of skiing activities. Trail planning, design, construction and maintenance needs differ from hiking and other summer use trails, although some trail types are suitable for all season use. Refer to Cross-country and Ski Touring Development Guidelines - BC Parks for more information on standards, signs and maintenance.

Design a Suitable Trail Type

Each type of cross-country skiing or ski touring trail may be graded as Easiest, More Difficult or Most Difficult. The 4 trail types refer to design, construction and maintenance standards, not necessarily difficulty. See also trail Grades, below.

Type I: Cross-Country Skiing Racing Trail

- Develop trails to the high standards required for cross-country ski racing.
- Conform to Cross Country Canada (C.C.C.) regulations on length, grade and width specifications.
- Design racing trails for one-way skiing.
- Intensive Recreation Zone

Type II: Cross-Country Skiing Trail

- Develop trails for day use cross country skiing, not necessarily to racing standards of length and difficulty.
- Conform to minimum widths and grades, depending on grooming equipment.
- Provide a variety of routes with different degrees of difficulty and distances and can accommodate a wide range of skiers. Design trails for partial day, or full day use.
- Provide groomed trails for classic and free technique. Design trails wide enough for double tracking.
- Natural Environment Zone
- Intensive Recreation Zone

Type III: Packed Skiing Trail

- Develop trails for cross-country skiing on a day use or overnight basis.
- Allow for moderate to light use, usually on a one way loop.
- Consider using suitable existing summer hiking trails, where grades, trail width, and elevation gain or loss is reasonable.
- Groom trails occasionally or not at all. Rely on skiers to set tracks.
- Design trails for classic technique, may be in a backcountry setting.
- Consider planning Type IV trails in conjunction with backcountry cabins.
- Natural Environment Zone
- Wilderness Zone

Type IV: Ski Touring Route

- Develop a system of routes over an area undefined by trail markings or grooming. The wilderness skier is a route finder, often using map and compass.
- Consider marking the route at intervals with brightly coloured wands placed upright in the snow.
- Consider planning Type IV routes in conjunction with backcountry cabins, where appropriate.
- Wilderness Zone

Layout and Length

- Locate ski trails in areas where the snow cover is consistent for several months. About 60 cm of snow will adequately cover rocks and logs. Steep, open, south-facing aspects are the first to lose their snow. North-facing aspects are more exposed to prevailing winds. Consider trail locations along the lee side of hills, in wind-sheltered valleys and tree shelter for skier comfort and to reduce drifting and wind-packing. Provide at least a partial vegetation screen on south or west facing ridges and slopes to reduce trail icing and drifting.
- Use the satellite loop, stacked loop, spoked wheel and maze forms since they provide a variety of routes differing in length and ability level to accommodate a wide range of users. Design the base loop in a trail system as the Easiest trail to accommodate novice skiers. Provide a number of routes for full and partial day use, with outer loops designed as the most difficult trails for advanced skiers. Maximize the number of one-way trails.
- Provide a wax testing and warm-up loop next to the trailhead and parking areas.
- On Type I and II trail systems, provide a flat or gently undulating open area for instruction and race starts.
- Select trail lengths in accordance with the number and type of skier and the expected type of use. Day use packed trails differ from racing trails. Backcountry packed trails or touring areas have specific but less rigid requirements. Full day use may range from 22 km for average skiers to 36km for fast skiers.
- Consider these user categories to estimate trail lengths and skiing times:
  - slow tourer 4 - 5 km/h
  - average tourer 5 - 6.5 km/h
  - fast tourer 8 - 9.5 km/h
  - racers 9.5 - 13 km/h
- Provide 3-5km long Easiest trail loops for a skiing time of about 1 hour. Provide longer More Difficult and Most Difficult loop options for advanced skiers, up to 13-15km for a 1-1.5 hour ski. Advanced skiers may travel 30-50km in an outing.
- Design smooth curves that allow rhythmic skiing. Avoid long straight sections of trail. Align the trail near attractive winter features such as open marshes, open aspen forests, or creeks.

Grades

Trail grades help categorize different levels of route difficulty. Design suitable trail gradients as a key part of ensuring safe and enjoyable skiing. Once the trail route flagging is finalized, consider cutting a 1 m centre-line to check gradients and curves. Measure grades with a hand-held clinometer. Use a basic formula of about 1/3 level, 1/3 uphill and 1/3 downhill topography in laying out the ski trail. Ensure trails closest to parking are the easiest, with level terrain. Use the guidelines for these nationally recognized categories of trails. Apply these guidelines to Type I (racing), Type II (cross-country skiing), and if desired to Type III (packed trails). Type IV trails require route finding skills and in most cases should be graded as Most Difficult regardless of terrain conditions.

Easiest

- Do not exceed a 10% maximum grade on downhill runs, ensure that the average grade does not exceed 5%.
- Make slope surfaces smooth, and curves wide and gentle.
- Design several short slopes in preference to fewer long slopes since to retain slow speeds and make climbing easier.
- Avoid descents with steep side-slopes .
- Avoid exceeding a 5m elevation gain on single vertical climbs. Limit total climbing over a 3-5-km trail distance to no more than 100 m in elevation.

More Difficult

- Do not exceed 25% maximum grades for downhill slopes. Average slope grades should not exceed 18%.
- Curves may be sharp, but leave ample room for skiers who overshoot them.
- Avoid downhill sections that let skiers accelerate beyond controllable speed.
- Allow for up to one-third of the trail to be uphill with some steep but short climbs.
- Avoid exceeding 75 m in elevation gain on single vertical climbs. Limit the maximum overall climb to less than 600 m over the length of the trail. On shorter trails over a 5 km distance, limit elevation gain to 35 m.
- Design trails between 5 and 15 km in length.

Most Difficult

- Do not exceed a 40% maximum downhill grade.
- Allow for more curves and undulating surfaces.
- Provide adequate runout distances at the bottom of steep or long slopes.
- Allow for up to one-half of the trail to be uphill.
- Limit single climbs over a 15 km distance to 100 metres in elevation.
- Design trails longer than 15 km in length, with the total vertical climb not exceeding 1,500m.

Design Safe Trails on Slopes

- Design smooth widely arcing curves on hills that will allow skiers to stay in the track. Tilt sharp curves to the inside, at a slope not exceeding 5%. Widen the trail on curves.
- Avoid sharp blind corners on steep slopes where natural hazards such as large trees or rocks are located next to the trail. End long hills with a level section to reduce speed. Provide level rest and speed check areas on long slopes. Avoid placing intersections at the bottom of steep downhill runs.
- Consider a level or uphill trail at the beginning of a trail system to allow skiers to warm up. Poor light and icy conditions may prevail in the late afternoon when skiers are tired. Place easier runs near the end section of the trail.
- Use a 3 m clearing width where grooming will be done by snowmobile, for example on Type II or III trails. Use a 5 to 6 m clearing width for Type I trails to be groomed by large specialized equipment such as the Piston-Bully.
- Allow for sufficient clearance to herring bone or side-step up hills. On slopes exceeding 10%, use a 3 metre minimum width.
- Clear to height of 2.5 m, plus the expected maximum snow depth. In coastal areas the snow depth may be 2-3 m or more, resulting in a required clearing height of 4.5-5.5 m.
- Where branches might droop under the weight of snow or ice, provide extra clearance.

Structures

Bridges

Bridges installed on cross-country ski trails increase the season of use. Small streams that freeze solid do not always require bridging.

- Design bridges wide enough for tracks and poles, and strong enough to support grooming equipment.
- Use railings if the bridges are high. Consult an engineer if the bridge span or design requires special attention.
- Use brush-filled crossings for shallow streams not requiring bridging during other seasons. Lay the brush piles across streams in late fall, thickly enough to ensure that the snow layer will be well above the water level.

Cabins

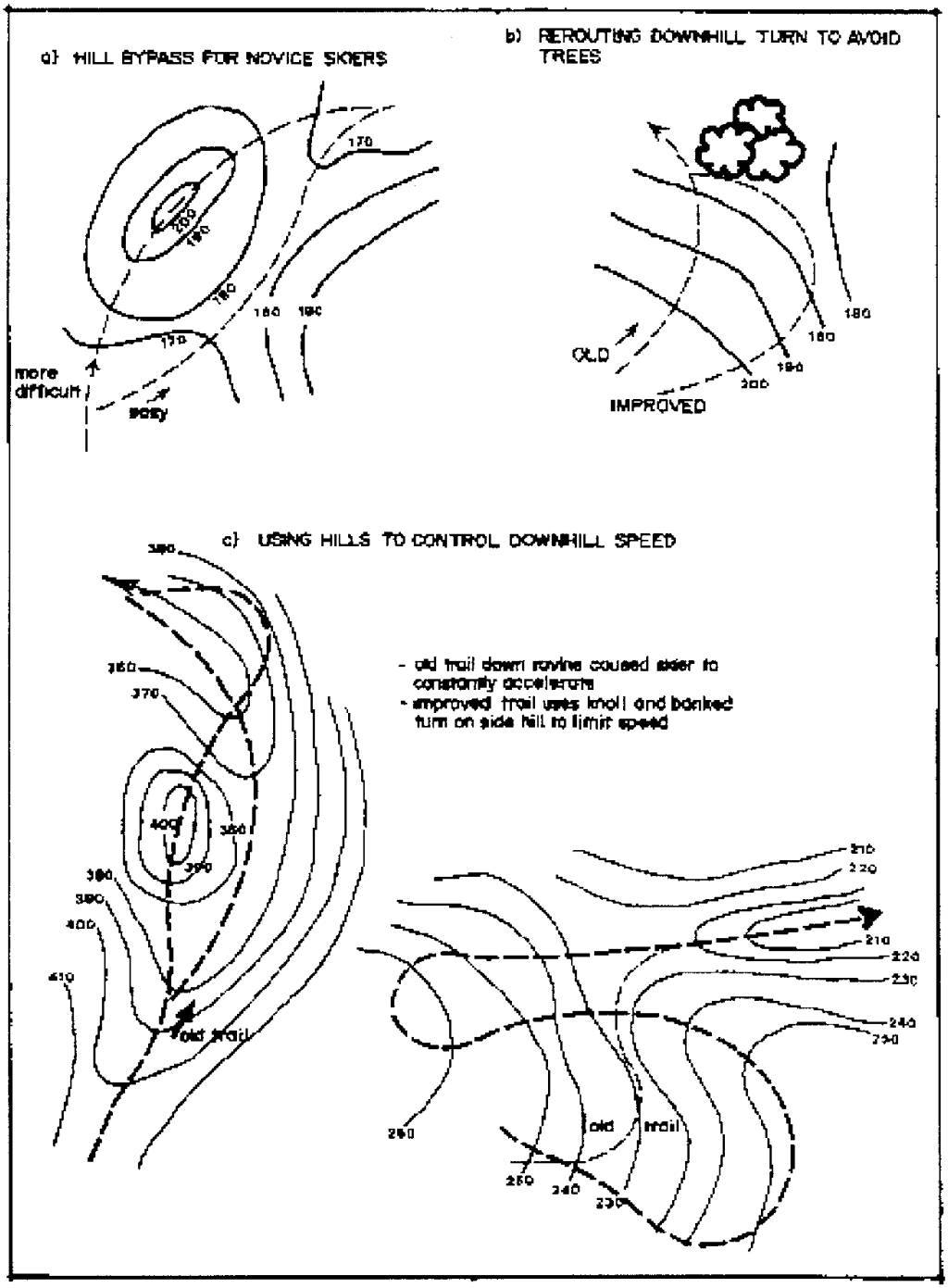
- Consider cabins or wind shelters on cross-country ski trails. Locate shelters at main trail junctions or other areas where they can be used by a maximum number of people.
- Provide accommodation at intervals which can be readily travelled in one day. The lengths of these intervals will depend on terrain conditions and skier ability. For average tourers, intervals of 15 to 20 km may be used. If adverse weather conditions are prevalent in an area, a 15 km interval is preferred for safety reasons.

Provide winter use cabins with wood stoves and sufficient storage space for firewood. In coastal or other areas with heavy snowpack, consider wood storage on the ground floor, with the winter entrance on the second floor.

Signs and Safety

- Use the international recognized sign standards for Easiest, More Difficult and Most Difficult trails. Refer to Cross-country and Ski Touring Development Guidelines - BC Parks.
- Use signs to provide information and improve safety on the ski trails. Provide information on trail lengths, layout and facility locations at the trailhead. Provide standard signs at all trail junctions.
- Provide signs at all intersections to indicate the route home, difficulty level and other information. Design trail markers to be visible in poor weather and placed them where they will not be buried by snow. Display at least two of three elements on all trail signs: the symbol for degree of difficulty or any required warnings, directional arrow, text on distance to end of trail or the name of trail.
- Avoid avalanche areas and hazardous lake and stream crossings. A minimum of 15 cm hard blue ice is necessary for safe crossing on lakes or streams. Avoid routing trails under cliffs.
- Avoid dense tree canopies, particularly in tall, old-growth stands. The canopy intercepts much of the snowfall and when temperatures rise, large chunks of snow may fall onto the trail.

Figure 3: Tips on Cross-Country Ski Trail Layout
(from Ontario Ski Council)



Plan and Clear Trails to Allow Optimum Snow Cover

- Avoid south or southwest slopes to prevent early snow loss, crusting conditions and increased maintenance costs. If south facing ridge-tops or slopes must be used, locate the trail behind a screen of trees. Provide occasional openings for views if desired.
- Avoid large open marshes, poorly drained areas, and lakes as these are prone to windy conditions, shorter season of use, and wet or icy spots. Balance these problems with the visual advantages of providing variety in terrain.
- Right of way clearing widths depend on the trail standard. Packed Trail (Type III) requirements are not as exacting as those for groomed cross-country skiing (Type I and II).
- Use 1.5-2.5 m clearing widths for Type III single-lane packed trails, up to 3 or 4m for two-way trails depending on the grooming equipment to be used.

3.5 Snowshoe Trails

- Design snowshoe trails using the same general criteria as easy hiking trails (Type I and II) or packed ski trails (Type III). Consider using backcountry hiking trails (Type III) that have moderate grades as designated snowshoe routes.
- Provide short trail loops in day use areas, for example 2-3 km.
- Separate snowshoe trails from other winter activities such as snowmobiling or cross-country skiing.
- Avoid steep sustained grades for snowshoe routes.

3.6 Snowmobile Trails

Type I

- Design trails to the highest standards of width and provide smooth gentle grades and curves for all levels of ability, focus on family use.
  Consider using horse trails and old roads.
  Design trail systems 30 - 130 kilometres in length.
- Intensive Recreation Zone
- Natural Environment Zone

Type II

- Design trails to the minimum standards of width and gradients to provide more challenging intermediate to advanced snowmobiling.
- Allow for narrow clearing widths, steeper grades and sharper curves.
- Consider using existing horse trails, old roads.
- Use Type II trails as routes through the park or to Type III areas.
- Natural Environment Zone

Type III

- Designate routes or provide open play areas with no developed trails, for example on snowfields or selected meadows where environmental impacts are minimal.
- Assume a high degree of skill and experience.
- Natural Environment Zone

Layout and Length

- Plan trails to provide access to scenic or natural recreation feature areas.
- Plan winter trail use for snowmobiling only. Snowmobiling is generally not compatible with cross-country skiing or snowshoeing.
- Use a multiple loop layout for day and partial-day use. Plan a short, easy loop of approximately 1.5 km near the trailhead and separate from the main trail system to allow space for novice riders to receive instruction as well as for groups to take turns using one machine.
- Develop loops for partial day use of 24-40 km for novices, 40-65 km for intermediates and 65-80 km for advanced users. Plan full day routes of 45-80km for novices, 80-120 km for intermediates and 120-180 km for advanced users.
- Evaluate potential winter hazards prior to route development. Consider snow depth, avalanche potential, light conditions, night use, cliffs, gates, fences or water crossings. Avoid locating trails within l0m of hazardous areas such as cliffs, boulders, embankments, kettle holes, etc. If there is no alternative route, provide signs to warn of natural hazards.
- Monitor snow conditions of the proposed route during the winter prior to trail development to identify areas of drifting. Design the trail to reflect the most adverse drifting and slope conditions expected for any portion of the trail.
- Design trail crossings and junctions at right angles and place signs for all directions of travel. Use level grades on approaches to crossings. Avoid intersecting more than two trails at any one junction.
- Note the sun orientation in relation to trail alignment and avoid, when possible, long trail sections where the sun's glare hinders vision.

Grades

- Allow for variety in the vertical alignment. Plan vertical alignment in proper combination with horizontal alignment to control speed for user safety. Stay within a 25% grade limit. Exceed this limit only for a short distances. Ensure the approaches to steep trail sections are straight and gradual. Design the trail to provide smooth transitions between gradients.
- Use a maximum sustained grade of 8% for easiest trails to 15% for more difficult trails. Do not exceed a maximum grade on short pitches of 25% for easiest trails and 35% on most difficult trails.

Clearing and Tread

- Clear easiest trails to a width of 5 m and difficult trails to 4.2 m.
- Clear all trails to a minimum height of 2.5 m. Allow extra clearing room for drooping snow laden branches.
- Allow for a groomed width of between 3 m and 3.6 m. Design turning radii no tighter than 7.6 m.

Environmental Protection

- Locate trails in areas where acceptable levels of environmental impact are expected.
- Avoid locating snowmobile trails near critical winter or spring habitat for large mammals. Pay particular attention to sheep, goat, moose and caribou habitat. Avoid raptor nest sites.
- Avoid spring wildlife travel corridors.
- Avoid locating snowmobile trails in areas where a lack of snow may cause vegetation damage. Avoid south facing slopes where snow melts early.
- Locate trails to avoid or minimize noise or engine exhaust fume effects on other winter users, such as cross-country skiers or snowshoers.

3.7 Special Trails

Multi-use Trail Types

- horse-foot trails
- foot-bicycle trails
- bicycle-foot-horse trails
- ski-foot/horse trails
- snowmobile-ski trails

Recreation activities on trails change over time. Hiking trails may now be in demand as mountain bicycle routes, or ski trails. Each type of trail has specific standards, but some of these standards are suitable for different activities at different times of the year. For example, Type I and II cross-country ski trails may be suitable Type I or II bicycle trails. Problems arise when trail standards and user expectations are not compatible.

When considering multi-use trails think about:

- the park management zone objectives,
- the potential additional maintenance costs of different kinds of uses,
- the safety of users,
- the potential for user conflicts if the reasons for using the trail are different,
- how multiple use would affect the “limits of acceptable change” standards.
- Reduce potential conflicts in multi-use areas by providing separate routes in critical areas. Use detour trails around fragile areas and provide separate campsites for different types of users, such as hikers and horse riders.
- Consider using trail design as a zoning tool to manage multiple use trails. For example, change the surface treatment from crushed stone to natural soil where the road bicycle zone ends.
- Avoid foot-horse or bicycle-foot trails in hazardous areas such as cliff edge routes, or very steep exposed ravines. Widen multi-use trails along any hazardous sections.
- Avoid blind curves on multi-use trails. Widen curves to allow pedestrian safe passage.
- Avoid joint hiker-horse trails near hiker water supplies, such as creek crossings or campsites. Ensure horse crossings are well downstream of hiker crossings.
- Avoid joint use ski-snowmobile trails as these two uses are generally incompatible. Where access routes are limited, use is light, and trails are wide, consider joint use where ski tracks may be set to one side.

- Avoid ski and snowmobile trail crossings if possible. Where crossings are required, ensure good sight lines, level crossings and right-angled intersections.
- Separate ski and snowmobile trails with topographic or vegetation buffers to reduce noise and diesel fume affects on skiers.
- Consider using wide graded ski trails for summer horse or bicycle use, since these types of trails are often better able to withstand use impacts.
- Use old road beds for multiple use trails.

3.7.1 Interpretive and Wildlife Viewing Trails

Summary

- use interpretive planning principles,
- link the trail to the park interpretation plan,
- determine the interpretation objectives, themes and storylines,
- decide on the type of trail:,
- determine layout and design criteria,
- let the interpretive features and the projected users determine the trail layout and length,
- avoid use by bicycles, horses or motorized vehicles,

Type I: High Profile Interpretive Trail

- plan Type I trails for high profile frequently visited interpretive features such as Liard Hotsprings, or Manning Park's Sumallo Grove,
- design and construct the trails to Type I or II Foot Trail standards with a "stand alone" custom designed interpretive sign component,
- plan trails between 100m-2km in length, and allow for walking times of 5 minutes to 1 hour. Remember that 10 minute to 30 minute trails are popular walking times for day use or points-of-interest trails,
- use guidelines for barrier free access.

Type II: Post and Pamphlet Trail

- plan Type II trails to interpret unique or typical features in the park,
- design and construct these trails to Type II Foot Trail standards,
- provide pamphlets, trail guides and numbered posts to communicate the interpretive stories,
- provide a box to distribute interpretive pamphlets,
- plan trails between 1-3 km in length.

Type III: Interpretive Walking Trail

- plan Type III trails to interpret the park relative to ecosection representation, geology, wildlife, human history or other features,
- design these trails to Type II or III Foot Trail standards,
- provide a trail map that describes the park flora, fauna and human history. Reference the map and text to specific trails or areas,

Use Interpretive Planning Principles

- Interpretive foot trails provide an experience that enriches the user's understanding of the natural, cultural or historic features of the park. Interpretive trails allow for maximum interaction between the users and the environment.
- Interpretive trails are often self-guiding trails, that use a variety of approaches such as interpretive signs, leaflets or other methods to convey a theme and storylines to the park visitor. Most of the information communicated to the visitor comes from the environment itself. Much of the success of this communication depends on the skill with which the trail route is planned, for example, the viewing positions and the sequence of experiences. Consider the natural or cultural features as an integral part of the interpretive trail planning.
- Determine the interpretive trail audience to help decide how the interpretive message should be presented.
- Locate interpretive trails where there is an opportunity to convey several messages as part of an overall theme. Locate trails where ecological links between different elements of the environment may be interpreted.
- Develop a theme for each interpretive trail. Themes provide a focus for the various storylines that may be presented on the trail. Use interpretive storylines for trail signs or brochures to communicate meaning and relationships of the natural or cultural features along the trail.
- Design the trail to provide a logical sequence of interpretive messages.
- Minimize conflicts with other types of land uses such as playgrounds, campgrounds, or roads.
- Consider ease, comfort and safety of use. Pay special attention to special needs users and wheelchair access. Consider trails adapted for blind users where the focus is on interpreting feels, smells and sounds.

Layout and Length

- Plan the trail layout and length to communicate the interpretive message in the most effective way.
- Where sensitive features are the reason for the interpretive trail, take design, construction and maintenance precautions to minimize adverse effects on the feature.
- Adapt interpretive trails to the foot trail standards. In most cases, use Type I or II criteria in designing and building interpretive trails.
- Use a loop trail layout, with spurs and satellite loops to provide additional variety. Design the trail with many curves and natural stopping or viewing points to slow users down, and allow them an opportunity to understand interpretive stories.
- Assess the physical ability and interest level of the intended users.
- Design short campground or day use interpretive trails to provide a 20 minute to 1/2 hour walk. Most interpretive trails are about 1 kilometre in length.

Grades

- Avoid trail grades greater than 5% unless wheel-chair access is not planned. The most desirable grades are less than 5%. Avoid sustained grades more than 10%, with a maximum grade for short pitches of no more than 15% for a 30 metre maximum.

Tread

- Design a tread surface and width suitable for the terrain and type of use. Provide a 45 cm to 60 cm tread for single file trails, and 90 cm to 180 cm for walking side by side. Widen trails at sign locations or provide a separate viewing area.
- Consider bark chip or rounded gravel as a trail surface to discourage bicycle use, but remember that these materials also discourage wheelchair access. Wood chips and wood shreds have little impact on the natural environment, are quiet to walk on, and have a natural appearance.
- Use tread guidelines for other types of foot trails.

Structures

- Consider the necessity for interpretive structures, such as viewing blinds or towers, to enhance viewing opportunities.
- Design bridges and boardwalks to allow users to stop and view interpretation features.
- Use rounded or angled railings designed for leaning on.
- Provide low angle illustrative signs that do not obstruct the view and are easily read while observing the interpretive feature. (See section on signs).

3.7.2 Barrier-free Trails

Summary

- determine special layout and design requirements,
- use national standards where appropriate,

These guidelines may apply to all types of trails, although not all trails will be barrier-free. For example, Type V foot trails are not suitable for wheelchair access, but Type I and II trails may be. Apply these guidelines where access by disabled people is planned.

- Develop barrier-free trails to accommodate users who may be aged, blind or visually impaired, deaf, confined to a wheelchair, require crutches or a cane, or who have respiratory ailments.
- Adapt Type I, II and III foot trail standards for use where barrier free trails are desired. Plan the barrier-free trail to the foot trail standards, but modify the length, grades, structures and tread surface as required.

Layout and Length

- Design barrier-free trails to the highest design standards for ease of use, comfort and safety.
- Locate trails close to other park facilities.
- Use a loop trail layout, providing a 20 minute to 1 hour experience.

Grades

- Maintain grades at 0-3% and do not exceed a maximum sustained grade of 5%. Avoid grades greater than 8% over a maximum distance of 4 metres where the trail is designed for wheelchairs. Avoid trail grades greater than 5% unless wheelchair access is not planned. Provide steps on non-wheelchair trails when grades exceed 10%.
- Provide level resting areas approximately 2 metres long at the end of each length of slope. Provide level areas at all turning points on slopes.
- Slopes exceeding 5 percent are considered ramps and on some interpretive trails should have handrails. These are as much for people using crutches or canes, and for people who are unsteady on their feet, as they are for people in wheelchairs.
- Provide two handrails, the topmost for persons walking (90 cm from the ground), the lower for persons in wheelchairs and for children (75 cm from the ground). Extend rails 45 cm beyond the top and bottom of slopes. Make rails strong enough to support the weight of two or three persons.
- Handrails help persons in wheelchairs when coming down slopes because they can be used to reduce speed. Maximum grade can be increased to 15 percent if two handrails are provided 85 cm apart and 75 cm high. The surface of handrails should be smooth so persons do not scrape their knuckles if they run up against them, e.g. no projecting bolts. Use wheelstops (or low curbs) along the edges of the tread on slopes.

Clearing and Tread

- Plan for a 2-metre minimum trail width. For wheelchair use on moderately used trails, make the trails 1.2 m wide for one-way traffic and 2 m wide for two-way traffic. For minor foot trails, use widths from 60 to 150 cm.
- Use surfaces suitable for wheelchair use, such as asphalt, chip-seal asphalt, crushed stone sealed with stone dust or asphalt emulsion, compacted cinders, some types of crushed shale, decomposed granite, or boardwalk.

Structures

- Ensure bridges, boardwalks and steps are wide enough for easy passing and have secure footing under wet conditions. Use non-skid materials, with the boards laid parallel to the direction of the trail. Parallel decking has fewer cracks and edges and is easier for users with canes or crutches to negotiate.
- Provide handrails on steep or long steps. Extend the rails 60 cm past the top and bottom of steps. If these extensions are horizontal, they will alert blind users to the start and end of steps.
- Specify a smooth transition from trail surfaces to bridge decking. Where handrails are not used, install edge railings that extend beyond the ends of the bridge.
- Use handrails on slopes exceeding 5%. Such slopes are considered ramps and should have handrails. Use two handrails, the upper for walking persons and the lower for wheelchair users and children. Extend rails 45 cm beyond the top and bottom of the slopes.
- Arrange handrails so that they may be used from the right or the left, since users may be incapacitated on either their left or right side. Handrails on either side or a double handrail in the center of a ramp will be sufficient where volume of use is not high. In heavy use areas, provide a double set of handrails so that separate rails may be used for climbing and descending. Ensure the surface of the handrails is smooth with no projecting bolts.
- Place benches for resting at 45 to 60 m intervals. Provide back rests and high arm rests assist users to sit and rise more easily.

3.7.3 Portage Trails

- Compare high standard portage trails to Type II foot trails, and backcountry portage trails to Type III or IV foot trails.
- Design portage trails for ease in carrying or hauling canoes or other craft. Use construction guidelines similar to foot trails.
- Select a portage site with a safe and smooth landing, preferably with sandy or rounded gravel shoreline material. On rivers, select a site off an eddy with no upstream or downstream boulders, log jams or other obstructions.
- Clear a level landing area, large enough to hold two canoes and equipment.
- Clear a trail 1.5 m wide for portaging canoes, wider if small motorboats or rafts will be used on the route.
- Design the portage grade consistent with the type of use. On heavily used portages, canoes may be dragged over the route on wheels. Provide grades less than 8%-10% maximum in these routes. On remote wilderness portages, canoes will likely be carried by one or two people. Provide grades as level as possible and not exceeding 15-20% over short distances.
- Avoid sharp corners that would prevent easy walking and turning with a 5.5 m (18ft) canoe.
- Specify cutting all stumps flush with the ground and protruding branches flush with tree trunks.
- Provide resting posts, where a canoe can be braced at an angle by single portagers. Alternatively, clear a large branch about 2.5m off the ground to allow for resting the bow of the canoe

4.0 Trail Signs

Refer to other sections for sign information. During the trail planning stages consider the inclusion of:

- trailhead signs
- en route direction signs
- information signs
- hazard signs
- interpretive signs

- Minimize the number of trail signs.

- Match the type of sign to the recreation and natural setting. For example, use subtle, less intrusive signs in wilderness areas, more prominent signs in high use areas where warnings or regulations may be important.

- Follow established sign design principles for ease of reading and comprehension. Minimize wording on trail and interpretive signs.

- Consider pictorial and symbol signs in place of verbal warnings.

- Consider low, ankle-level signs to help prevent trampling of vegetation or disturbance of artifacts along trail routes.

- Use international or national standards and symbols for signs. For example, use standard Cross Country Canada signs for cross-country skiing trail signs. See Cross-country and Ski Touring Development Guidelines - BC Parks.

5.0 Related Trail Facilities

Refer to other sections for detailed information on related trail facilities. During trail planning and design, consider:

- parking
- toilets
- bear resistant waste containers
- water supply
- self-registration kiosks
- picnic shelters
- warm-up huts
- accommodation huts
- viewpoints
- benches
- campsites
- bear resistant food storage
- horse corrals, hitches
- bicycle racks

- Match the facility design to the park management zone.

- Consider maintenance requirements of trail facilities, for example wood supply and storage at warming huts.

6.0 Trail Construction

Summary:

- select and prepare equipment,
- work methodically,
- clear the route,
- select a tread surface,
- construct the tread,
- select trees for use in construction,
- clean up clearing debris,
- select and build trail structures,
- manage the construction.

6.1 Select and Prepare Equipment

- Ensure all safety and first aid requirements are considered prior to the start of construction. Determine the hazard rating for the trail construction project. Refer to standard safety requirements manuals.

- Use hatchets, saws, axes, power saws, clippers (long-handled preferably); mattocks, hammers (for nailing markers on trees), brush cutters. Some people prefer to use the back of a hatchet instead of a hammer since the hatchet can also be used for removing small branches which may obscure the marker (thus enabling one to do two things with one tool).

- Sharpen all tools and ensure they are in first-class condition. Carry an extra saw blade for Swede saws, and files for sharpening tools. Power saws require extra gas (mixed with oil), extra oil for the chain, tools to tighten the chain and a round file for sharpening the teeth.

- Supply a First Aid Kit. Leaders must impress upon all participants the hazards involved, and ask them to use extra care.

- Use work gloves and other protective wear such as hard hat, face and ear sound protection when using power tools.

6.2 Work Methodically

- Work in small groups, spread out along the marked route, and work carefully from one marker to the next. If everyone works in the same spot, there is more risk of injury.
- Emphasize thorough work, not speed, even if this means coming back to finish the job.
- In open areas with dense undergrowth, clear the trail route of shrubs before cutting large trees. This allows for safe and easy movement when felling and limbing trees.
- Avoid disposing of debris in a haphazard manner. Make use of it.

6.3 Clear the Route

- Match the trail clearing and tread width to the type of trail.
- Stake the trail route from start to finish. Stake the centre-line for minimum standard trails and both sides of the trail for higher standard trails. Place the stakes to define the trailbed and clearing limits.
- Before full excavation and construction take place, clear and excavate a narrow work path from the outside stake towards the centre-line. This path establishes the grade and excavation line for the rest of the trailbed. If alterations are needed, less time and damage is done than if the entire trail width is graded.
- Clear vegetation to provide safe and unimpaired movement along the trail. Remove adjacent shrubs and small trees that will quickly grow back into the right-of-way. Remove branches that will obstruct travel. Clear branches to a height of 2.5 m on hiking and bicycling trails, higher for winter use, or horse trails.
- Cut stumps flush with the ground. Cut branches flush with tree trunks. Cut branches all around the trunk to minimize the visual impact.

- Remove ground cover plants, trees and shrubs that cannot be bypassed. Leave rocks in place unless they are numerous enough to be a hazard or hindrance. On bicycle trails and ski trails remove all large rocks and obstructions.

- Cut small exposed roots back to the trail edge to prevent sucker growth through the trail surface. Avoid cutting large tree roots that might result in a windfall hazard.

- Remove large branches by sawing in three places to prevent tearing the bark.

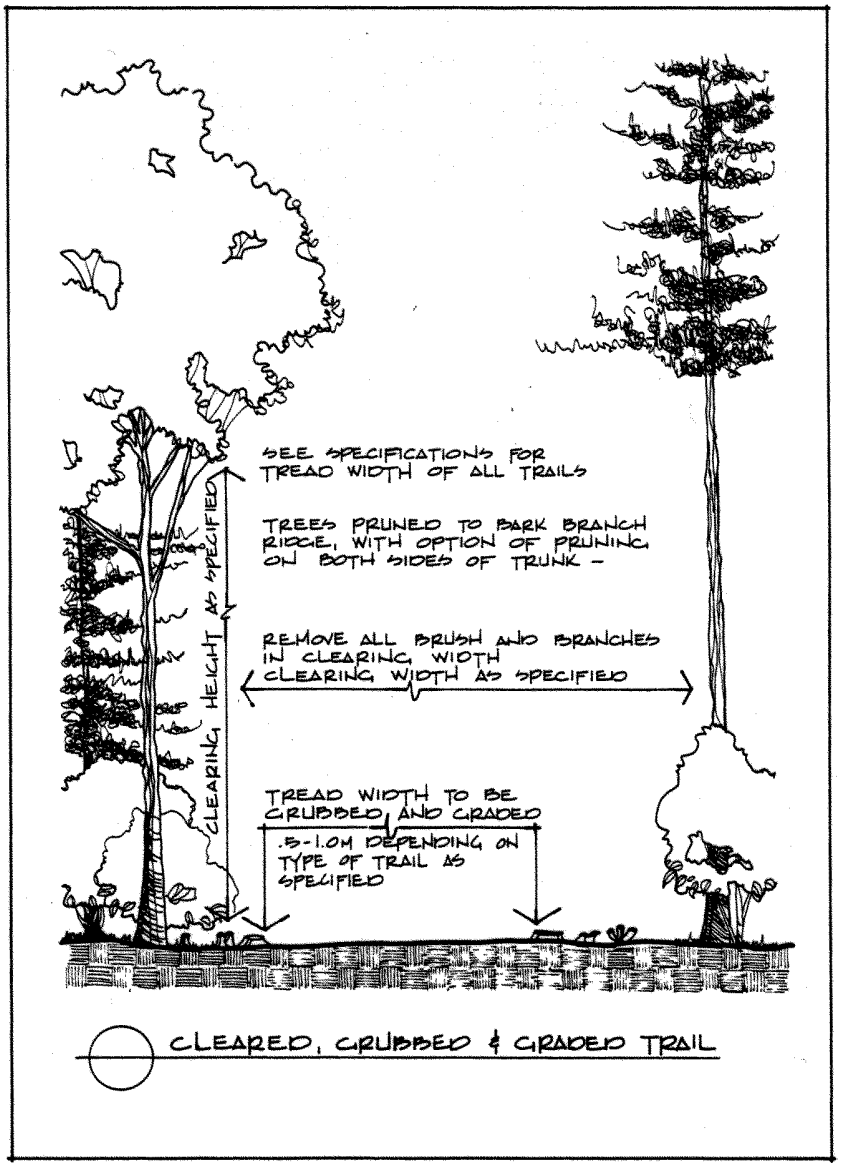
- Avoid cutting terminal buds on small trees next to the trail as this promotes lateral growth.

- Remove windfalls or cut wide sections through the trunk. On sideslope trails the upper cut should be 30 cm back from the top of the embankment. Beware of windfalls on slopes as the upper section may be hazardous if cut free.

- Remove all dangerous trees and snags that may fall onto the trail.

- Consider using selected logs and branches from clearing operations to help build up the trail tread. This is suitable for Type III or IV hiking trails but not for uses where a very firm or even surface is required, e.g. for bicycle or equestrian trails, or trails where service vehicles will be used.

Figure 4: Cleared, Grubbed and Graded Trail



Consider using selected logs and branches from clearing operations to help build up the trail tread. This is suitable for Type III or IV hiking trails but not for uses where a very firm or even surface is required, e.g. for bicycle or equestrian trails, or trails where service vehicles will be used.

6.4 Select a Tread Surface

- Bear in mind that the best tread surface is achieved by planning the trail route over the most suitable soils.

- Consider firmness, evenness, dryness, strength, and appearance in selecting the type of tread surface. Avoid surfacing requirements by locating trails on well drained coarse-textured soils. Avoid clay, organic soils or pure sand soils.

- Decide if the trail will be used by maintenance vehicles. Prepare the trail sub-base accordingly.

- If tread surfacing is not planned, retain the existing cover of native sod, organic matter and soil material. The native sod may remain intact after light pedestrian use, while heavier use will eventually result in a mineral soil tread. Remove native sod to create a mineral soil tread only if the soils are coarse-textured and stable.

- If surface material is required on finer textured soils, excavate a bed to receive the material. Apply a minimum thickness of crushed 25 mm gravel or local equivalent. Roll or tamp the surface to achieve satisfactory compaction and tread durability.

- Mix clay or limestone dust into sandy tread soils to help bind the soil particles and provide a firm walking or riding surface.

- In fine textured or wet soils provide a barrier between the granular surface material and the native mineral soil. Consider porous synthetic fabrics (such as Mirafi) that allow passage of water and yet help contain the surfacing material. Weigh the benefits of these types of fabrics against the maintenance costs that result when the fabric becomes exposed after heavy use. In very wet muddy areas, use a layer of logs or build a boardwalk.

Wood and Bark Chips

Wood chips blend well with most natural surroundings and are quiet and comfortable to walk on. They are not firm enough for bicycle or special needs trails, and scatter too easily for equestrian trails. If chips are over 75 mm deep, walking is difficult. Wood and bark shreds are similar to chips, but they require less maintenance and compact better to provide a firmer footing. The shreds bind together to form a mat-like surface that allows water infiltration and holds soil particles in place.

Wood chips do not compact well and will spread unless the tread is lined with stones or logs. On slopes the chips may become slippery when wet. Avoid using chips on a sloping tread. Chips tend to remain damp and may become slippery. Sawdust compacts fairly well but has the disadvantage of "drawing" moisture from the ground. Avoid wood chips (and shavings) and sawdust on cycling trails or trails for handicapped people.

- Consider producing chips on location using mechanical chippers and using branches and saplings cleared from the trail.

- Avoid cedar wood chips since toxic leachates could enter watercourses. Use hemlock, spruce, pine or fir chips.

- Specify small and flat chips. Use log or timber stringers at the trail edges to hold the chips in place. Alternatively, grub out organic material to create a bed for the chips. Top-dress the trail once a year to replace rotting chips.

- If a thick surface is required, use a base of crushed stone or soil cement under the chips.

Crushed Stone

Crushed stone (gravel) provides a smooth, firm, durable surface that is very suitable for trails with high use requirements. Crushed stone surfaces are more easily repaired than asphalt surfaces and the patched areas do not show.

Gravel trail surfaces are suitable for a wide range of trail activities. Clay-gravel mixtures provide a trail surface that approaches asphalt or concrete in consistency and helps reduce the spreading seen on gravel only trails.

Sorted or pit run gravel is relatively inexpensive if locally available. It compacts well and is durable and smooth. Gravel surfaces can become very dusty. Avoid attempts to remedy the situation with chemicals, such as calcium chloride (CaCl), because the chemicals will kill vegetation along trail edges.

- Grade the material to a maximum size of 20 mm mixed with smaller sizes to ensure stability. Apply gravel surfaces as outlined below:

  - remove surface vegetation,
  - apply and compact 50 - 150 mm of pit run gravel if required,
  - apply and compact 50 mm of crushed gravel,
  - grade the surface and "crown" the trail to facilitate proper drainage.

- Use 3/4 inch (19 mm) or 1/2 inch (12 mm) crushed angular stone. Avoid round stones as these will not bind well. Use rounded stones only if slow walking speeds with no bicycles or wheelchair access is planned.

- Mix the crushed stone with a binding agent such as stone fines, limestone dust or asphalt emulsion to provide a durable surface.

- Excavate the trail tread to a depth of 150 mm or as specified, place and compact the crushed stone. Use a mechanical roller or hand tamper for compaction.

Crushed Limestone

Crushed limestone is similar to gravel surfaces. Limestone is generally rolled to provide a smooth surface suitable for most uses, but must be graded regularly to maintain an even tread. Use construction procedures similar to those for gravel surfaces.

Soil Cement

Soil cement produces a hard, durable trail surface by mixing several centimetres of parent material (preferably gravel) with cement and water. When properly "crowned" this tread will shed surface water with little or no erosion. Use this surface on very heavily used trails. It is not suitable for equestrian use because the surface is too hard for the horse's hoofs.

- Use cement and asphalt to bind the soil particles and increase the durability of the existing soil.
- Improve the trail surface with a sealing coat of asphalt and stone chips. This surfacing is less costly than stone chips since relatively little material has to be imported to the site.
- Consider adding cinders to form a compact and smooth surface suitable for most types of trail activities, including special needs and equestrian trails. Through wear, the upper layer of cinders breaks down to fill the interstices in the underlying cinders, creating a durable sealed surface.
- Use surface cinders with a 15 mm or less diameter.

Asphalt

Bituminous concrete (asphalt) trails with a compacted gravel sub-base are suitable for Type I foot and bicycle trails. Although development costs are high, annual maintenance costs for paved trails are much lower than for trails with other types of surface treatments.

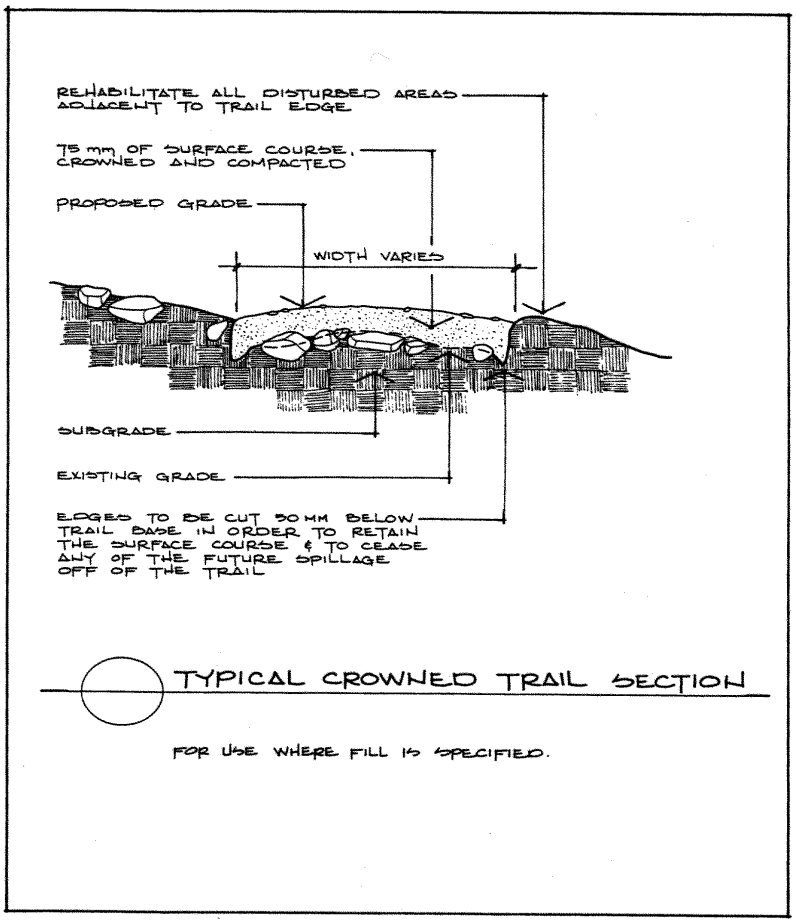
- Remove all vegetation during asphalt trail base preparation. Excavate to place a gravel sub-base of 100 - 150 mm. Crown the slope to facilitate proper drainage.
- Apply a 50 mm asphalt lift. Roll and compact as specified.
- Consider a chip-seal asphaltic surface, where a layer of crushed gravel is rolled over a base of asphalt.
- Consider a primer coat to help prevent vegetation from penetrating the pavement.

Shale and Granite

Fine, compacted shale is similar or superior to compacted gravel in wearability and construction procedures. If the shale is coarse, crush it prior to installation.

- Crown and roll the surface for a durable, water shedding surface.
- Decomposed granite provides a smooth compacted trail finish, but may become muddy in areas with heavy rainfall. Some types of granite are better suited for trails. Test the material selected prior to specifying it for a large job.

Figure 5: Typical Crowned Trail Section



6.5 Construct the Tread

- Stake the trail route from start to finish. Stake the centre-line for minimum standard trails and both sides of the trail for higher standard trails. Place the stakes to define the trailbed and clearing limits.

- Before full excavation and construction take place, clear and excavate a narrow work path from the outside stake towards the centre-line. This path establishes the grade and excavation line for the rest of the trailbed. If alterations are needed, less time and damage is done than if the entire trail width is graded.

- Grade the trail bed on slopes as required. On slopes, remove leaf litter and surface soil material from the cut-and-fill areas and save for later use.

- Select an angle for cut and fill slopes based on local soil conditions, amount of rainfall and plant cover. Ideally, retain cut and fill slopes at less than 1:1.

- Spread topsoil and organic material on large embankments susceptible to erosion to encourage vegetation regeneration. On very steep slopes, use netting material, such as jute mesh or chicken wire held in place with stakes, to hold the topsoil and mulch in place.

- Round out the top of embankment shoulders to prevent soil from sliding onto the trail. Remove boulders, logs and other debris that may fall onto the trail. Avoid disturbing plants at the top of the cut slopes and at the base of embankments.

- Trim exposed roots flush with the soil surface.

- Pitch the trail tread at 1.5-3% toward the outside edge to allow for drainage. Make the tread slightly wider in areas where sloughing of the trail edge is likely to occur.

- On talus or rubble where little or no soil is present, construct the outside part of the trail with hand-placed rocks, 50% of which are 30 cm in diameter or greater.

- Build the outside bench from rock other than those forming the inside bench. Fill all voids in and under the trailbed surface with rock and mineral soil deep enough to provide a firm tread.

- Where soils are not excessively mucky, use a layer of small branches as a trail base. Branches with dense growths of lateral twigs are most suitable, e.g. fir and spruce. Lay out branches in a criss-cross pattern to form a mat.

- Use mattocks wherever necessary to carve out the slope by pulling the earth down onto the previously placed branches and trees, and achieving the same shelf-like effect.

- For narrow wilderness trails on extremely steep slopes, wedge a log parallel to the edge of the trail, against two standing trees. Fill the gap between the log and slope with small branches, rocks and earth to achieve a "shelf" for the trail.

- Consider geotextile products for use in fine textured or wet soil areas. These are thin sheets of synthetic fabrics which allow passage of water, yet separate surfacing materials from underlying soils. These barriers increase the bearing capabilities of surfacing, because there is a greater lateral dispersion of load and pressure. Bear in mind that fabrics may become exposed after heavy use, resulting in maintenance costs.

6.6 Select Trees for Use in Construction

- Select trees for trail construction from sites not noticeable from the trail, or use trees that must be removed from the trail right-of-way. Remove bark to facilitate drying.

- Prefabricate the required dimensioned lumber in the off-season.

- Select and use wood preservatives with care, if at all. Use construction practices that can help reduce decay. Build structures so that the ends of planks, stringers and posts are kept as dry as possible, since these points are the most susceptible to decay. When constructing bridge decking on stringers, avoid overlapping the ends of the stringers to prevent contact with the sill. Use a treated wood spacer between the stringer and the sill. Also use spacers between the decking and foot railings to allow air circulation. Tilt railings and the tops of posts slightly so that water drains off.

- See also manual sections on wood structures construction.

6.7 Clean Up Clearing Debris

- Remove all construction debris from the trail areas. Dispose of vegetation debris in a way that hides it in the fall, winter and early spring, when deciduous trees and shrubs have no leaves.
- Avoid piling debris next to the trail. It is a fire hazard and is unattractive.
- Limb and drag small trees and large branches, butt first, at right angles away from the trail so that the cut ends are not visible.
- Cut up small branches and saplings and scatter at least 3 metres away from the trailbed. Ideally, screen the debris from sight and place it flush with the ground.
- Salvage vegetation for firewood or tread surface chips. Use cut trees to construct bridges, steps, corduroy surfaces or stringers for the trail tread edges.
- Avoid dumping debris down slopes. Debris is unsightly, may damage vegetation and promote erosion. Avoid clogging natural drainage courses with vegetation debris.

6.8 Select and Build Trail Construction Elements

6.8.1 Drainage

Surface and subsurface water along the trail poses problems for construction and maintenance. Assess the nature and severity of potential drainage problems prior to finalizing the trail alignment and construction method. Use several proven techniques to control surface water drainage. Consider alternative design solutions for drainage structures. For example, reduce maintenance by using drainage dips instead of culverts.

Crowns and Cross-Slopes

- Trail surface crowns shed water in two directions. Crowns are suitable over level ground or where trail ditching is constructed on both sides of the trail.
- Cross-slopes shed water to the outside of a slope. Prevent the formation of rutting on the trail by using crowns or cross-slopes.

Drainage Dips

- Drainage dips are incorporated into the trail tread during initial stages of construction by reversing the prevailing grade for a distance of 4-5 m or more. Drainage dips divert run-off from the trail tread. Drainage dips are effective, inexpensive, and do not detract from the natural setting. (See Detail #8).

Cross-drains

- Cross-drains intercept water on slopes and shed it to the outside of the trail. Construct cross-drains with log rounds, squared rough-cut timbers, or local rocks. (See Detail #14).

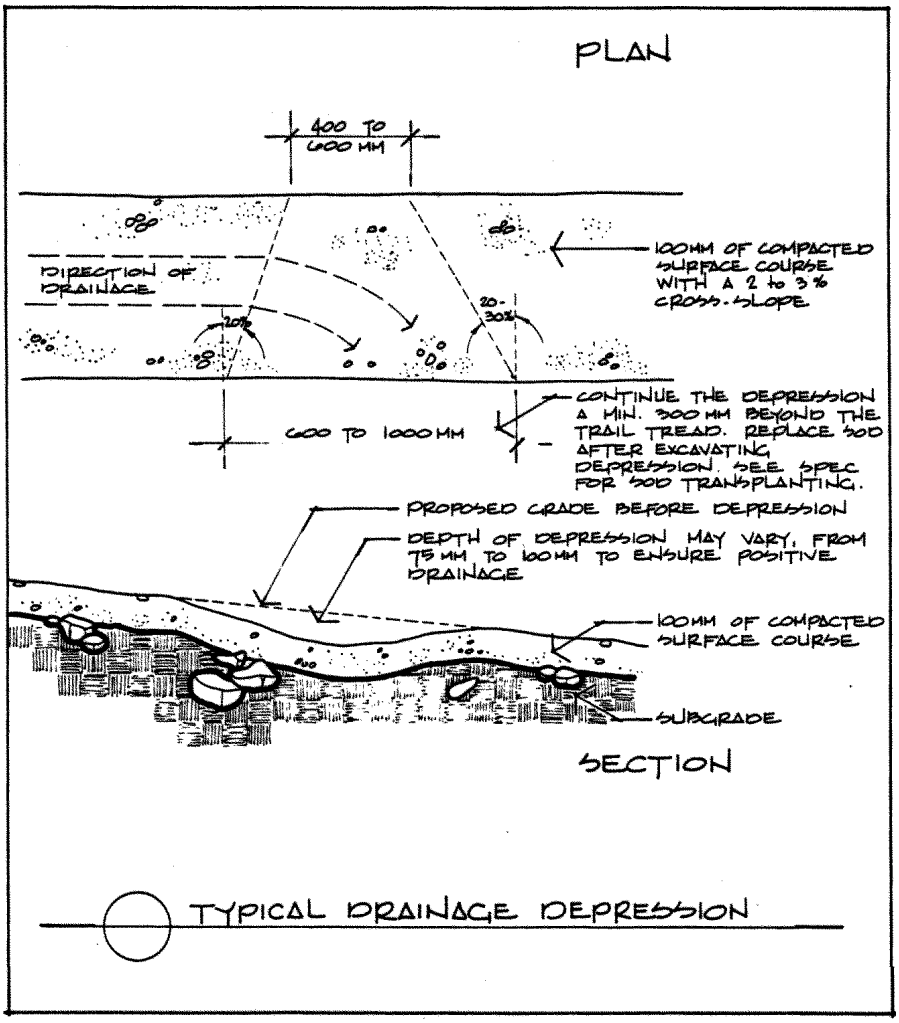
- Excavate a trench at an angle across the trail tread to place logs or rocks, Cross-drains should reinforce the correct angle and slope to allow the self-flushing of fine sediments. Place coarse granular fill or cobble rocks on the uphill side of the drain. Extend the porous material beyond the edge of the trail tread. Backfill around the drain structure as required. Ensure the drain structure is flush with the trail surface. Compact the backfill.

- Avoid the use of log cross-drains on bicycle trails, since they may have a slick surface and cause cyclists to slip.

Table 8: Frequency of Cross-drains in Metres

Material Type	Grade in %						
	2	**4**	**6**	**8**	**10**	**12**	**15**
loam	100 m	50 m	30 m	25 m	15 m	-	-
sandy clay	150 m	100 m	75 m	50 m	30 m	15 m	-
clay	-	150 m	100 m	75 m	50 m	30 m	25 m
gravel or rounded rock	-	-	250 m	150 m	100 m	75 m	50 m
shale or angular rock	-	-	275 m	200 m	125 m	100 m	75 m

Figure 6: Typical Drainage Depression



6.8.2 Bridges, Culverts and Boardwalks

- Use bridges to cross rivers, streams, wetlands or areas of shallow water that are unsafe to cross, or where uncontrolled crossing would result in unacceptable environmental impacts. Consider stream flow characteristics, bank and stream bed erosion potential, fish habitat, peak run-off periods, snow loads and ice conditions. Provide adequate boat clearance on navigable watercourses. Select a suitable bridge design based on the expected type of use, span, available local materials and location.

- Use plastic or metal culverts on small drainage ways, where drainage dips or other structures will not be adequate. Select a suitable size to accommodate seasonal high water levels, and set at a level that will not interfere with drainage. Place rocks around the ends of the culvert to stabilize the fill material and hide the ends of the pipes. Alternatively, cut the pipe ends back at a 45 degree angle to reduce the visual impact of the culvert. Place 10 cm of granular surfacing over the pipes.

- Consider rock culverts constructed with local materials. Hand place rocks in an excavated trench to form a rock-bordered channel.

Simple Bridges

- Place stepping stones across minor drainage swales and streams. Avoid stepping stones if flood conditions would make the crossings impassable.

- Construct bridges during the late summer or fall when the stream banks are dry and stable. Record the spring high water mark and build the bridge at least .5 m above that mark where feasible.

- Use one or two-log bridges where the crossing is relatively free of hazards, and the amount of use is low. On two-log bridges place the trunk stems in opposite directions for maximum strength.

- Select trees that are straight and most uniform in diameter and with the least amount of branches. Peel the logs.

- If the log is more than 12" in diameter at its thinner end, use one stringer. Otherwise, use two stringers side by side. Cut the corresponding notches in such a way that their sides, rather than the bottoms are touching. This will ensure a snug fit and will prevent rocking of the stringers sideways.

- Top the logs by making cross-cuts with the chain saw, two inches apart, then cutting off the sections with an axe or a mattock. Use diagonal cross-cuts 1/4" deep over the flat surface of the topped log to prevent slipping.

- Use rocks or soil fill to stabilize bridge ends.

- Limit the bridge span according to the size of the log. Ensure the log spans over the water course and extends at least 1 metre over each bank. Secure the log ends with rock rip-rap or timber cribbing. Flatten the top surface of the logs for easier and safer walking. Construct a hand-rail on bridges over hazardous crossings.

- Try to install the bridge abutments at the same level to prevent a slop across the bridge. Log bridges are slippery when wet.

Timber Bridges with Decking

- Construct log or timber bridges with decking for Type I foot trails, horse and bicycle trails. Place plank decking with 10-20 mm spacing for drainage and air circulation. Use timber wheel stops on low level crossings and hand-rails where the bridge is more than 1.2 m above the water.

- Consider using raised galvanized metal brackets to hold stringers in place and help prevent wood rot.

- Try to use one stringer span to cross creeks. Centre piers may cause debris to get caught in mid-stream, and the bridge may be swept away. If long enough stringers are not available locally, consider using a cable suspension bridge or other method. If flooding and debris are not a problem, support every bridge section longer than 4 m by a crib or gabion. Design bridges to support large mammals such as moose.

Figure 7: Single Log Bridge with Handrail

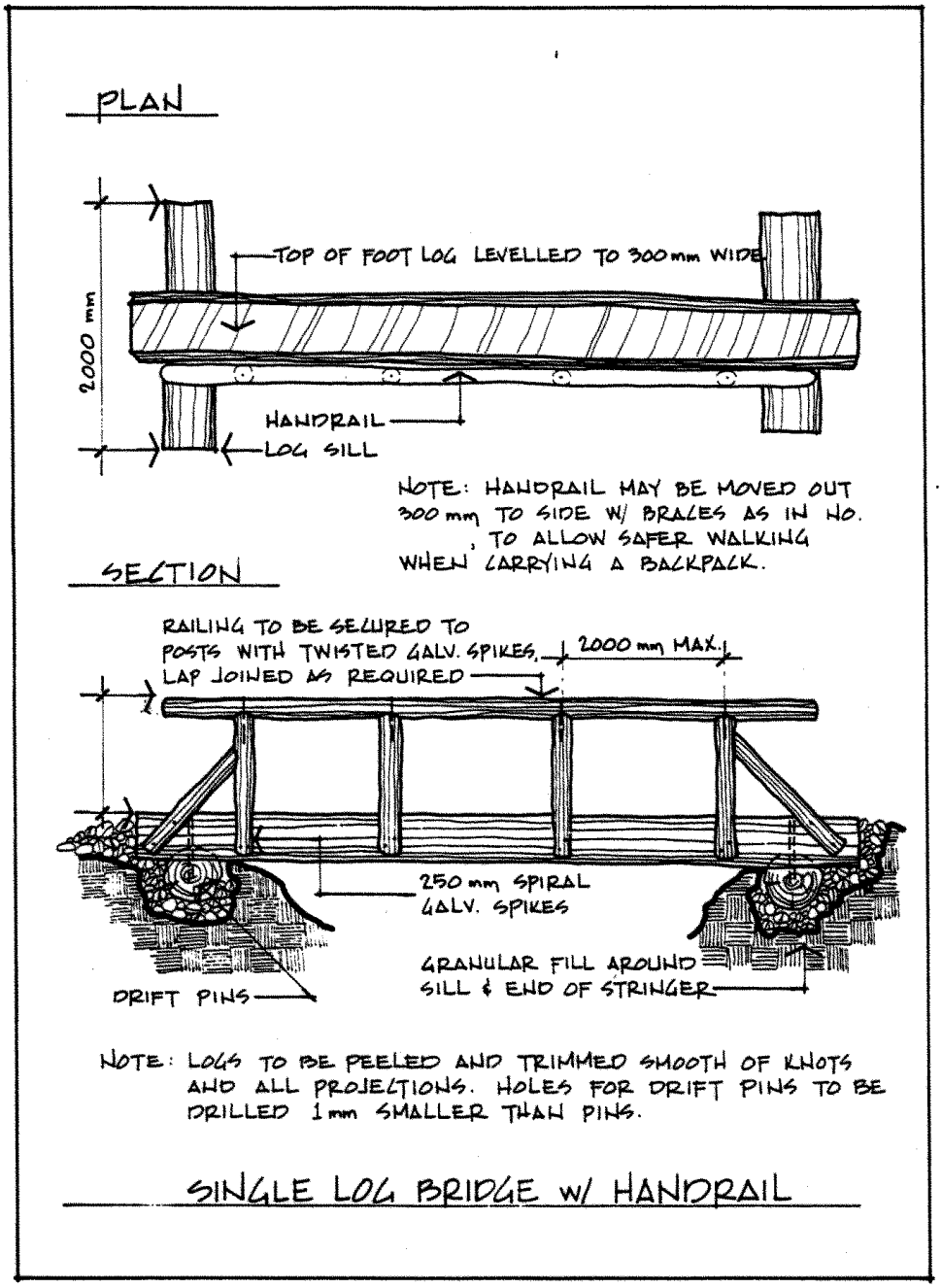


Table 9: Log Bridge Span Table

Span	Minimum Log Diameter
2 - 6 m	250 mm
6 - 8 m	325 mm

- Use custom designed bridges for spans over 5 m, or over hazardous waters. Consider suspension bridges for long spans to reduce construction and maintenance costs.

- In wetland areas, allow for adequate drainage channels and variable water levels. Place the bridge above the maximum water level.

Cordwood Crossings

- Place peeled logs directly on the ground in approximately 2.5 to 3 m sections and secure with stakes at either end. Leave spaces of at least 35 cm between sections to allow for drainage channels.

- Use log stringers or boulder edging with granular fill to contain trail trends in soft areas. This is called a turnpike: the parallel placement of peeled logs (min. of 20 cm) with a 15 cm lift of rock placed in between for the tread surface. Depending on the type of trail use, place the logs either two or two and a half metres apart. Secure log stringers with wood stakes and set boulders well below the surface. Use this type of tread armor where ditches are required on both sides of the trail. Turnpike structures are less expensive than puncheons or corduroys.

Stringer and Decking Boardwalks

- Avoid open water bodies, except to provide interpretive or wildlife viewing opportunities.
- In low use areas, or where soil conditions permit, place timber or log decking directly on sills. In higher use areas, or in wetter areas, construct a log or rock sill on the ground level. Secure stringers to the sill and fasten decking perpendicular to the stringers.
- If log decking is used, split the logs and lay them down in an alternating fashion, first with the rounded side down, then up.
- Use floatation devices in place of sills to cross areas of standing water. Consider air-filled drums or encased styrofoam blocks. Anchor floatation devices to the bottom of the water body.
- Alternatively, drive posts into the bottom of the water body, and secure the bridge to posts with rings that allow the bridge to float up or down depending on water levels. If water levels do not fluctuate, fasten the bridge stringers to the posts.
- Use flexible plank decking on walks over sand. This form of bridging helps to control erosion. Drill a lateral hole through each end of the planks and then string the planks together with twisted galvanized cable.

6.8.3 Steps, Ladders and Walls

- Construct steps on short, steep trail sections to ensure user safety and help prevent soil erosion.
- Provide landings between short flights of 14 steps or less. Avoid long flights of stairs. Install handrails on at least one side of the steps where flights are steep or long.
- Avoid stair flights with less than three steps since they may not be noticed by pedestrians.

- Use acceptable riser height to tread depth proportions in step construction. Use a formula where the riser height times the tread depth equals 450 cm. For example, a rise of 10 cm requires a 45 cm tread depth, whereas a 15 cm rise requires a 30 cm tread depth. Ensure tread depths are at least 30 cm or more.

- Design the steps to suit the terrain conditions, slope and intended type of trail use.

Log or Timber Risers

- Select logs or rough sawn timbers to build risers placed at grade. Excavate the route for the risers. Fasten the risers to the ground with iron rebars or connect the risers with timber supports or metal brackets. Backfill and compact the tread surface.

- To build curved steps on a slope, follow the contour of the land to minimize site disturbance. Draw a lime line to show the desired curve. Use railway ties (15 cm x 20 cm) or other rough sawn timbers for the steps. Vary the spacing according to the slope.

Steps on Stringers

- Use steps on stringers in high use areas or where rock, sand or roots make it difficult to set steps into the ground.

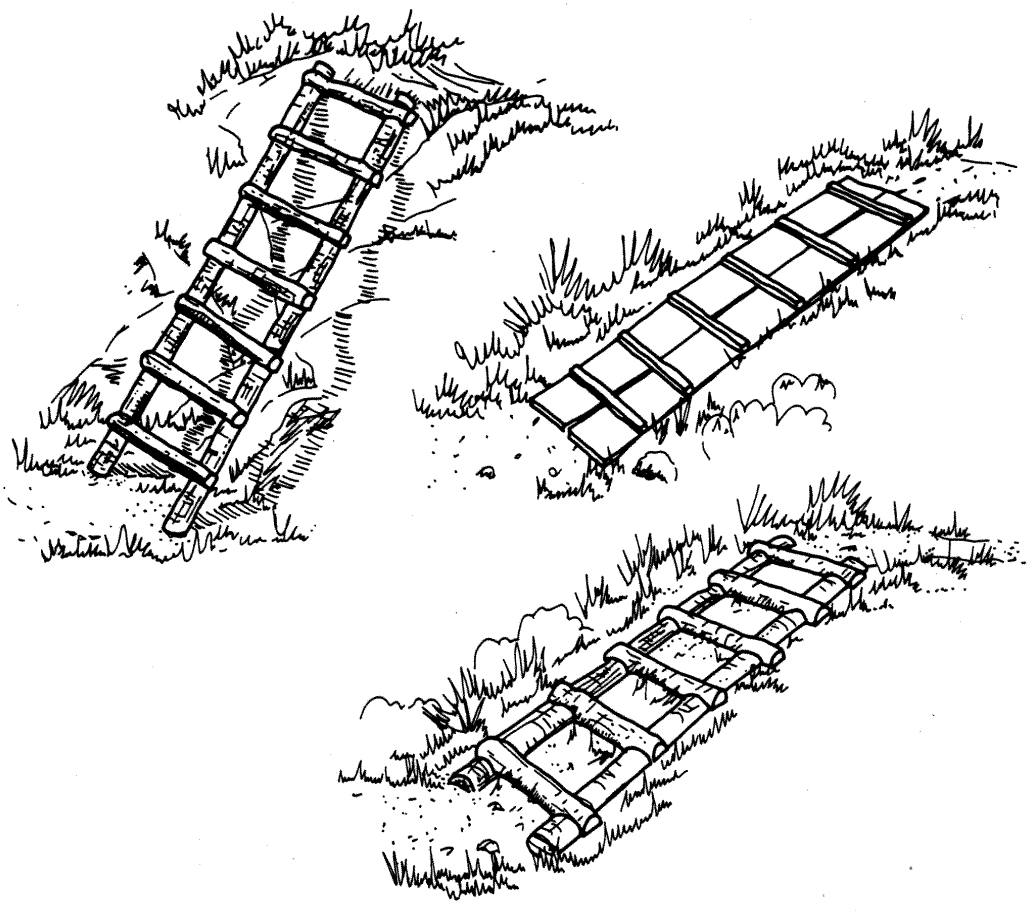
- Use rough sawn timbers and galvanized nails and bolts for all step construction.

- Consider boulder steps if local rock is available. Set boulders into the slope. Fill the tread area with smaller rocks and granular material.

Ladders

- Use ladders on trails designed for more agile hikers where grades exceed a 1:1 slope. Construct the ladder from on-site materials or build a timber slat and cable ladder.

- Use a flexible cable and wood slat ladder on sand. This form of step helps to control erosion. Drill a lateral hole through each end of the wood slats or planks and then string the planks together with twisted galvanized cable.



Barriers

- Use trail edge barriers at hazardous sites such as cliffs. Consider barriers to protect ecologically sensitive areas from user traffic or to prevent vehicle access to non-motorized trails. Construct barriers with logs, timbers, stones or boulders, depending on the availability of materials.

- Use stiles and dodgeways to form barriers that block motorcycle access to foot trails.

Retaining Walls

- Use log or drywall rock retaining walls where the leveling of necessary tread width will excessively steepen the downhill slope of the trail. Timber structures vary in complexity from a local single height log anchored with local stakes to walls composed of pressure treated logs and stakes, anchored with deadmen, up to four logs high. (See Details #26).

6.9 Manage the Construction

Summary:

- choose construction options,
- use standard contract procedures,
- consider cost saving measures.

Plan the construction phase of trail development as carefully as the design phases. Ensure that the construction practices will meet the specifications and guidelines of the design package. Poor construction nullifies good design. Well-designed and constructed trails require far less maintenance and hence reduced operation costs. Key points to bear in mind are the length of construction season, employee safety, the management of trail contractors, and performance standards.

6.9.1 Choose Construction Options

Use:

1. Parks Branch permanent or seasonal work crews, under the supervision of staff or a contract trail designer:

   - staff work crews may have specialized trail building skills,
   - staff work crews are familiar with management zones and park management practices,
   - labour costs of staff may be higher.

2. Contract work crews under the supervision of staff or design contractor:

   - capital costs may be lower if the tender is competitive, but staff liaison and supervision time may be high,
   - contract work crews may lack experience in parks or may not be familiar with the design and management intent.

3. Contract work crews under the supervision of contract supervision staff.

4. Volunteer work crews under staff supervision.

   - volunteers may be highly experienced and motivated to perform the work.

5. Job creation project work crews under staff supervision:

   - work crews may lack experience in trail construction,
   - result may be uneven between projects.

6.9.2 Use Standard Contract Procedures

- Tender trail construction contracts well before the construction season to allow time for bidding, contract award, administrative arrangements and mobilization of trail crews.

- Ensure competent supervision of all trail construction work. Monitor each phase of the work and check compliance with the design specifications. Record any deviations from the original design intent.

- Choose between full-time supervision or critical stage inspections. Suitable stages for inspections are after clearing, after tread preparation, after construction of bridges and other structures and substantial completion. Complete a final inspection after the work crew has remedied any deficiencies noted during the substantial completion inspection.

- Allow for design and specification changes to accommodate site conditions.

6.9.3 Consider Cost Saving Measures

- Pre-cut and prefabricate all structures. Fly in materials to remote areas for assembly on site.

- Fly in fill by helicopter if economical. One 45 gal. drum will hold .2 m3 or about 700 lbs (~318 kg) of crushed fill.

- In remote areas, compare the cost of flying trail fill and other materials from nearby staging areas, versus hand digging at several small borrow pits in the park. A helicopter may still be needed for local transportation, so the cost of labour may well exceed the cost of doing the whole operation by helicopter. For example, even if flying time per m3 is cut in half, the cost of two people digging out a m3 of fill, plus getting to and from the site could make up the difference in cost.

- Consider economies of scale. The cost of constructing short trail sections may be cheaper if done in-house, but longer trails may be more economical if done by contract.

- Consider splitting out certain aspects of construction to achieve cost efficiency. For example, the unit price of fill for trails could be reduced considerably if all the required fill was trucked to a staging area and transported to sites in one season's operation; even though the construction period may extend over several seasons.

- Provide maintenance for trail rehabilitation work during the establishment period. Plant in the fall to reduce this maintenance requirement since plants are past their growing season, and would not need moisture until the spring. Snow melt moisture will reduce the need for immediate watering. If landscape rehabilitation is done in mid summer, then a crew will have to water the plants unless rainfall is adequate. Maintenance during the establishment period will increase the initial cost, yet is essential to protect the investment.

7.0 Trail Maintenance and Rehabilitation

7.1 Maintain the Trail

Summary:

- set up a trail maintenance program,
- set maintenance standards,
- set up a maintenance schedule,
- assign seasonal, weekly, and periodic tasks,
- decide on labour and equipment requirements,
- use standard procedures for routine summer trail maintenance,
- use standard procedures for routine ski trail maintenance,
- check performance standards.

7.2 Set up a Trail Maintenance Program

A maintenance program helps ensure the safety of the trail user and the preservation of the trail environment. A high maintenance standard implies quick response to trail deterioration and adherence to the trail management steps using the limits of acceptable change (LAC) method.

- Set trail maintenance standards based on the "limits-of-acceptable change" approach.

- Practice environmentally sound maintenance, and use techniques appropriate for the type of trail. For example, on interpretive trails, avoid power weed cutters to trim vegetation along trail edges. Avoid the use of chemicals to retard vegetation growth.

- Prepare an annual trail management plan as part of the Annual Park Management Plan. List the total requirements for maintaining a trail to the desired standards. Base the plan on previous maintenance requirements, current trail condition survey data, a knowledge of trail volume and use, and a continuing evaluation of user requirements. Use the plan to determine budget and staff requirements for the maintenance program.

- Establish the frequency of trail monitoring based on the park management zone, the volume and type of use and on the environmental conditions of the trail route.

- Prepare a trail condition or maintenance survey report. The survey provides up-to-date information on all trail features and environmental conditions. Compile a standardized checklist, giving a clear and concise record of trail conditions and required maintenance procedures. Base the survey on the LAC approach to trail management.

- Assess the type and volume of use with traffic counter devices, trail register records and by counting the type and volume of vehicles at the trailhead.

- Consider distributing a user questionnaire on trail conditions to assist in evaluating overall impact.

- Successful trail operation depends on managing the type, volume and season of trail use in relation to the trail condition to ensure that the trail continues to meet its development objectives.

- Repair heavy use trails (Type I, II, and III) in the spring and maintain once a month during the heavy use season. Maintain winter trails after snowfalls, or as conditions deteriorate (see specific guideline below).

- Prioritize trail maintenance tasks:
  - correct unsafe conditions,
  - repair environmental damage,
  - restore the trail to the desired conditions.

7.3 Routine Summer Use Trail Maintenance

Annual Spring and Early Summer Tasks

- Clear windfalls, dangerous trees and areas where slides have covered the trailbed, for safety reasons and to prevent detouring. Slide material on trails forces users to the outside edge of the tread, which is usually on fill and is the weakest part of the trail. Once the slide material is removed, repair the trail tread to the original specifications. If a tree has fallen over a trail and cannot be easily removed, cut a gap to allow passage. On some wilderness zone hiking trails, consider leaving the tree, but chop a step into it.

- Remove loose rocks and debris from the tread surface.

- Repair trail wash-outs.

- Remove new plant growth on the trail annually. Clear in the spring and early summer when the new growth is soft. Selectively clear for views where appropriate.

- Level the trail tread as necessary and restore the tread grade to the original slopes. Use local material to fill ruts, holes, low spots or muddy areas. Refill approaches at each end of bridges, boardwalks or corduroy sections.

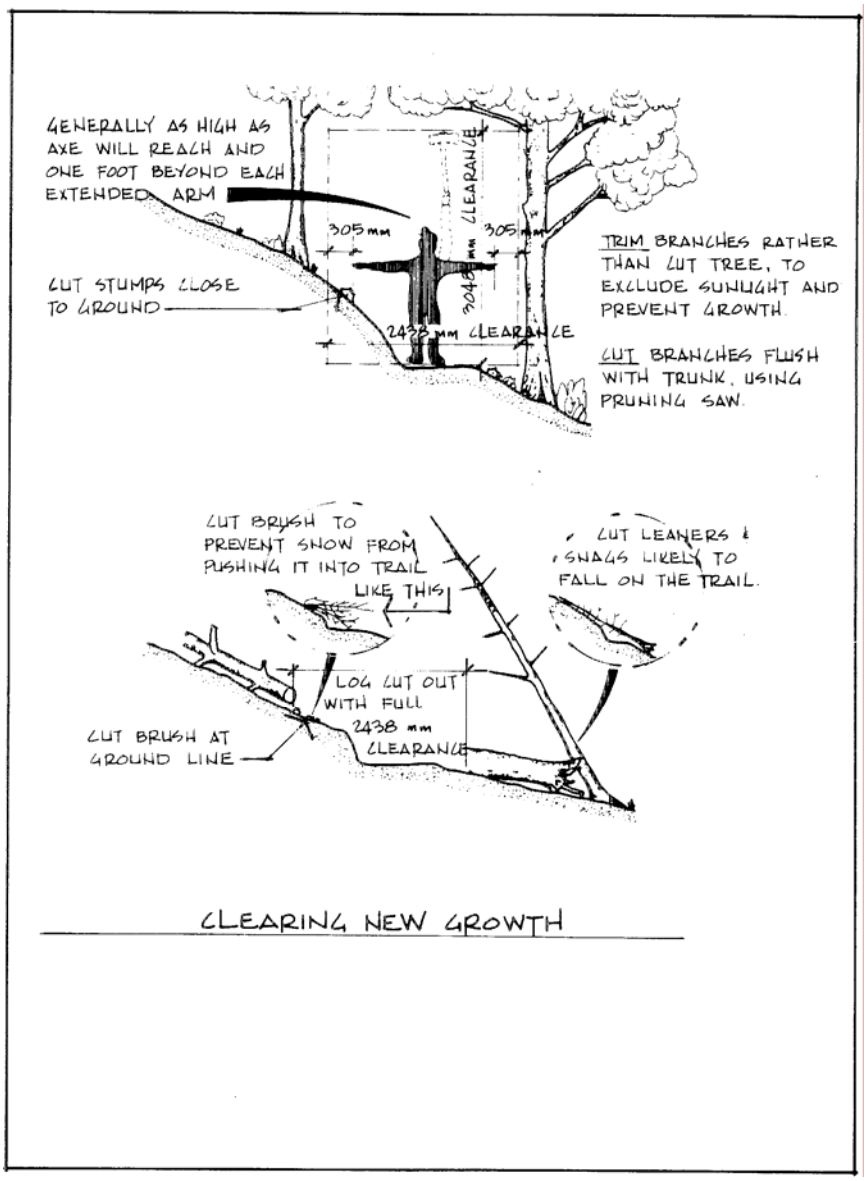
- Repair erosion-damaged facilities promptly to prevent further damage. Check for erosion effects after spring runoff. Check and repair water bars, drainage ditches, culverts and drainage dips. Construct additional drainage structures if needed.

- Check and repair all structures after spring runoff and after severe summer storms. Check for signs of rot. Remove debris from around bridge supports. Secure all loose side rails or curb logs and respike all loose decking. Ensure any structural repairs and replacements meet the original construction requirements. Remove large rocks from stream fords to help ensure a safe crossing.

- Check, repair or replace signs and trail markers prior to the major use season. Remove any vegetation that obscures signs. Provide additional signs or trail markers where any confusion on the trail route is evident.

- Re-grade the trailhead parking area.

Figure 8: Clear New Growth



Weekly or Monthly Tasks (as use warrants)

- Maintain trailhead facilities such as toilets or waste containers.
- Re-supply trailhead information kiosks with route or safety brochures.
- Remove windfall or other debris on the trail tread.

Maintain as Required

- Severely compacted soils may damage nearby plants and increase surface runoff. Aerate the soil and add granular surfacing materials to help reduce the compaction. Consider closing sections of trail to allow the area to recover.

- Consider trail hardening, boardwalks or bridges if wet and muddy areas on a trail cannot be drained by diverting the water off the trail. Repair small muddy areas by constructing a stone treadway or rock box. For a stone treadway, set large, angular rocks in the mud in a flagstone fashion with the best walking surface face up. A rock box consists of smaller stones placed side-by-side in a log frame made of peeled logs that have been spiked together. See trail construction details for boardwalk and bridge design guidelines.

- See trail upgrading and rehabilitation sections.

7.4 Decide on Labour and Equipment Needs

Two person backpacking maintenance crews have proved most effective in U.S. Forest Service trails. Tools used by two-person crews included:

- shovel
- double bit axe
- cross-cut saw (and/or chain saw)
- brush axe
- pruning shears
- trenching tool
- pruning saw
- hammer
- brush mower
- portable rock crusher

The most common trail maintenance jobs include:

- removing windfall
- constructing or cleaning water-bars
- cutting weeds and brush
- removing loose rock
- removing imbedded rock
- limbing

- tread construction
- removing leaning trees

7.5 Routine Cross-country Ski Trail Maintenance

General Notes

- Design the trails keeping in mind the type of grooming equipment that will be used. Narrow bridges, deep depressions, unsafe ice over water, and steep hills may hinder or prevent the use of some types of equipment.

- Carry out pre-season maintenance prior to the first snow. Remove windfall and undertake any tread repair maintenance as outlined in the summer trail maintenance guidelines. Remove large rocks, twigs and branches at ground level so that protruding material will not injure falling skiers. Mowed trails hold more snow than unmowed trails.

- Ski season maintenance focuses on the snow cover. For more detailed information on snow packing, tracksetting and snow grooming procedures, consult the Cross-country and Ski Touring Development Guidelines - BC Parks Branch.

- Set new tracks after a heavy snowfall. Light snowfalls will not obliterate the old track. The simplest way to reset a trail is to ski it. A good track provides a smooth level base that is sound and continuous, and is 2 to 5 cm deep.

- Use a track vehicle in high use areas to compact new snow and set tracks. Compaction helps to extend the use season since compacted snow is slower to melt in the spring thaw. If tracks become badly iced from frozen rain or freeze-thaw cycles, a track cutter helps improve them.

- Prohibit ATV and snowmobile use on ski trails. ATVs and snowmobiles obliterate ski tracks, create "moguls" that are difficult to ski across, roughen the trail surface, and cause trails to become overly compacted and icy. Walkers and snowshoe users also break up parallel ski grooves. If walkers or snowshoe users are expected on ski trails, place signs to remind them to stay to the side of the ski tracks.

Groom to Standards

- Check the trail conditions after every snowfall.
- Trail grooming and packing depends on the type of trail. It includes packing and/or setting newly fallen snow and renovating poor trail conditions, such as hard pack and ice. The amount of grooming increases with the number of skiers using the trails. After considerable use, trails become hard packed and often rutted when wet snow freezes. This makes control difficult and skiing tedious, especially on hills.
- Track setting means preparing a set or sets of two ski tracks, according to standards shown in Figure 10.
- Packing a trail with a snowmobile is easy, but there are a few tricks to producing the desired smooth trail. Pack at a slow speed since snowmobiles lose directional control as speed increases. Second, pack in several passes. Start by packing the extreme side of the trail and work towards the opposite side with each pass. Packing an entire trail width once is usually adequate. If heavy new snow means it must be done again to ensure a firm surface, wait until the entire width of the trail has been done once, then start again. Use any type of snowmobile for packing. Heavier machines set a firmer base.
- Keep the machine flat at all times or the treads will angle into the snow and leave a ditch which must be filled in before it freezes into place. On traverses, pack flat by angling the machine into the hill: stand with both feet on the uphill side of the snowmobile and lean uphill. This creates a flat trail shelf. On extra steep hills, it's sometimes necessary to shovel snow to the low side of traverses to build the trail up and make it flat. Do this before packing.
- Know when to pack. For instance, avoid packing wet snow if the temperature is expected to drop below freezing, because an unskiable frozen surface will result. When left alone, the wet snow will dry out with the drop to below freezing temperatures, resulting in loose granular, almost powder like snow. Groom the improved snow after the freeze. Packing may be necessary several times during a heavy snow storm; otherwise too much snow will accumulate and you will not be able to keep the snowmobile flat. Keep the machine flat while packing deep snow by travelling at a low speed and a constant shifting of body weight. It's easier to begin packing after 15 cm of snow have fallen, and repeat each time that much snow accumulates.

- Set tracks on packed trails when there is adequate snow cover to drag a track sled without having to worry about hitting stumps or rocks under the snow. Most track sleds work in the same manner. There are two 5 cm wide cutting blades set 15 cm apart which are mounted to a sled and pulled through the snow. The upper section of the blade is one inch wider than the lower section to allow for passage of the binding and ski boot. These blades carve two tracks through the snow about two to three inches deep. Track sleds must be heavy enough to allow the cutting blades to dig into the packed snow surface. Ensure that track sleds have enough lateral stability so that they set straight tracks. This is especially important when going downhill.

- Before setting tracks, choose a route that will avoid going over the same set of tracks twice. Parallel sets of tracks are useful wherever the trail is wide enough. On hills where skiers are likely to snowplow to maintain control, keep the track as far to the side as safely possible. Otherwise, it will be eradicated after two or three skiers snowplow over it. Set two tracks on hills, one for going up and one for coming down.

- On trails wide enough for skating technique, set the track to one side to allow a clear packed path for skating.

- Set tracks with enough room on both sides for poling without hitting brush or trees, or interfering with other skiers. This is especially important for races. Set tracks at a low enough speed that the tracks are deep enough and do not fill in with snow thrown back by the sled. On downhill runs, travel slowly to prevent snow from coming off the sled and rolling into and filling the tracks. Do not set tracks on steep hills on touring trails if they will present control problems for skiers descending.

- Increase machine speed going uphill to keep the snowmobile from bogging down. If the machine does bog down, it will dig a hole which must be filled before the track can be reset from the bottom. If possible, set tracks going down the steeper hills to avoid the problem.

- When tracks have been skied out or become iced, and when trails are packed hard or snow has melted and refrozen solid, control of skis is difficult and it's time to groom again. With proper grooming equipment, such trails can be good to excellent again without additional snow.

Use the BC Parks Standard Maintenance Guidelines

Type I and II Trails (Racing and cross-country skiing trails)

Snowpacking

- Pack the total width of the trails after the first snowfall, or after an accumulation of 15 cm of the first snowfall.
- Repeat packing when necessary to provide a solid base, and at least after every 15 cm of snowfall.

Grooming and Conditioning

- Create a smooth, level trail bed that is firm enough to support skiers and their poling action and at the same time have enough loose snow to enable a track to be set into it.
- Pay special attention to renovation of the tracks whenever icy conditions are encountered.

Track-setting

- Provide a level, smooth, hard base, with a sound, continuous track with hard sides and no sharp kinks. Set tracks 2-5 cm deep.
- Avoid setting tracks on sharp curves requiring step turns to negotiate, on steep downhills where snowplowing is required for control, or on steep uphills requiring a herringbone technique.

Type III Trails (Packed Trails)

Snowpacking

- Use a snow machine to drive over the snow after at least 15 cm of new snowfall.
- Vary the frequency of packing depending on trail use, but aim for one packing pass after every 15 cm of new snow.

Annual Maintenance

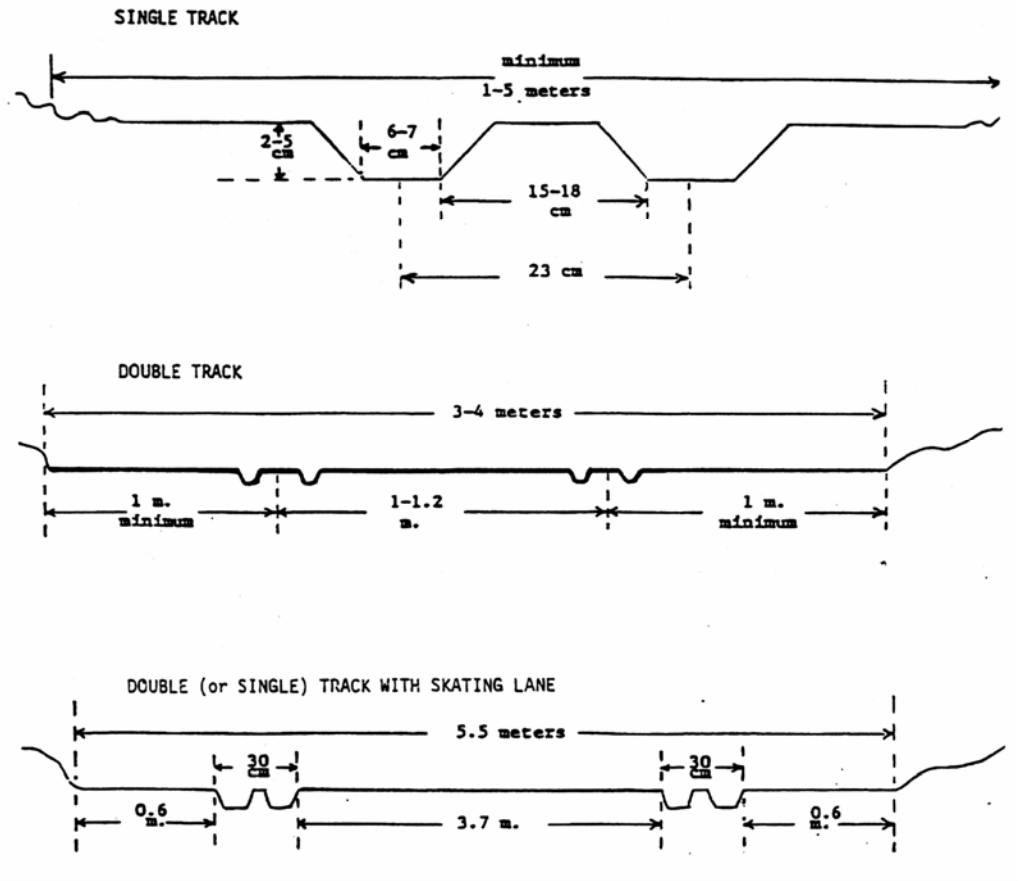
- Conduct annual trail maintenance as required.

2 to 3 Year Maintenance Cycle

- Improve and regrade problem areas over the entire length of the trail system. Assume costs ranging between 6-10% of the initial cost of construction. Maintenance tasks will include:

  - rebuilding ditches and shoulders,
  - repositioning culverts,
  - repairing or maintaining signs,
  - resurfacing or regrading trail sections,
  - repairing or maintaining bridges and other structures, e.g. painting, or replacing parts
  - removing brush.

Figure 9: Track-setting Specifications



5 to 10 Year Maintenance Cycle

Anticipate major trail upgrading, alterations or facility replacement. Assume costs between 15 and 30% of the cost of initial construction. Maintenance will include:

- rebuilding, rerouting or upgrading trails,
- repairing or replacing bridges and structures,
- replacing signs.

Be Aware of Race Standards

This is a summary guideline of Canadian Ski Association Rules and Regulations for park manager. Consult the most recent manuals for full details on race preparation.

- Lay out the cross-country course to be a technical, tactical and physical test of the racers' qualifications. The degrees of difficulty should be in accordance with the level of the competition. Lay out the course as naturally as possible, varying the prescribed differences in height, climbs, flat and downhill sections to avoid any monotony. When possible, lay out the course through woodland. Avoid locating the most strenuous climbs on the first two or three kilometres, and avoid long downhill runs during the last kilometres.

- Avoid breaking the skiing rhythm with too sudden or sharp changes of direction or by steep climbs, which force the competitors to herringbone. Lay out the downhill sections so that they can be negotiated without danger, especially on a particular fast or icy track. Locate changes of direction before, rather than at the end of downhill sections and icy bends. Avoid sharp angles and narrow passages.

- Use a mechanical track setter for national sanctioned and F.I.S. meets, i.e. Canadian Senior and North American Championships.

- Ensure the width of the trail is no less than 3 metres so that mechanical preparation is facilitated.

- If two tracks are set for classic style events, they should be at least 1.2 metres apart, measured to the middle of each track.

Use Standard Course Lengths

	Kms			
Men:	10	15	30	20
Veteran men:		15	30	
Junior men:	10	15		
Junior boys:	5	7		
Junior ladies:	2	5		

The maximum distance for our younger classes are:

	Kms
Juveniles:	5
Midgets:	3
Mini-midgets:	2

Consider Height Difference

The difference in height between the lowest and highest points of the course may not exceed:

	Metres	Kms
Mens	200	10
	250	15 & above
Ladies	100	5
	150	10

The difference in height of any single climb, without a break of at least 200 m, the so-called "maximum climb" must not exceed:

	Metres	Kms
Junior girls & ladies:	50	5
	75	10
Mens	100	

The total climb should not exceed:

	Metres	Kms
Ladies & juniors:	150-200	5
Ladies:	250-300	10
Juniors:	250-400	10
Men & juniors:	300-450	10 & 15
Men:	450-600	15
Men:	750-1000	15
Men:	1000-1500	50

Prepare the Course

- Prepare the trails before the winter so that later they can be raced without danger even with very little snow. Remove stones, trunks, roots, brush-wood and similar obstacles.

- Trails must be wide enough for skis and poles on the same level, but must also allow unhindered overtaking. The course must be wide enough for double tracks, and if mechanical track-makers are used in winter, there must be enough room to operate them. If heavy machines are used, they must keep to the original conformation of the track and not drive straight over all obstacles.

- Use a group of forerunners to ski the tracks in at least one hour before the start.

- Where changes in direction occur, stop mechanical track-making to allow racer's skating tracks to develop on the turns. On downhills at sharp directional changes do not set a track in order to allow the skiers to use alpine turning technique on the smooth trail surface.

Mark the Course

- Mark the course so that the competitor is never in doubt where the track goes. This is especially important in downhills and in turns. The competitor, on reaching one marker, should be able to see the next. In crossing fields or open stretches, insert frequent branches, sticks or stakes with bunting along the trail. Use wooden pegs or coloured strips or flags made of paper or cloth as route markings.

- Attach route markers to sticks, trees or branches at eye height or below. The marking should be done in the direction in which the race will be run. Where there may be reasonable doubt as to direction of course, marked with clearly visible arrows. Post special sign boards indicating the length of course (i.e., 15 km or 50 km).

- Mark in the following colours (or combinations in relay races):

Ladies:	Men:
5 km blue	15 km red
10 km violet	30 km yellow
20 km other	50 km orange
3-4 x 5 km red/blue	3-4 x 10 km green/yellow
	15 km nordic combined
	green

- Place kilometre signs marking every completed 5 km and mark the last 5 km of the race every kilometre, i.e., for a 30 km race, signs would read from start to finish...

  START "25 km, 20 km, 15 km, 10 km, 5 km, 4 km, 3 km, 2 km, 1 km, FINISH

Measure the Course

- Measure the course using tape or line or a wheel with an odometre.

- Include a course profile showing the topography of the course in the bid sent to the National Office prior to the race and made available to the competitors at the meet site.

- Adapt profiles off large scale topographic map or determine with survey instruments such as altimeters or levels.

Inspect the Course

- Give competitors an opportunity to inspect and practice on the course. Provide maps and profiles.

- National Championships courses shall be marked and ready for practicing 3 days prior to the day of the race. Only in exceptional circumstances may the Jury close or limit it to certain sections or hours. If closed, another course must be open for training. Competitors are to be requested to ski in the direction of the race while on inspection tour.

- All Cross Country Championship events, Junior and Senior as well as all Nationally sanctioned events requested must be approved and inspected

with respect to facilities and organization by an appointed Technical Delegate.

Provide Refreshments During the Race

- Place a refreshment station on all courses up to 15 kms at the finish; on longer courses food stations should be available to the competitors at a minimum of 5 km intervals and a maximum of 7 km intervals.

- Provide warm drinks at a temperature of 70-80 F. On no account should any alcoholic beverage be provided.

Prepare a Ski Trail Map

Provide:

- a map of the trail, with an inset map which provides regional location, identification of all access points and orientation points to the trail,
- trail classification and its designed purpose or activity, for example touring or cross-country skiing,
- the trail difficulty rating,
- the trail length in kilometres and/or time required to complete a circuit,
- the location of all potential hazards as well as points of interest along the route,
- address to write for further information on trails in the vicinity.

7.6 Monitor the Trail

Summary:

- collect baseline information for use in monitoring after trail construction,
- apply the principles of LAC,
- set up a monitoring program,
- monitor use, limit use if required,
- enforce regulations.

Monitoring is an essential part of trail management. Start the monitoring process before the trail is built or upgraded by collecting baseline information.

- Apply the principles of LAC as outlined in Section X.
- Establish traffic counter stations to monitor use.
- Use trail registers to estimate trailhead use.
- Obtain use estimates froms staff, local outdoors clubs or commercial guides.
- Provide public information on use trail restrictions, safety, environmental and social etiquette.
- Consider use zoning, seasonal or time restrictions, party size limits, user fees, permits, or other techniques if the monitoring program indicates a need to manage use levels.

Enforce Trail Regulations

- Use trail design, public education and public relations as the preferred trail regulation enforcement method. Make available the brochure, A Code of Ethics for the Enjoyment of Outdoor BC published by the Outdoor Recreation Council of BC.
- Use positive sign language in preference to a "do not" or threatening regulatory approach.
- Enforce trail regulations if other measures do not produce results.

7.7 Upgrade the Trail

Assess the Need for Upgrading

- Use the Limits of Acceptable Change (L.A.C.) approach to manage existing trails. Consider management actions to improve the trail:

  - increase environmental carrying capacity and decrease the impact on natural or cultural heritage resources,

  - harden existing trails and campsites, rehabilitate disturbed areas,

  - expand the trail capacity to accommodate existing and near term projected use,

  - consider use management once trails and facilities are used to capacity,

  - upgrade the trail where required to accommodate existing and projected use,

  - in backcountry areas, reduce water contamination risks by upgrading capacity of toilets and installing grey water disposal where appropriate,

  - provide information on wildlife/human conflicts and avoid uses that adversely impact wildlife,

  - provide improved unobtrusive signs where necessary to educate users on sensitive sections of the trail or to avoid rehabilitation areas,

  - provide improved public information on resource protection, and by avoiding use and sites that adversely impact resources.

Maintain User Satisfaction

- Plan for a maximum number of trail users consistent with acceptable predicted changes to the environment and recreational experience.
- Assess the need to place limits on party size to reflect limits of acceptable change to the environment and recreation satisfaction.
- Continue education on low impact camping and hiking methods.
- Ensure visitors know what level of use to expect on the trail, and suggest ways to avoid high use, such as travelling in the off-season.
- Consider use management when demand exceeds the desired management objectives.

Upgrade the Trail with Proven Techniques

Routine trail maintenance is outlined in the Trail Maintenance section. Trail upgrading includes tasks required to raise the standard of a trail or re-build worn out portions. These deal with the common problems of muddy and braided sites resulting from poor drainage, creek or depressed area crossings, trail sections on steep loose fluvial gravels or colluvium, trail sections over boulders and rough terrain, or steep slopes where drainage runs along the trail surface. Consider 7 main types of typical trail upgrading:

1. Fill deeply trenched trail areas to grade, keep existing preferred alignment, rehabilitate
   braids as needed,
2. Widen the clearing or trail tread,
3. Raise the trail above grade with fill, where wet conditions persist; rehabilitate braids at
   grade as required,
4. Suspend the trail above grade with boardwalk, where wet conditions persist,
5. Reroute the trail to better alignment with better drainage and grades,
6. Construct water bars and drainage ditches to alleviate trail erosion,

7. Construct bridges over creeks.

Prepare a trail upgrading and maintenance log as shown in the example from Chilkoot Trail:

Upgrading and Maintenance Log: Chilkoot Trail

Kms
65-.80 Alluvial Fan, see photos 7319, 73132.

- Place additional flat rocks at spacing that is comfortable to walk on; this should help reduce braiding.
- Annual maintenance required due to water flow.
- Consider low profile signs here or at Stone Crib to encourage hikers to stay on trail.

.80-1.60 Moraines, see photo 73140.

- Repair minor poorly drained sites with local fill.
- Assess need for additional rock cairns.
- Close one of trail braids, see photo 73140.

1.60-1.90 Large fan and meadow, see photos 73159, 73162.

- Place additional flat rocks as required to make walking comfortable.
- Place additional large rocks at creek crossing(s) to avoid braiding resulting from hikers looking for a crossing point.

1.90-2.65
- Place additional rock cairns in this section.

9410 Crater Lake-Morrow Lake, see photos 73208, 73249, 73257.

- Place additional flat rocks to define trail and reduce braiding; existing rock spacing is awkward to walk on.
- Place large rocks at braiding intersections to discourage use of alternate routes (photo 73208).
- Place large rocks at small creek crossing to discourage hikers from seeking alternate crossing points. Crossing below Morrow Lake needs attention.
- Place additional rock cairns along section where trail follows creek course.
- Set large rocks as required to facilitate easier walking in rough creek course sections.

7.8 Rehabilitate Trails

Summary

- determine which sections of trail should be closed and/or rehabilitated,
- use one of three basic approaches to rehabilitation,
- apply rehabilitation techniques suitable for the region.

Decide on an Approach to Rehabilitation

Rehabilitation pertains to repairing and/or revegetating both new and existing trails. Design new trails to minimize disturbed areas. Assess rehabilitation requirements for new trails at the design stage and salvage native plant material for transplanting during construction.

Assess rehabilitation requirements on existing trails by measuring criteria such as the amount of braided trail, the use of short-cuts, the length of wet and muddy sections, the depth of tread below the native sod layer, and disturbance to areas adjacent to trails.

Revegetation in many parks will be particularly difficult above tree line, while some sites may suffer from thin or droughty soils, winds, or heavy use. A short growing season, strong winds, thin or compacted infertile soils, and difficult maintenance conditions are some of the general constraints to revegetation in parks. A successful revegetation program will:

- set overall management objectives with respect to revegetation,
- weigh the cost of revegetation options against the likely long-term success,
- assess and design each site with respect to local conditions,
- integrate rehabilitation into overall site design and use,
- evaluate the success of each revegetation technique.

Select the most suitable rehabilitation technique from a continuum of three basic choices (adapted from Hingston, 1092):

A Do nothing except close disturbed areas; hope for natural revegetation.
B Improve site soil conditions, close area; hope for improved natural revegetation.
C Improve site soil conditions and intervene with revegetation; hope for successful plant establishment to provide rapid results.

All three approaches have some application to different sites, each with a different cost and result, as shown in Table 10.

Table 10: Comparison of Rehabilitation Options

A: Rest the site	B: Improve conditions	C: Intervene on site
- close site, - wait for natural revegetation,	- close site, - scarify soil, - place logs and brush to improve chance for natural revegetation, - consider fertilizer, - consider mulch to improve chance of seed establishment,	- close site, - scarify soil, - seed or transplant, with native species, - consider fertilizer, - water the site, - consider mulch,
- poor success rate, - very slow natural revegetation,	- good success rate, - will take time,	- good success rate, - immediate results, - may be risky on sub-alpine sites,
- no maintenance,	- low maintenance, - needs long closure from use,	- needs maintenance, - needs long closure from use,
- low cost,	- moderate cost,	- high cost,
- could be used on braided trails where there is no soil.	- suitable on some sub-alpine sites, - may be best option for cost effect.	- suitable where there is source of native plants nearby, or where vegetation will be cleared nearby, - water supply needed.

Consider Rehabilitation Options

- Use the technique best suited to each site. Option B is often the most cost effective with the least risk. Use and opportunistic approach that would use Option C methods if suitable conditions exist, when money, labour and plant material is available during site upgrading.

- Plan the rehabilitation carefully, assessing suitable species (e.g. rooting habit, nutrient and soil needs, resistance to trampling), soil preparation, planting techniques, fertilizer or water needs, mulches, wildlife impacts, season and weather for revegetation, and maintenance.

- Educate the public about rehabilitation efforts to avoid trampling of closed areas.

- Make a commitment to maintain rehabilitated sites as needed, and monitor the success of each project.

Use Proven Rehabilitation Techniques

- Consider rehabilitation only where this will not conflict with preservation of artifacts or other heritage resources.

- Use rehabilitation techniques known to work in very tough low maintenance situations.

- Try to rehabilitate in the fall, when plants are dormant, and to allow good growing conditions when there is plenty of spring soil moisture. Transplanted native sod plugs will have up to a month of growing in late spring and early summer before peak hiking season begins. Transplant during cloudy or wet weather.

- Rely on natural revegetation of prepared soil surface if local or imported native plants are not available.

- Prepare the soil by hand scarifying compacted areas. Allow natural reseeding to occur where transplanting will not be done; scarify to 5-10 cm.

- Control erosion from scarified rehabilitation sites. Consider using mulch to reduce erosion and improve the soil water retention capacity. Watch for contaminating weed species in mulch, and avoid using wood byproducts unless prepared to add nitrogen fertilizer.

- Place rotting logs or brush on rehabilitation sites, both to control traffic and provide an ongoing source of soil nutrients.

- Use local or imported native plants and seeds to rehabilitate sites. Avoid using plant material from sites with different microclimates or elevations. Use only plants adapted to the site. Select species with compact roots, that are resistant to trampling, and are known to be pioneer species suited to disturbed sites.

- Salvage native plant material from any sites to be cleared, use this material for rehabilitation on adjacent sites; salvage plugs of native material up to .5 m in diameter to increase success rate. Include all forest litter in plug transplant.

- When doing trail work, salvage native sod for use in transplanting into braids designated for closure.

- Dig up material for transplanting carefully, and replant as soon as possible, take as much native soil with the plug or raft of material as possible.

- If limited rafts or plugs of native material are available, space them out in the rehabilitation area, and allow for natural in-filling.

- Leave a small depression around the transplanted plug to collect any rainfall.

- Water rehabilitation sites thoroughly after planting, and periodically, if possible, the following growing season.

- Consider the use "please water me" signs in remote areas.

- Consider using slow release organic fertilizers when transplanting plants. Fertilizers pollute, and may not improve survival of transplanted native material. They may be more effective in promoting natural revegetation on a scarified site.

- Ensure use of rehabilitated sites is eliminated, by placing appropriate barriers, signs, and/or providing educational material at the trailhead.

- Monitor the success of rehabilitation efforts.

8.0 Cooperative Projects

- Assess the pros and cons of cooperative projects.
- Consider cooperative trail development and maintenance projects as a form of community and outdoor group partnership in park management. Although cooperative projects can take considerable time and effort to initiate, they often result in less damage to the trail and associated structures, and greater public understanding and trust in the park's mandate.
- Prepare contracts or other forms of agreements with volunteer groups to ensure continuity of understanding in commitments and responsibilities.
- Most volunteer trail work is undertaken by volunteers who are outdoor or service club members.
- Foster a partnership approach with clear responsibilities, lines of authority and communication. Respect each other's perspectives, give honest feedback and have the opportunity to say "no" or request changes.
- Prior to initiating any volunteer program, define objectives for volunteer services, and volunteer opportunities and requirements. Arrange administrative support.
- Identify a coordinator for the program. The coordinator may oversee recruitment, screening, placement, orientation, training and recognition.
- Decide on the amount and type of training required depending upon the skill required to perform the specific trail work and the skill and expertise the volunteer brings to the program.
- Use signs to acknowledge the cooperation of a group in trail construction or maintenance.

9.0 References

BC Forest Service. Recreation Manual. Ministry of Forests. Victoria, BC

BC Parks Branch. 1993. Cross-country and Ski Touring Development Guidelines. Ministry of Environment, Lands and Parks.

Canadian Parks Service (Parks Canada). Trail Manual. Ottawa, Ontario.

Canadian Parks Service. 1986. Trail and Backcountry Facility Designs. Prepared by J.S. Peepre and Associates for Environment Canada, Western Regional Office.

Canadian Ski Association, BC Division. Cross-country Ski Trail Manual: Building and Maintenance Guidelines.

Cockerton, D. 1990. Kananaskis Country Design Standards and Guidelines for Trail Systems (Draft Report). Alberta.

Colorado Mountain Trails Foundation Inc. Guide for Mountain Trail Development. In cooperation with USDA Forest Service.

Federation of Mountain Clubs of British Columbia 1989. Hiking Trail Maintenance and Basic Upgrading.

Forest Service, United States Department of Agriculture 1985. Trails Management Handbook.

Harvey, T.R. 1989. Directory of Technical Assistance Materials for Trails Development and Maintenance. American Hiking Society, Washington, D.C.

Hingston, S.G. 1982. Revegetation of Sub-alpine Backcountry Campgrounds: Principles and Guidelines. Resource Management Report Series KR-3. Alberta Recreation and Parks, Kananaskis Region.

Jarrell, T.R. 1974. Bikeways: Design, Construction, Programs. N.R.P.A. Special Publication Series No. 10022. Arlington, Virginia.

National Recreation and Park Association, Lancaster, R.A. (ed.). 1983. Recreation, Park and Open Space Standards and Guidelines.

National Parks Service, U.S. Department of the Interior. 1986. National Trails Assessment. Ontario Ski Council. Cross-country Ski Trail and Facility Design Manual. Ministry of Natural Resources, Ontario.

Outdoor Recreation Council of British Columbia. Hiking Trails: Building and Maintenance Guidelines for Volunteers 1978.

Parks Branch. 1960. Trail Standards. Department of Recreation and Conservation BC

Rutledge, Ron. 1992. Limits of Acceptable Change (LAC) Wilderness Training Manual. Recreation Branch, BC Forest Service, Victoria, BC

Stanley, R.L. and D.R. Fesenmaier. 1983. Recreation Planning and Management. Venture Publishing, State College, Pennsylvania.

USDA Forest Service. 1975. Surfacing Forest Trails With Crushed Rock. USDA Forest Service, Equipment Development Center, Missoula, Montana.

USDA Forest Service. 1975. An Evaluation of Two-man Backpacking Crews for Trail Maintenance. Equipment Development Center, Missoula, Montana.

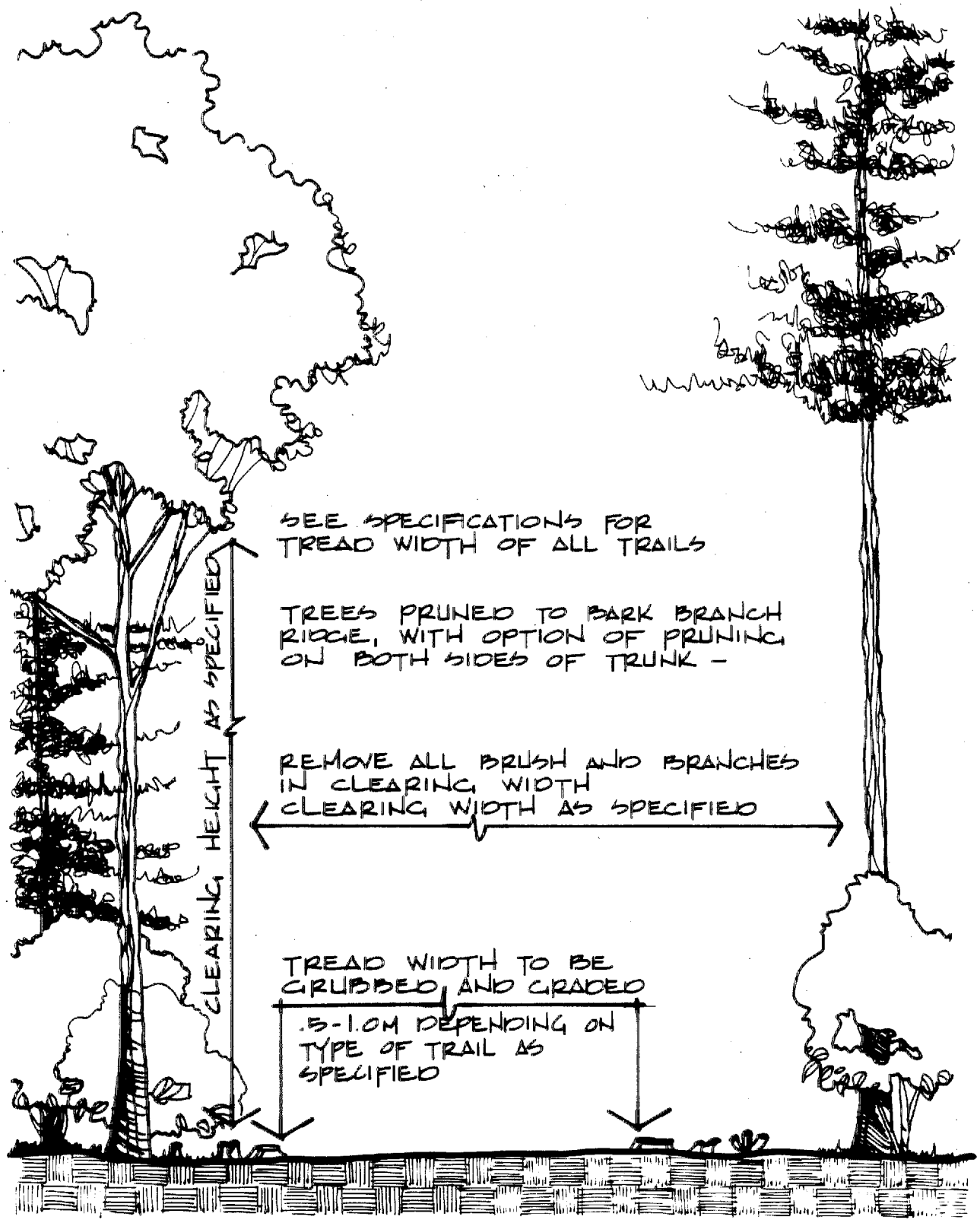
Vogel, C. Trails Manual. 1968. San Mateo, California.

10.0 Construction Details

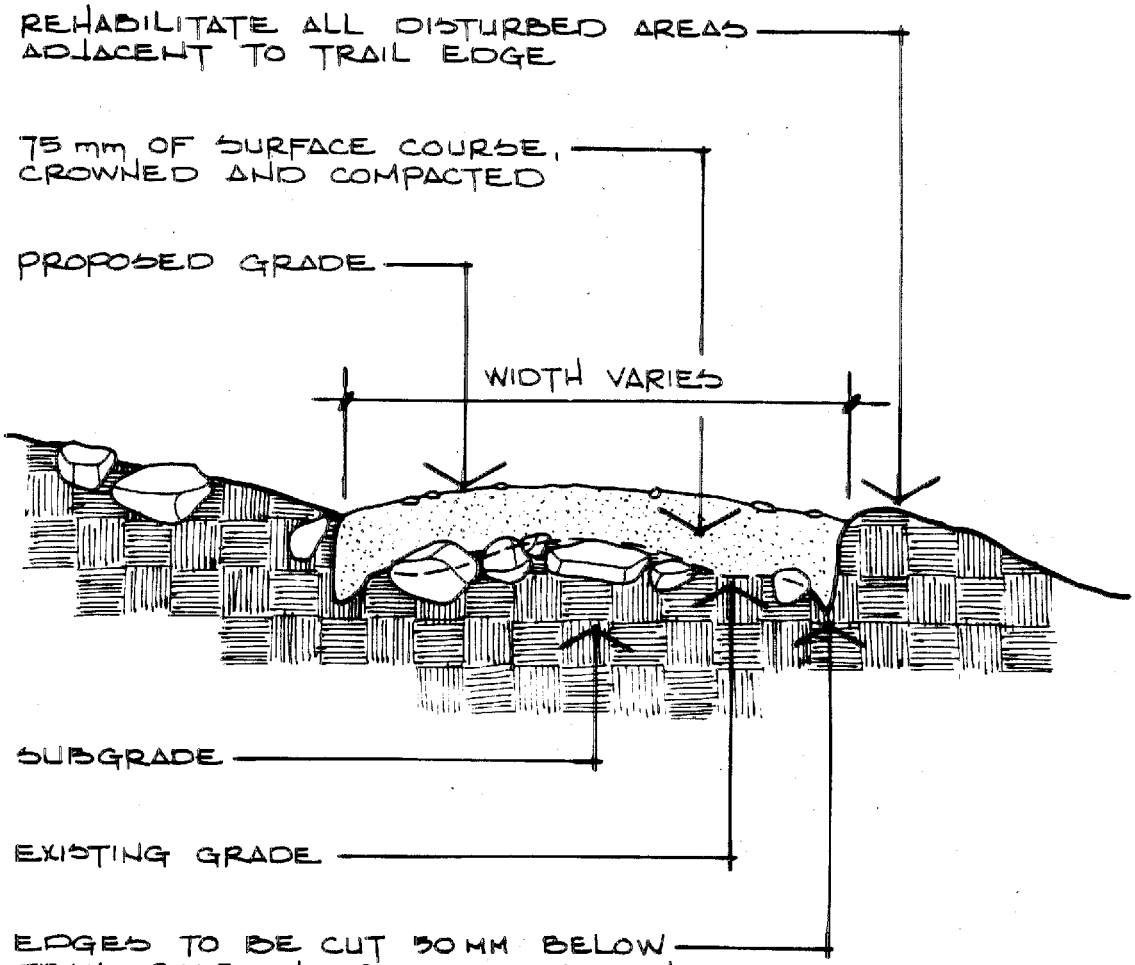
This specification could be modified as required to hand to staff or contractors to go out and build a trail.

Design and Construction Details

1. Cleared, grubbed & graded trail (level ground)
2. Typical crowned trail section
3. Trail on slope
4. Typical sodded ditch with crowned gravel trail
5. Trail construction on talus and rubble
6. Trail switchback construction
7. Typical drainage depression
8. Profile of drainage dip with rocks
9. Typical native sod ditch detail
10. Open rock culvert
11. Culvert with ditch
12. Log waterbar
13. Timber waterbar
14. Rock waterbar
15. Historic corduroy trail with option
16. Single log bridge with handrail
17. Split log bridge
18. Horse bridge
19. Log bridge with timber decking
20. Three log bridge with decking
21. Typical bridge end cribbing
22. Timber stairs
23. Timber steps with handrails
24. Ladders
25. Log retaining wall
26. Timber retaining wall
27. Dry stone wall
28. Gabion retaining wall
29. Trail closure and scarification
30. Native sod transplanting
31. Clearing new growth

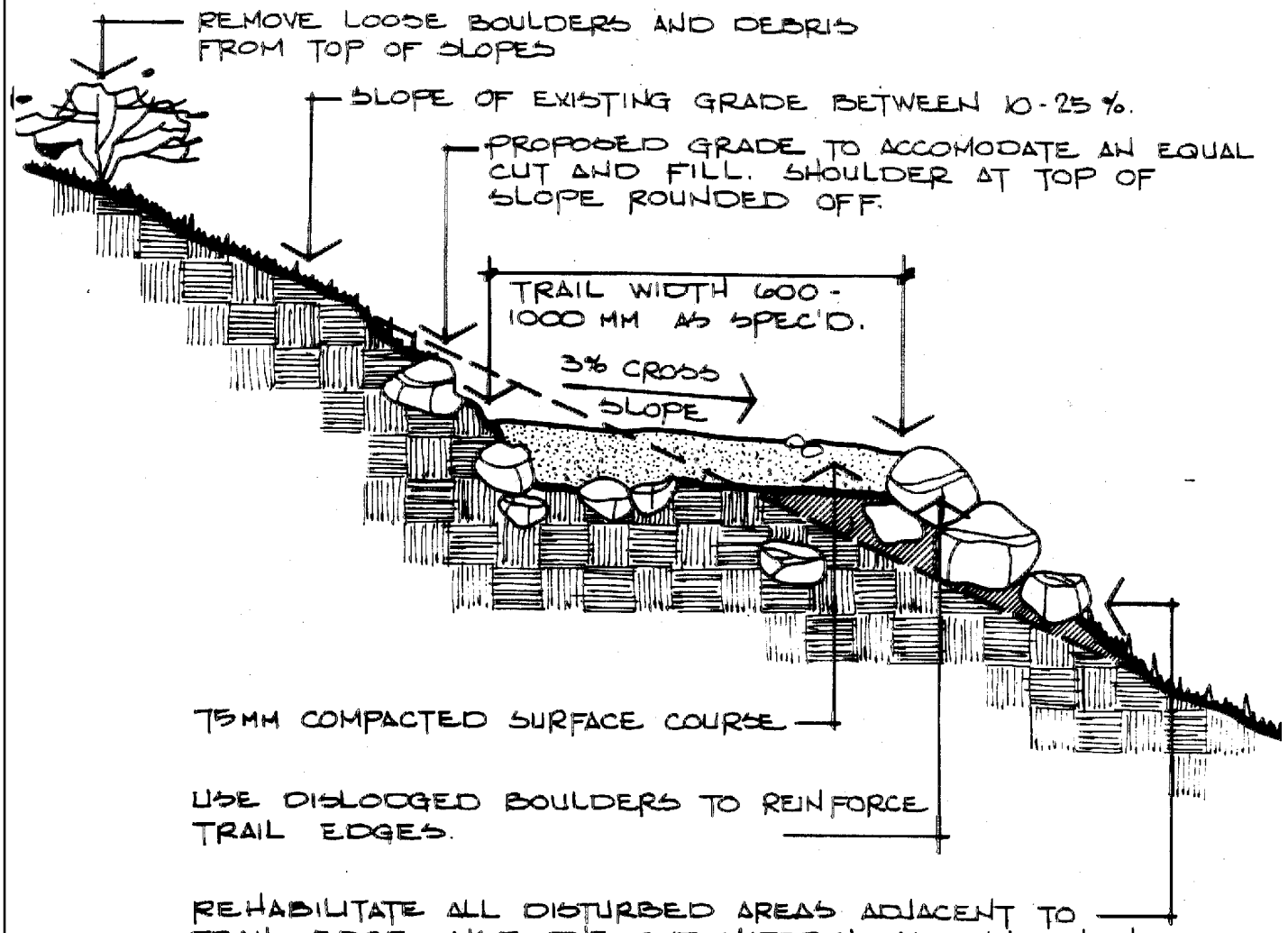


CLEARED, GRUBBED & GRADED TRAIL

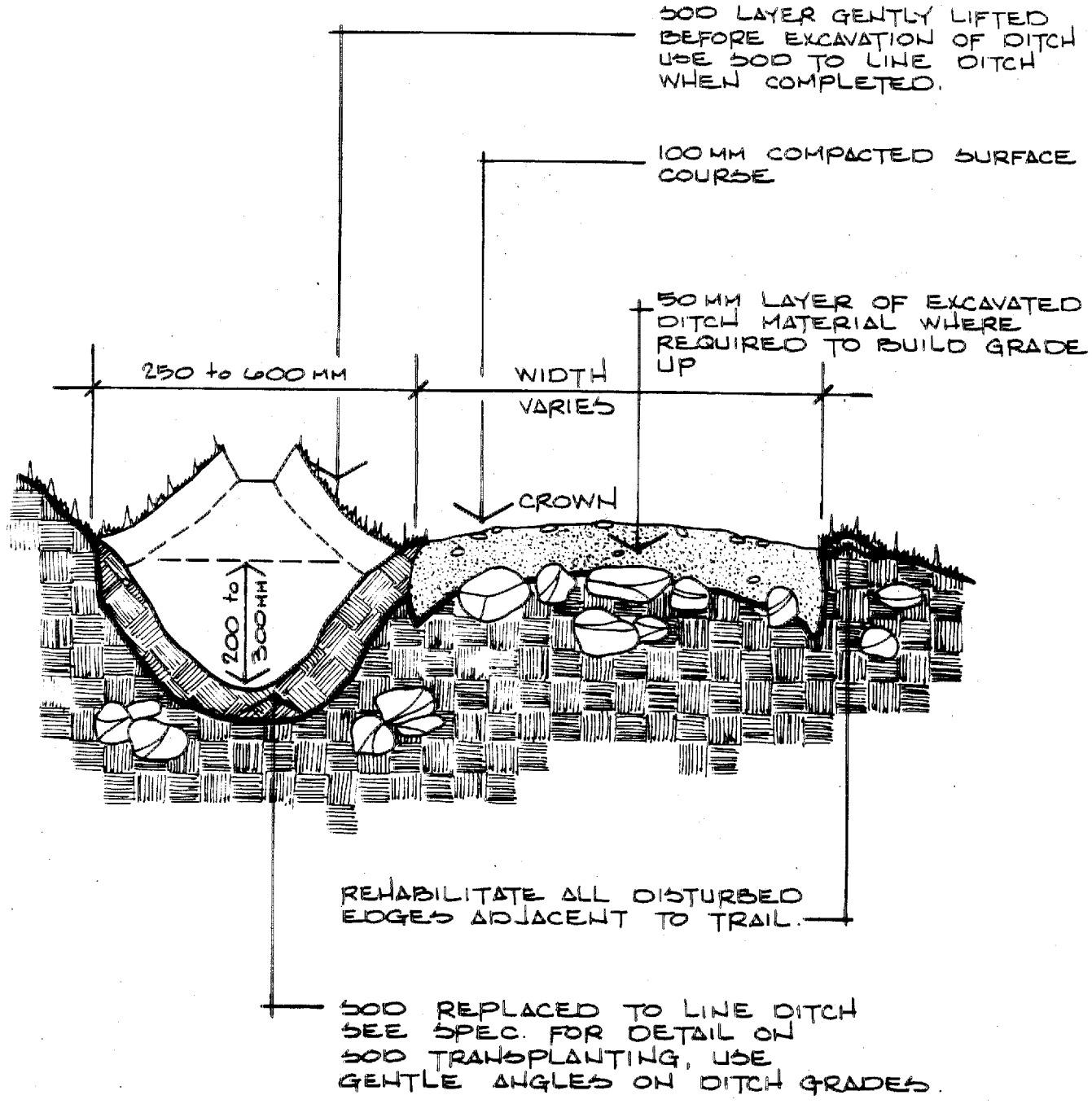


TYPICAL CROWNED TRAIL SECTION

FOR USE WHERE FILL IS SPECIFIED.

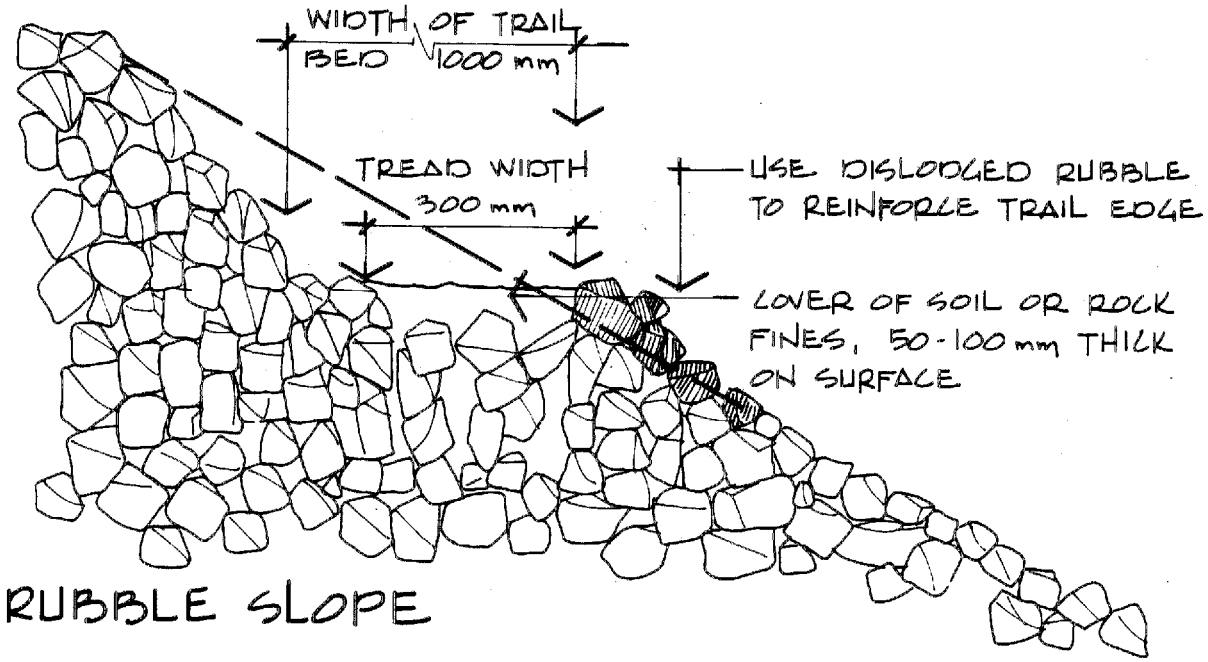


TRAIL ON SLOPE

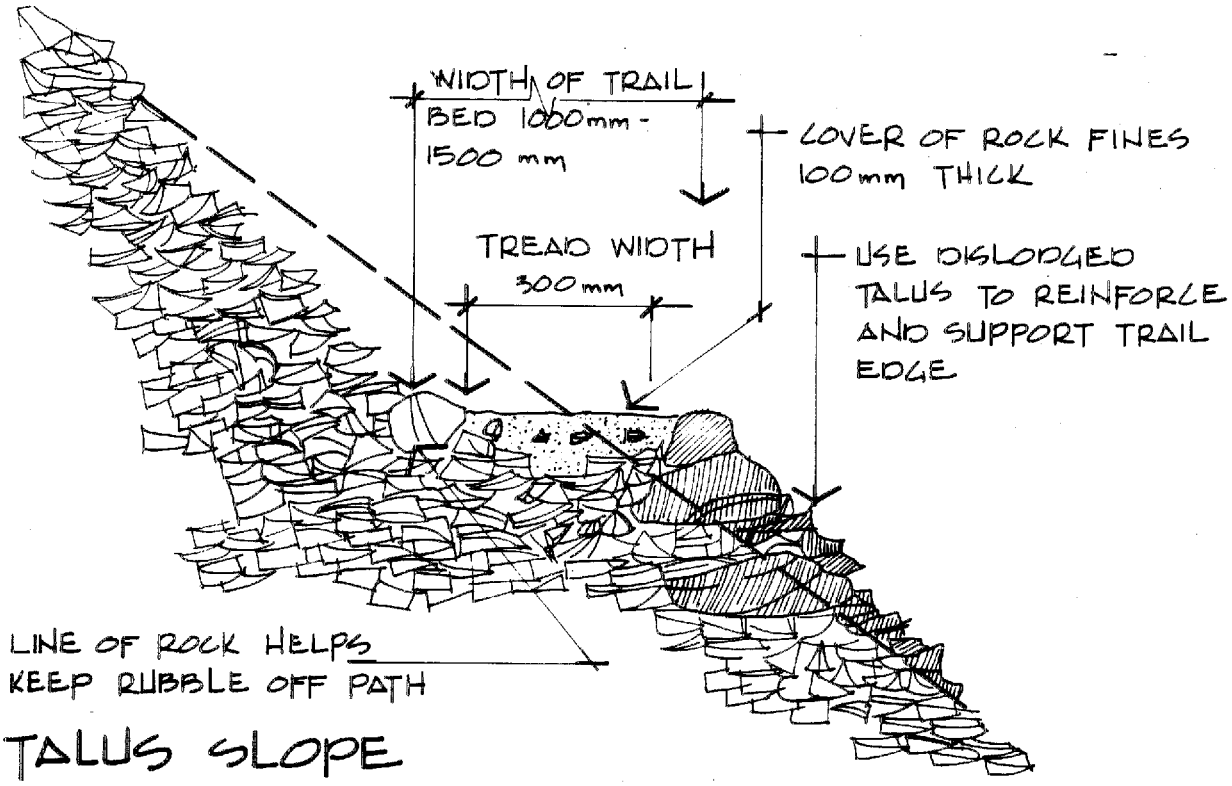


TYPICAL SODDED DITCH WITH CROWNED GRAVEL TRAIL

USE IN POORLY DRAINED SECTIONS OF TRAIL.



RUBBLE SLOPE

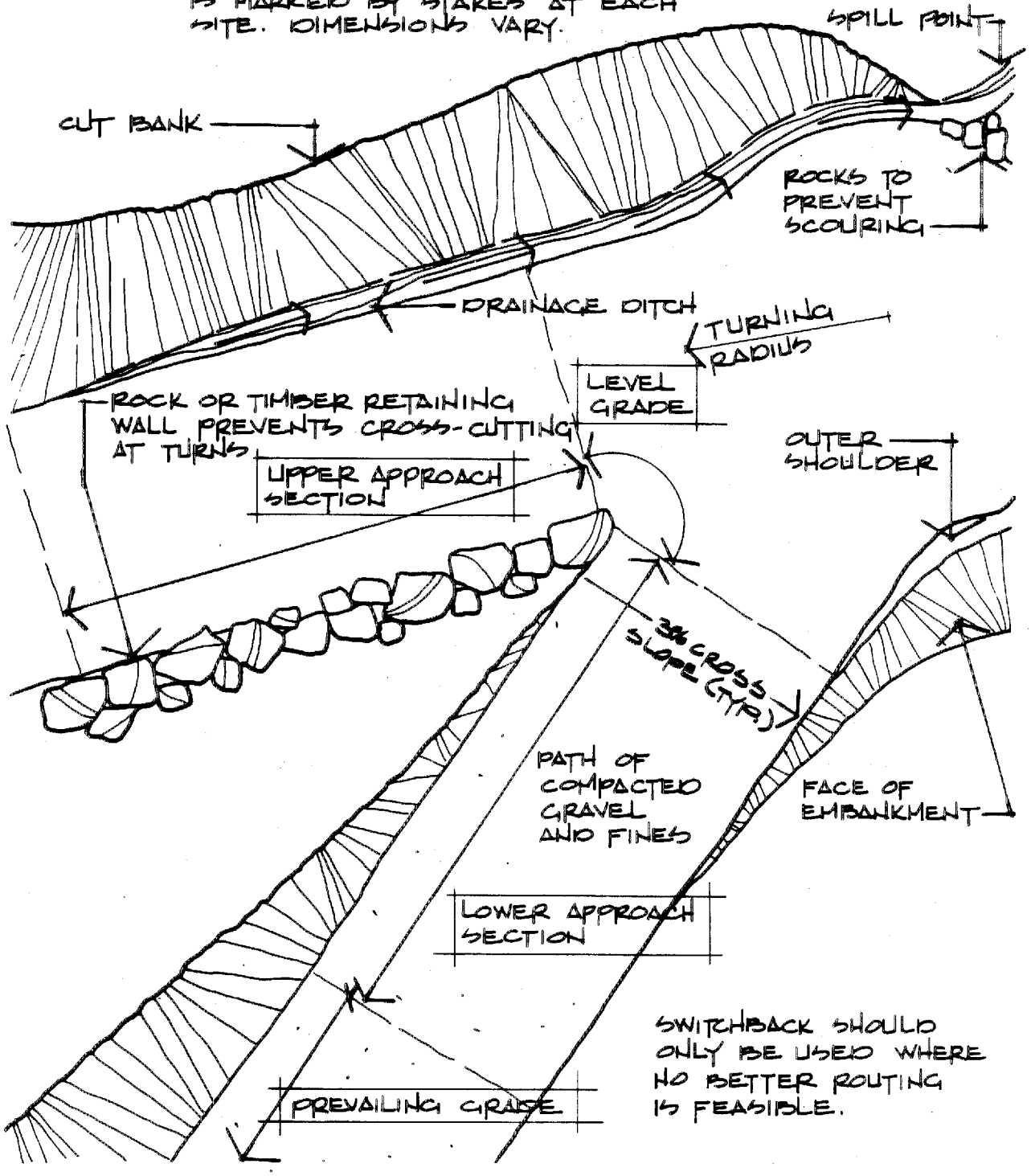


TALUS SLOPE

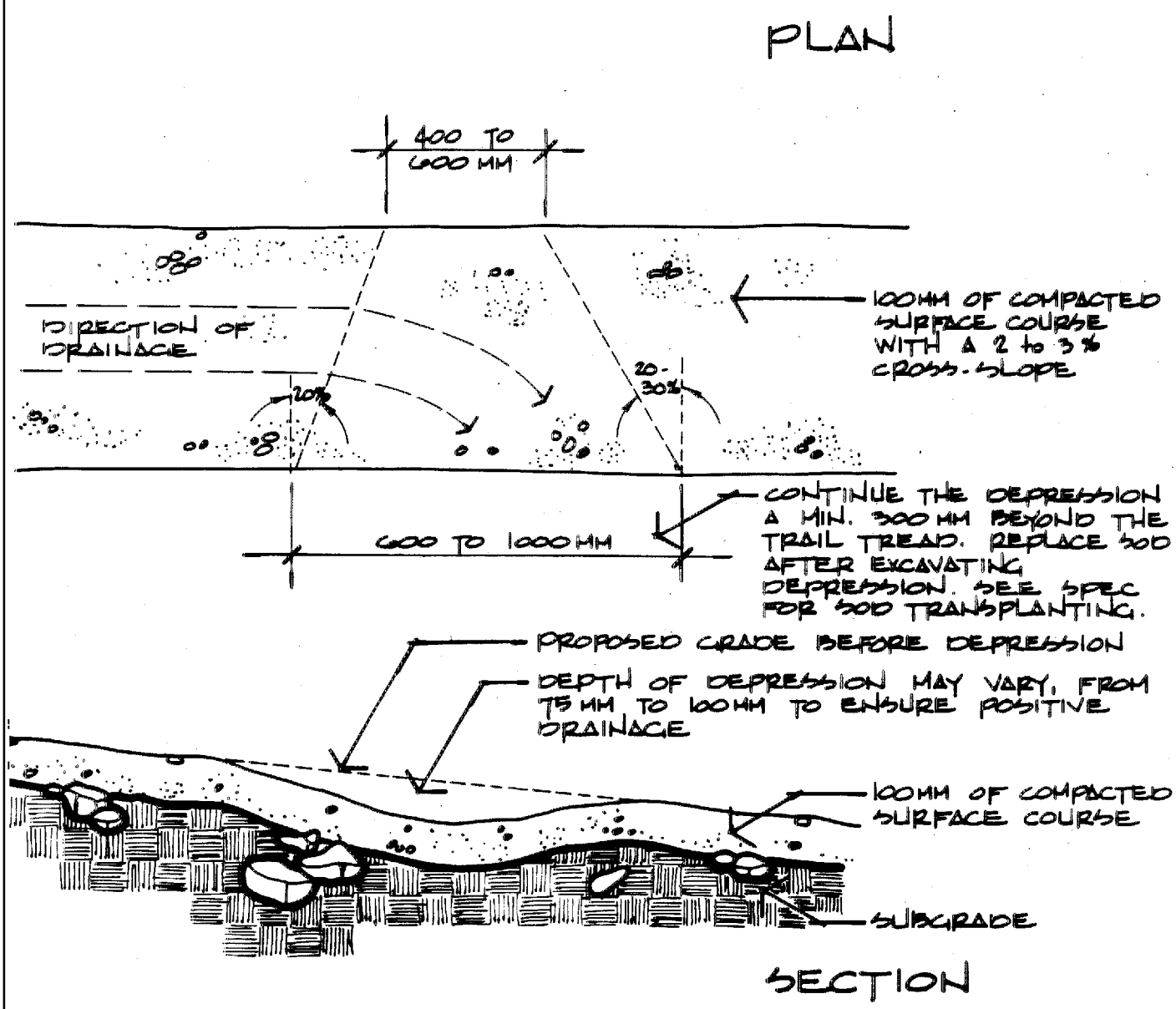
NOTE: TRAILS ARE TO BE CONSTRUCTED ON RELATIVELY STABLE RUBBLE AND TALUS SLOPES ONLY.

CONSTRUCTION ON TALUS & RUBBLE

NOTE: WHEREVER POSSIBLE, TURN SHOULD BE MADE ON LEVEL GROUND. THE TURNING RADIUS IS MARKED BY STAKES AT EACH SITE. DIMENSIONS VARY.



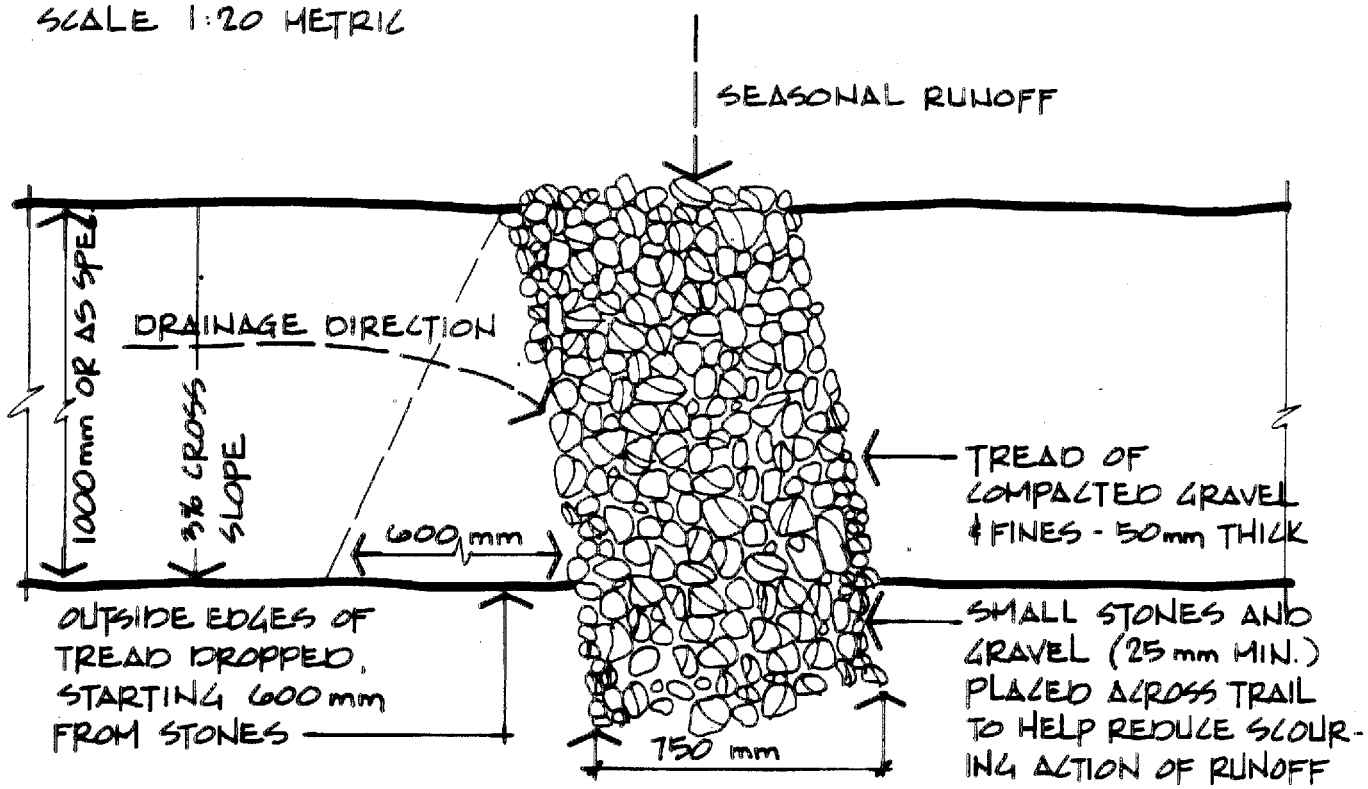
SWITCHBACK PLAN



TYPICAL DRAINAGE DEPRESSION

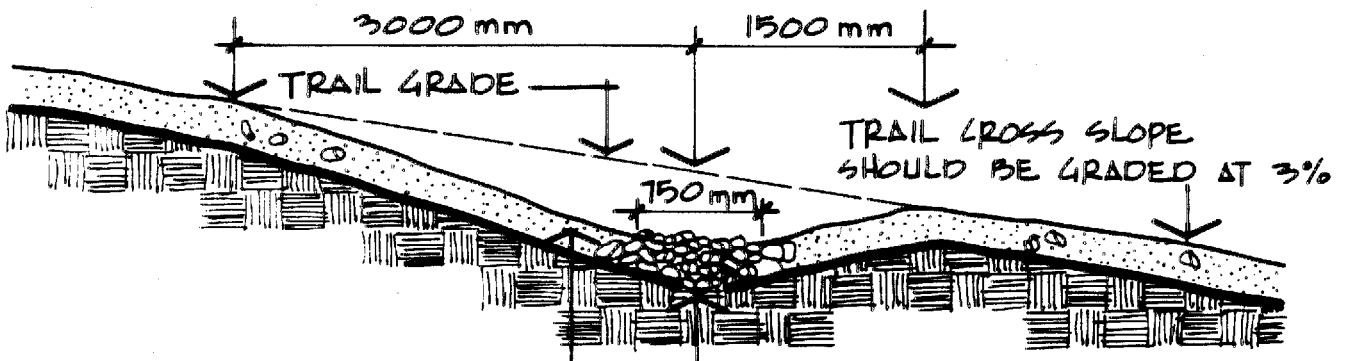
PLAN

SCALE 1:20 METRIC

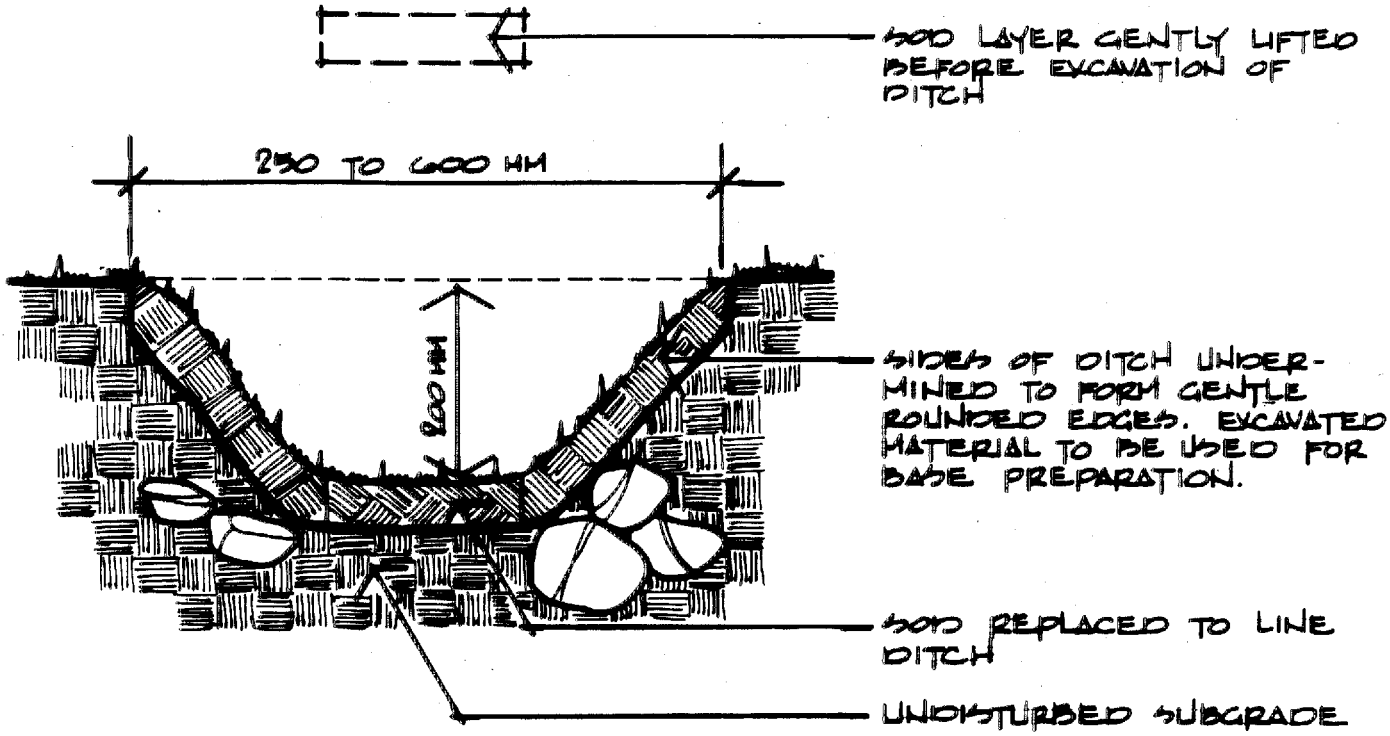


PROFILE OF DRAINAGE DIP

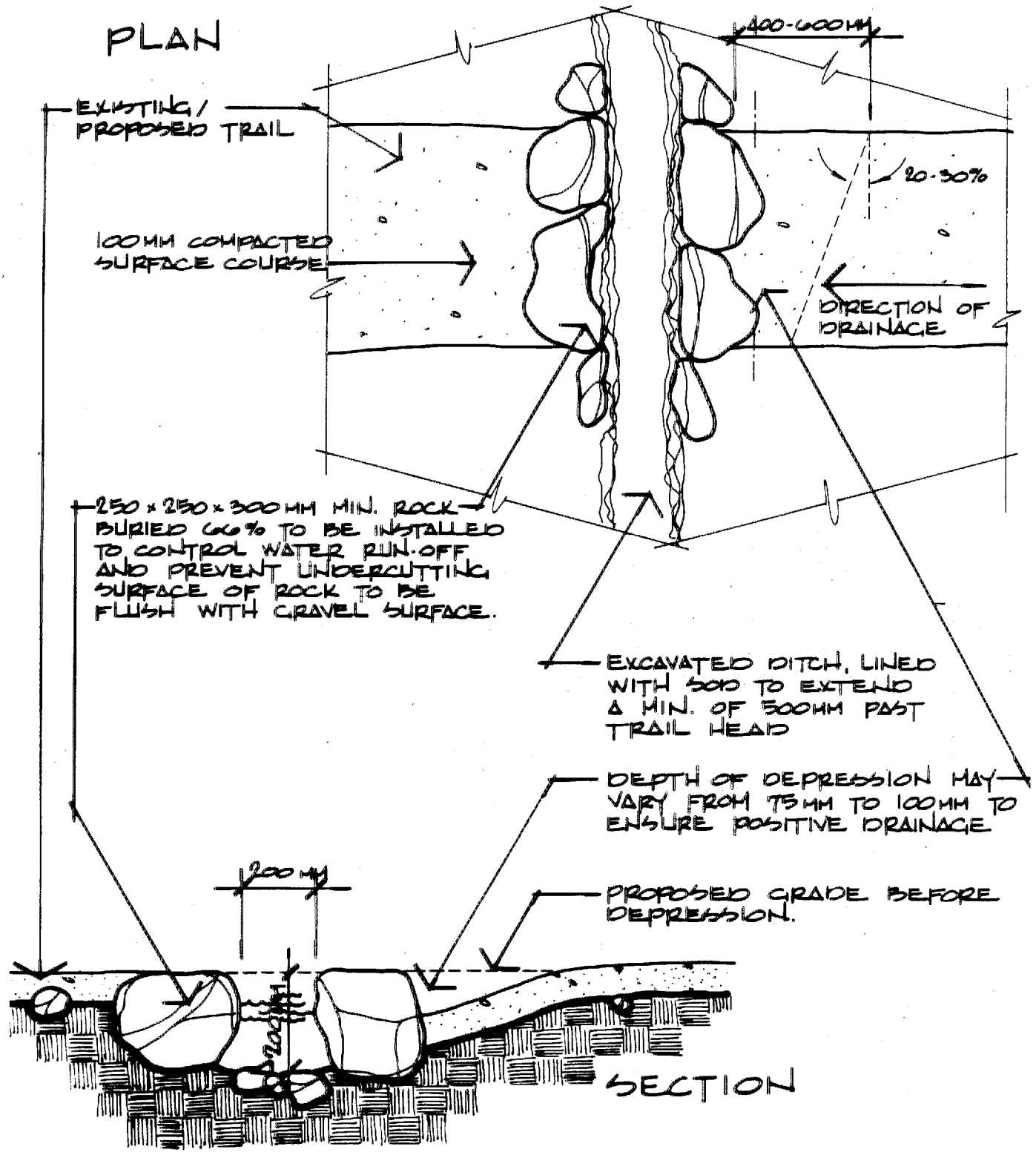
SCALE 1:50 METRIC



NOTE: USE A DRAINAGE DIP WHERE SEASONAL RUNOFF OR A MINOR TRICKLE CROSSES THE TRAIL.

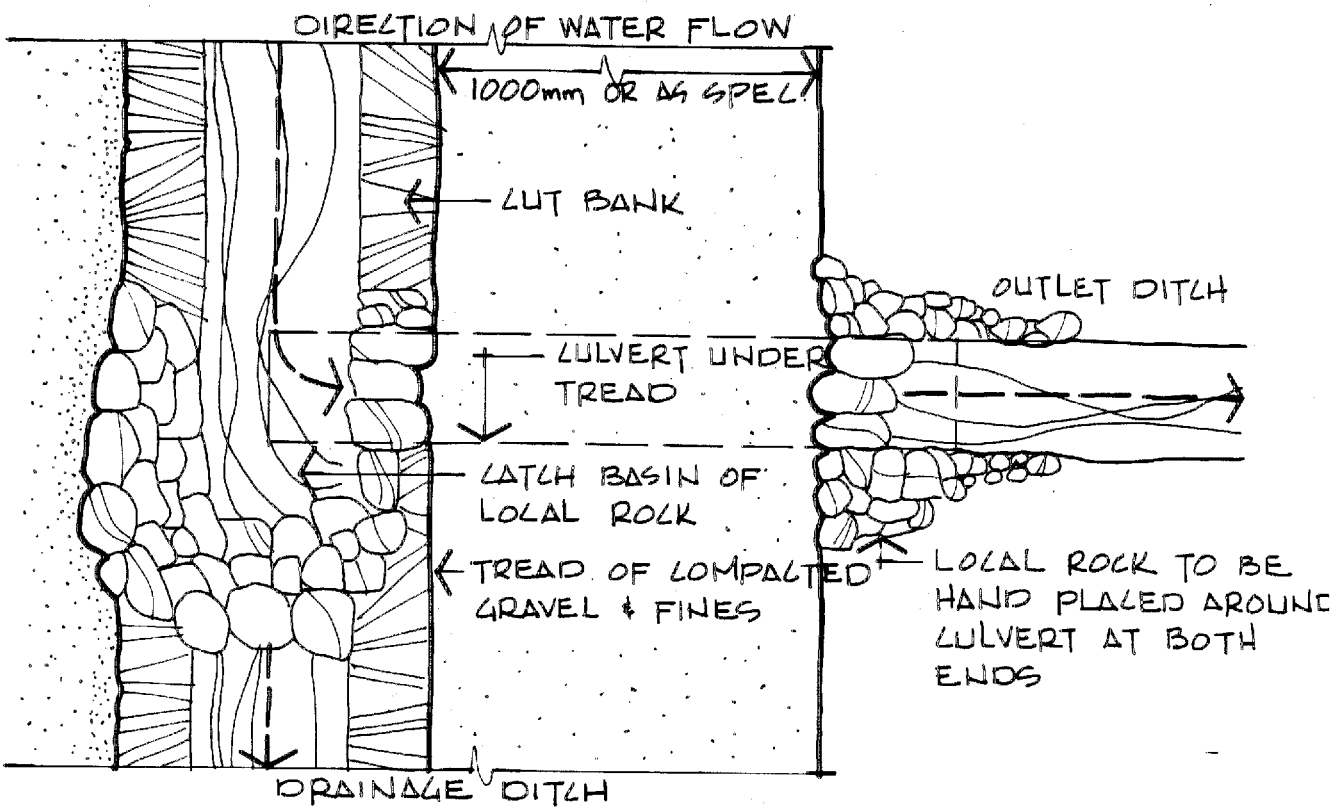


TYPICAL NATIVE SOD DITCH DETAIL

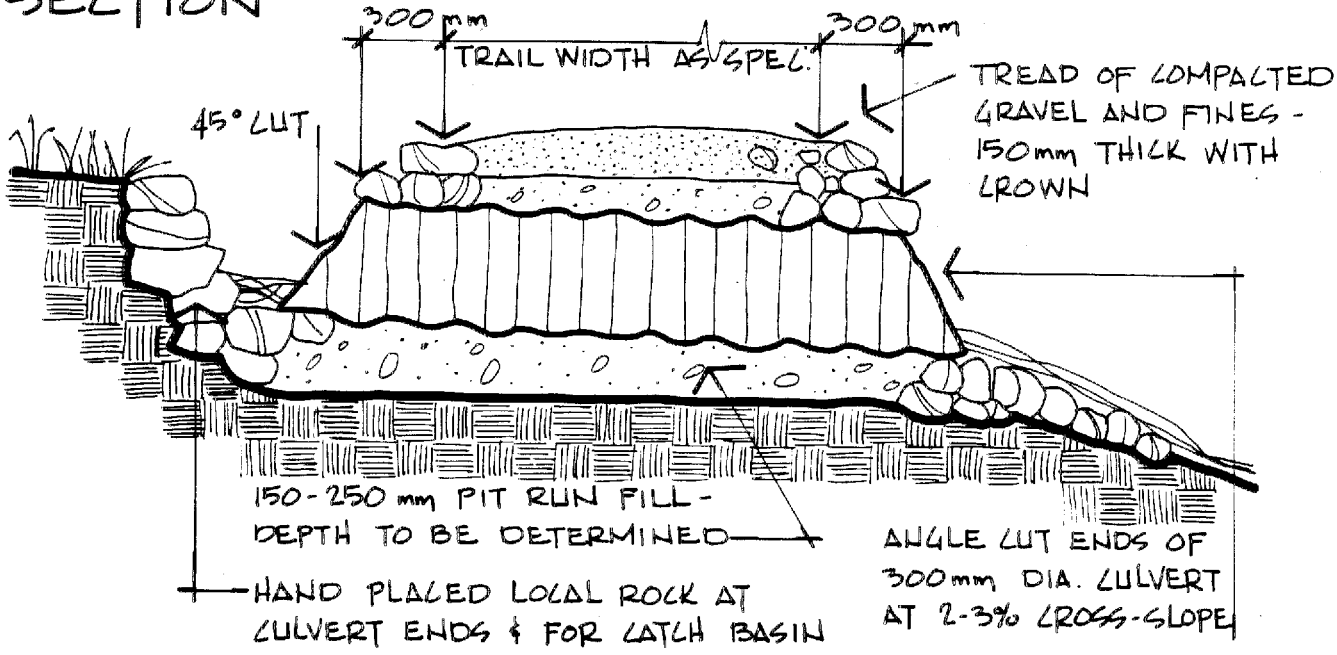


OPEN ROCK CULVERT

PLAN



SECTION

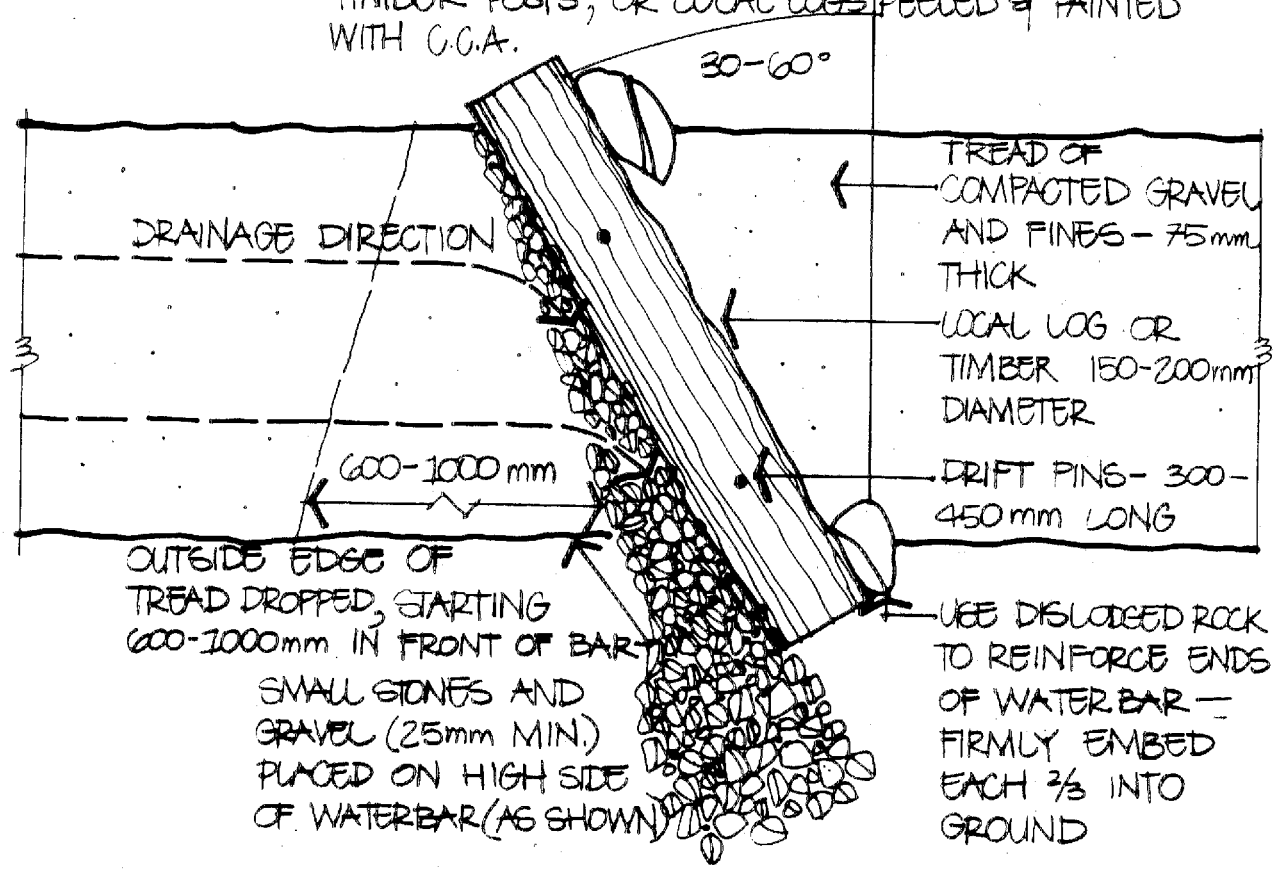


NOTE: ANGLE CULVERT ACROSS TRAIL WHERE HEAVY SPRING FLOWS ARE EXPECTED.

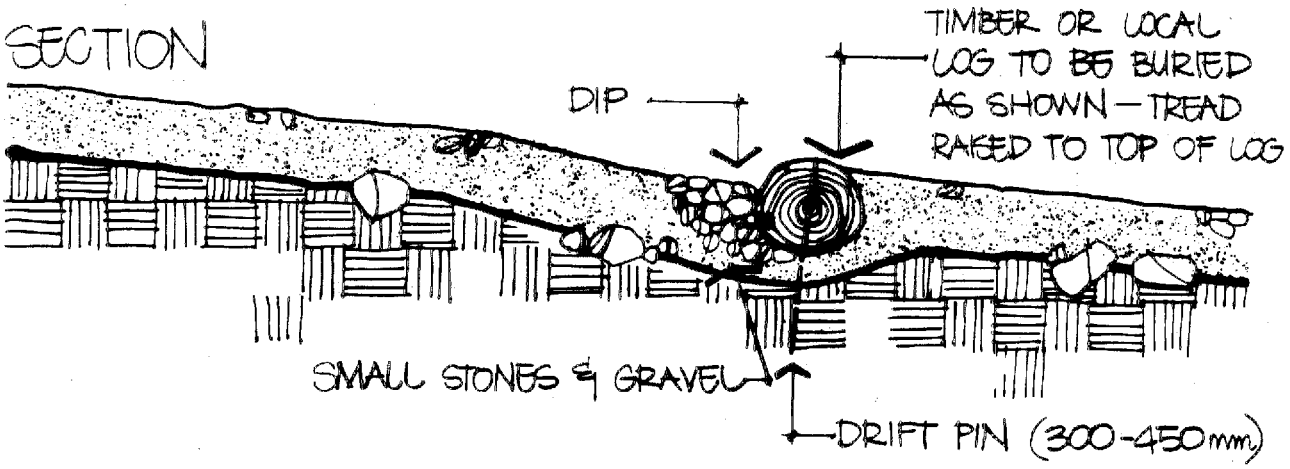
CULVERT WITH DITCH

PLAN

NOTE: WATERBARS TO BE INSTALLED ON TRAIL GRADES GREATER THAN 5%. USE PRESSURE TREATED TIMBER POSTS, OR LOCAL LOGS PEELED & PAINTED WITH C.C.A.



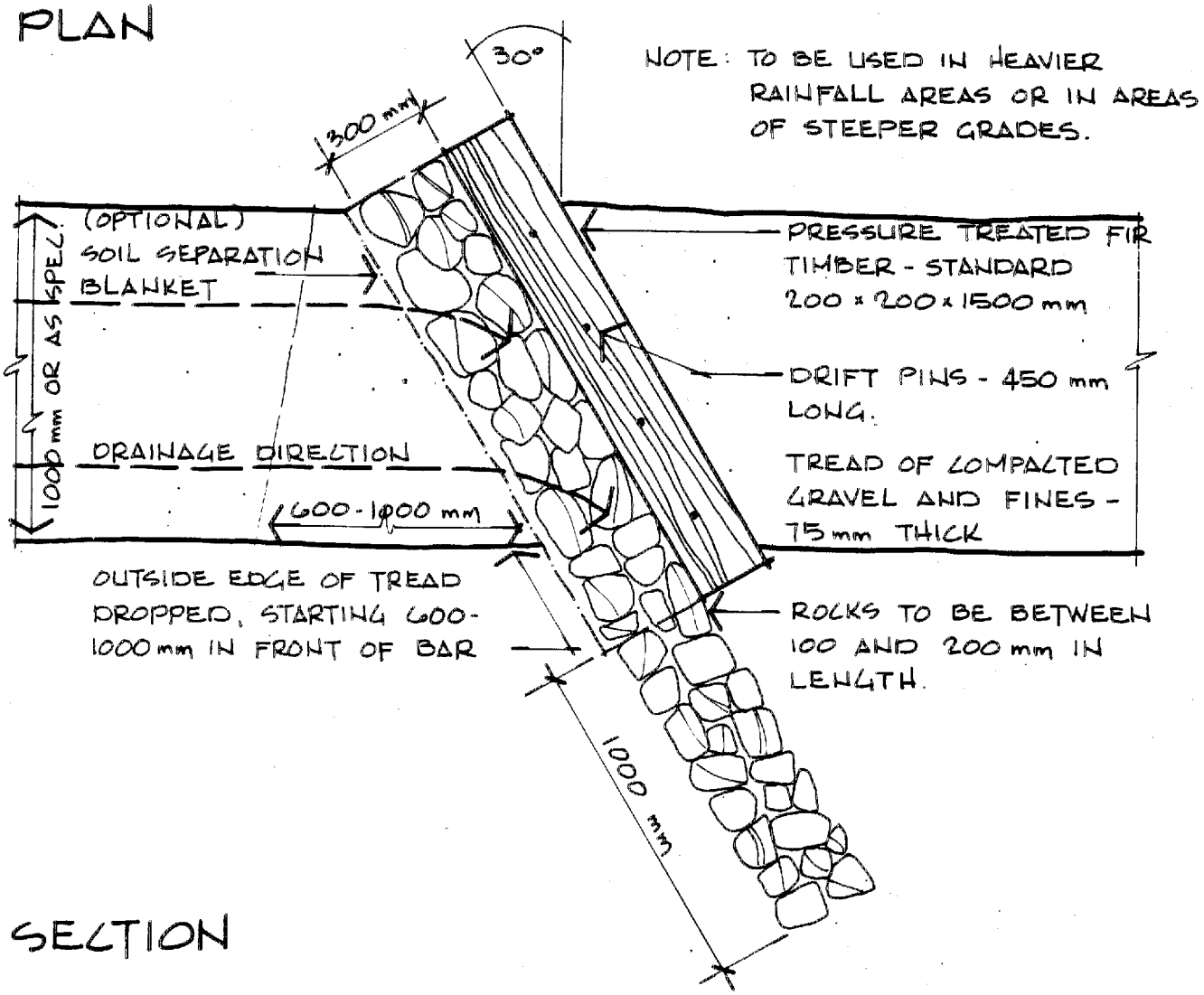
SECTION



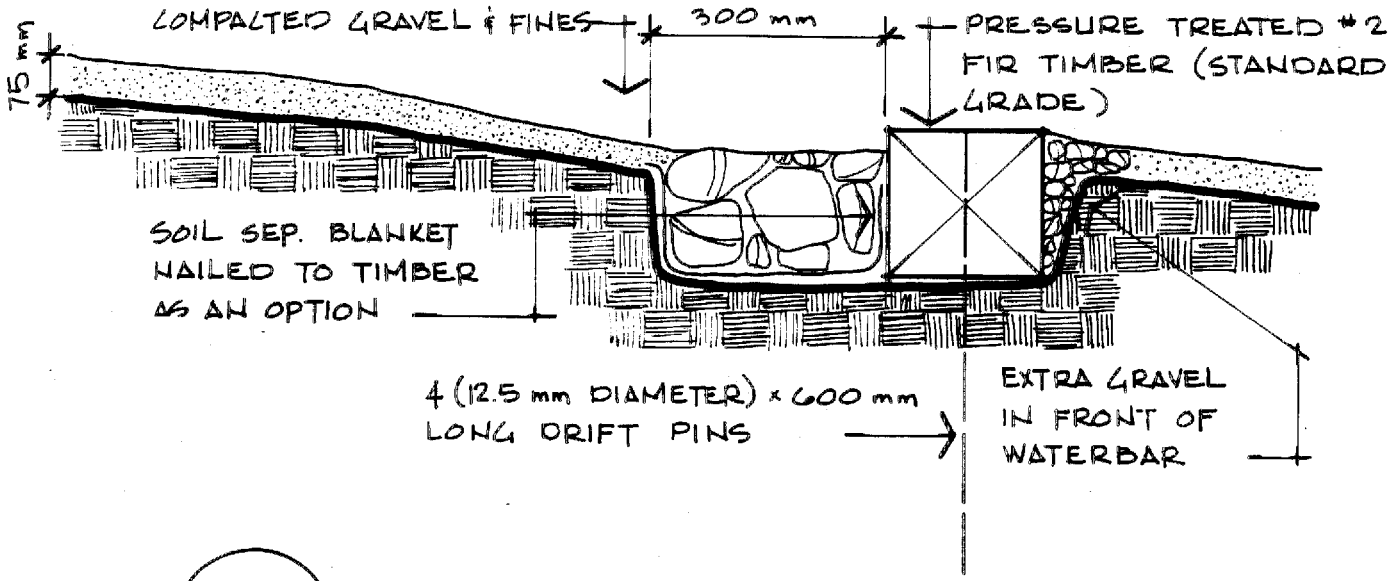
NOTE: INSTALL LEADING EDGE OF LOG ALMOST FLUSH WITH GRADE TO ALLOW BICYCLE USE WHERE DESIGNATED.

LOG WATERBAR

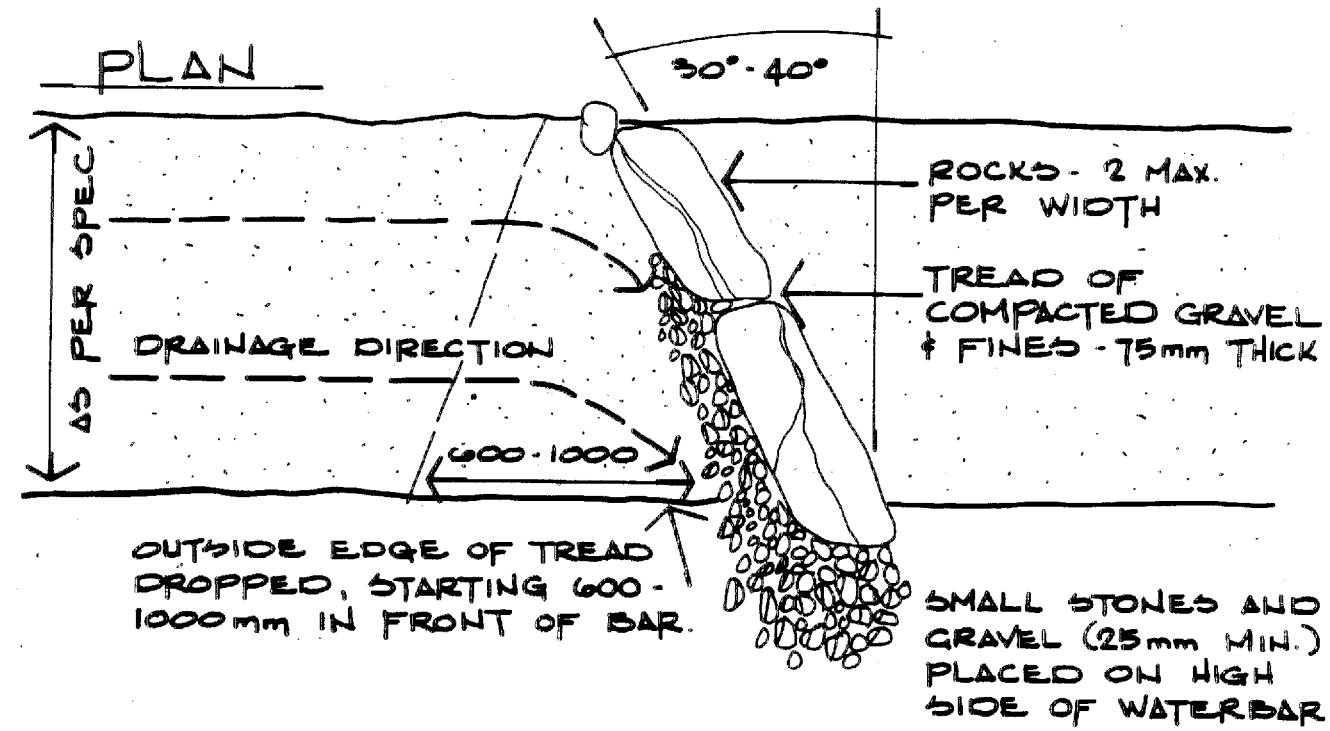
PLAN

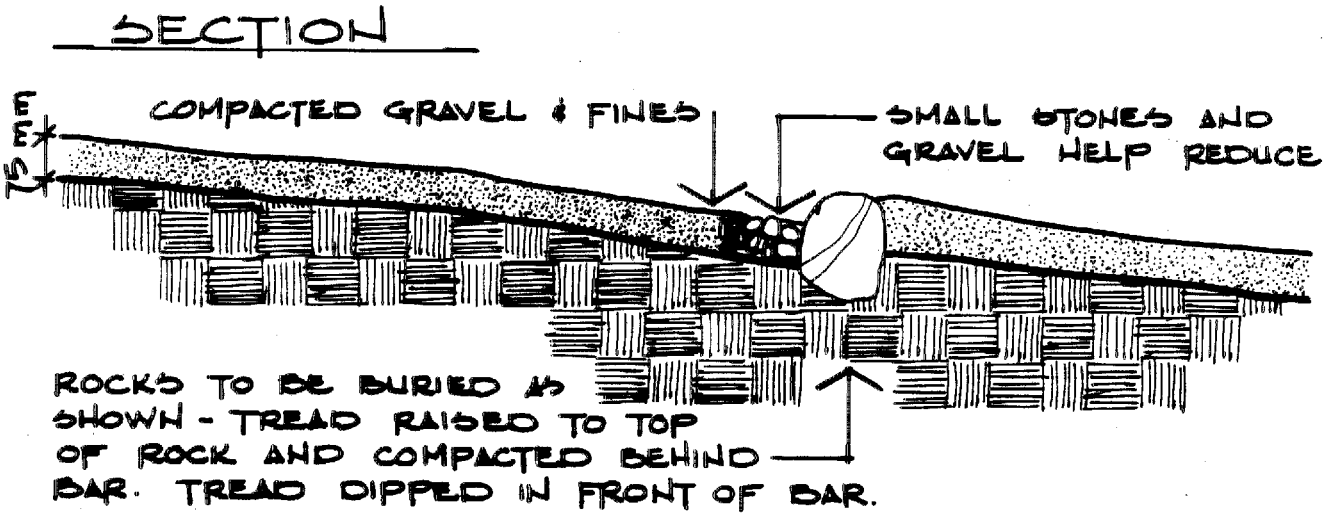


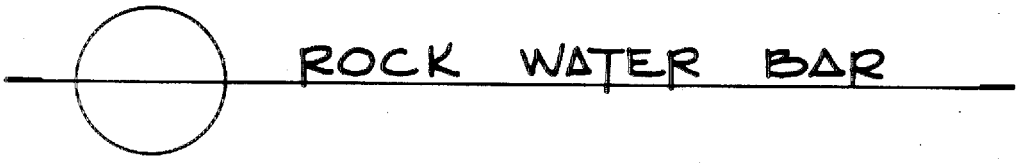
SECTION



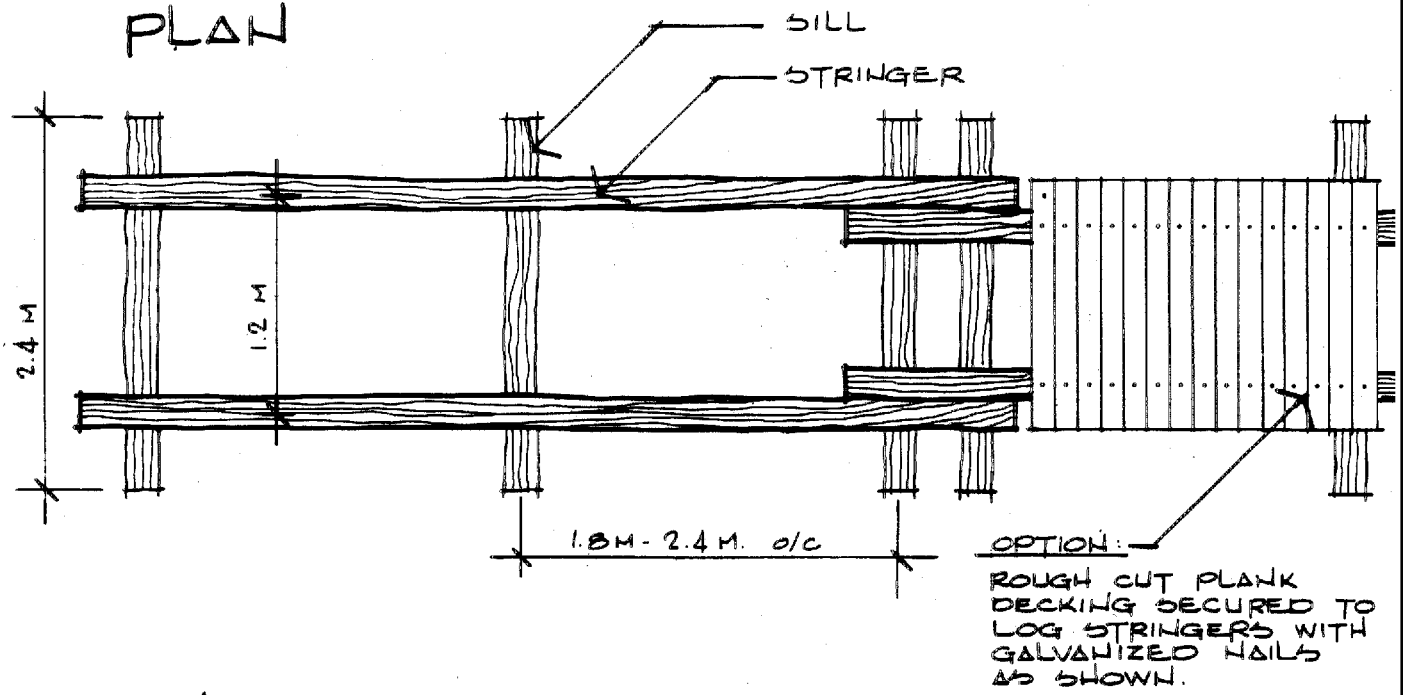
TIMBER WATERBAR


PLAN
30°-40°
AS PER SPEC
DRAINAGE DIRECTION
600-1000
ROCKS - 2 MAX. PER WIDTH
TREAD OF COMPACTED GRAVEL & FINES - 75mm THICK
OUTSIDE EDGE OF TREAD DROPPED, STARTING 600-1000mm IN FRONT OF BAR.
SMALL STONES AND GRAVEL (25mm MIN.) PLACED ON HIGH SIDE OF WATERBAR

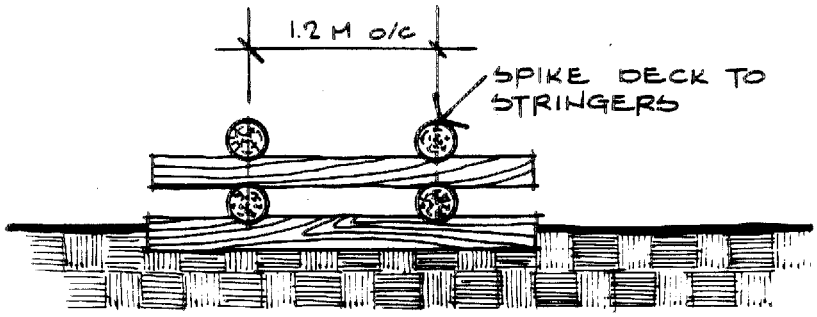

SECTION
75mm
COMPACTED GRAVEL & FINES
SMALL STONES AND GRAVEL HELP REDUCE
ROCKS TO BE BURIED AS SHOWN - TREAD RAISED TO TOP OF ROCK AND COMPACTED BEHIND BAR. TREAD DIPPED IN FRONT OF BAR.


ROCK WATER BAR

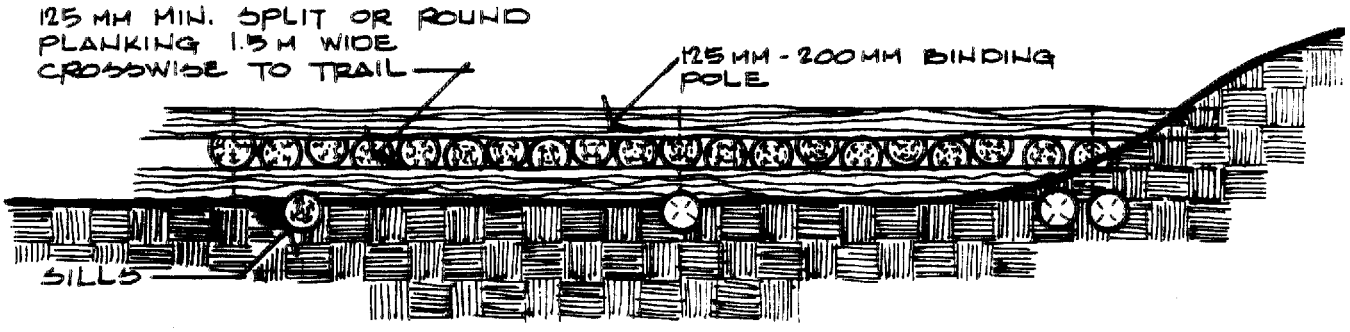
PLAN



END



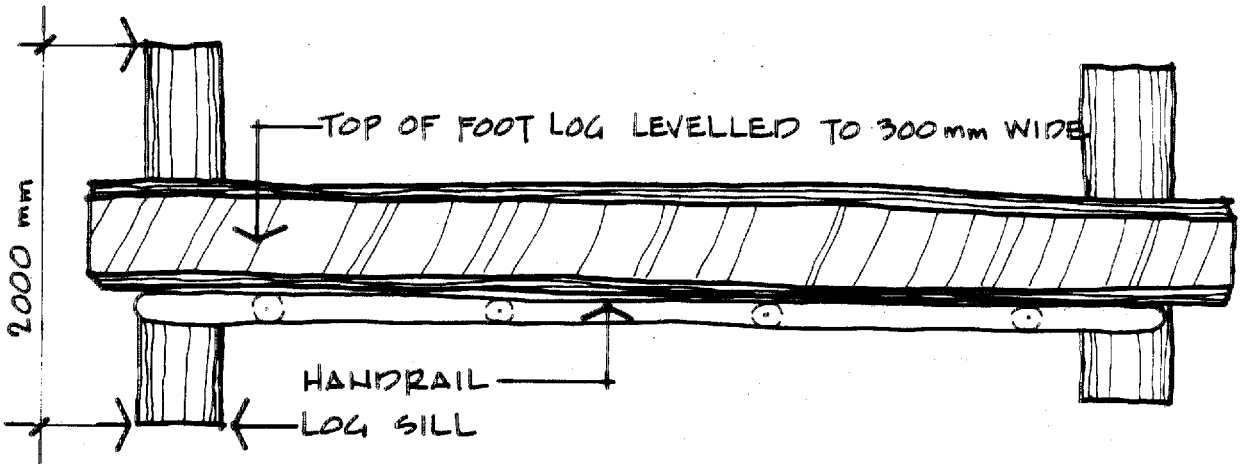
SIDE VIEW



HISTORIC CORDUROY TRAIL WITH OPTION

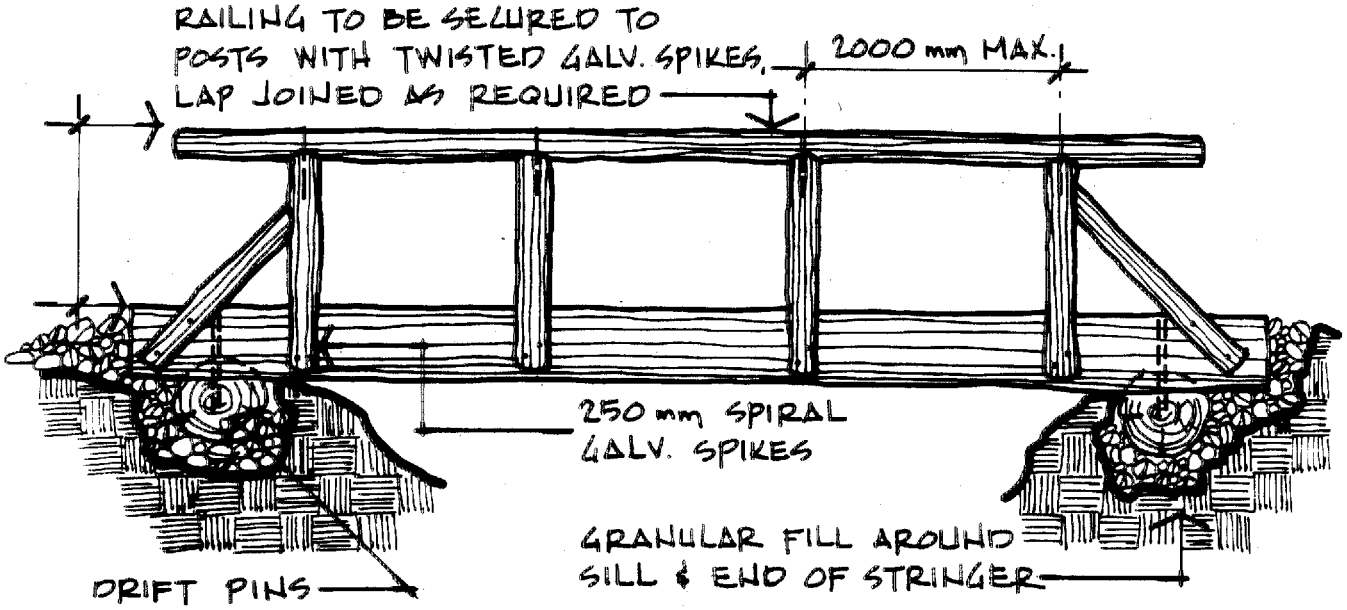
USE FOR MARSH CROSSINGS

PLAN



NOTE: HANDRAIL MAY BE MOVED OUT 300 mm TO SIDE W/ BRACES AS IN NO , TO ALLOW SAFER WALKING WHEN CARRYING A BACKPACK.

SECTION

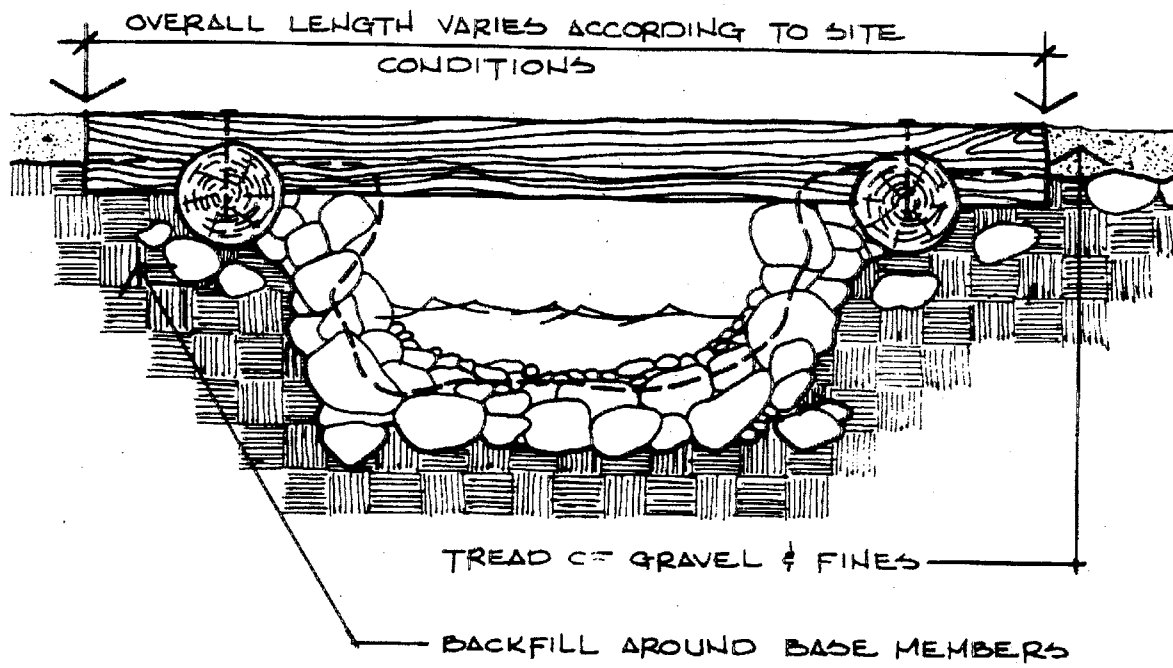


NOTE: LOGS TO BE PEELED AND TRIMMED SMOOTH OF KNOTS AND ALL PROJECTIONS. HOLES FOR DRIFT PINS TO BE DRILLED 1 mm SMALLER THAN PINS.

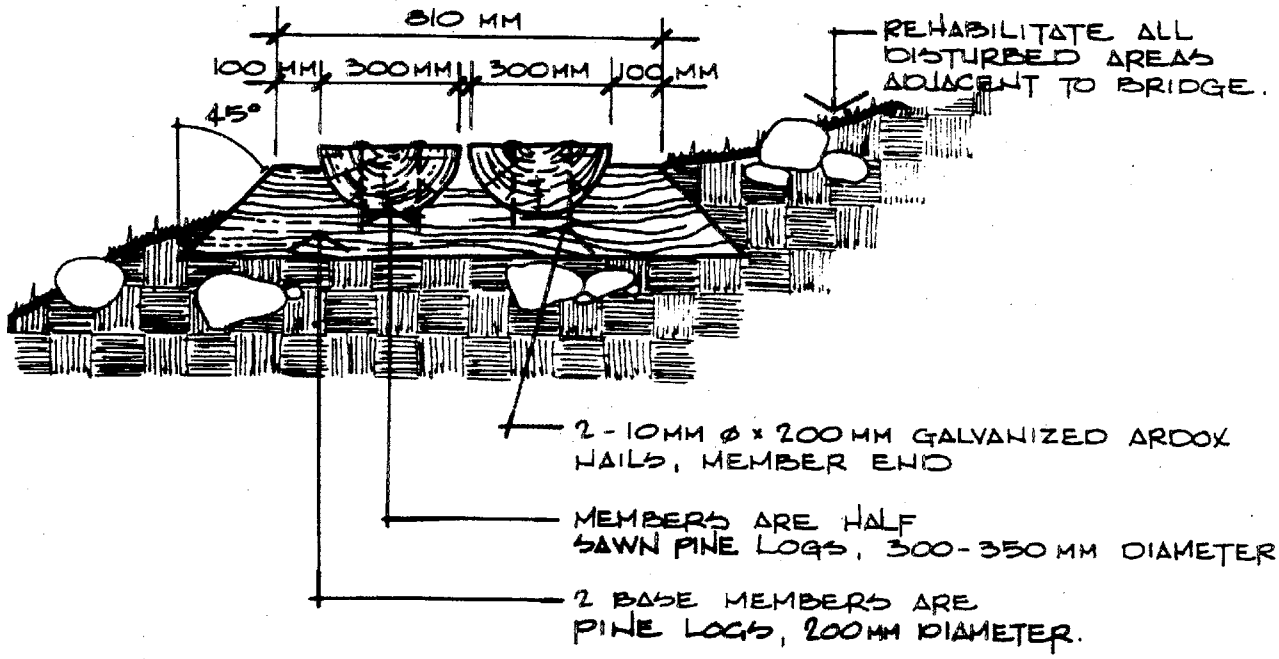
SINGLE LOG BRIDGE W/ HANDRAIL

SECTION

NOTE: SPLIT LOG BRIDGES CAN BE MADE WITH ONE HALF LOG.



ELEVATION

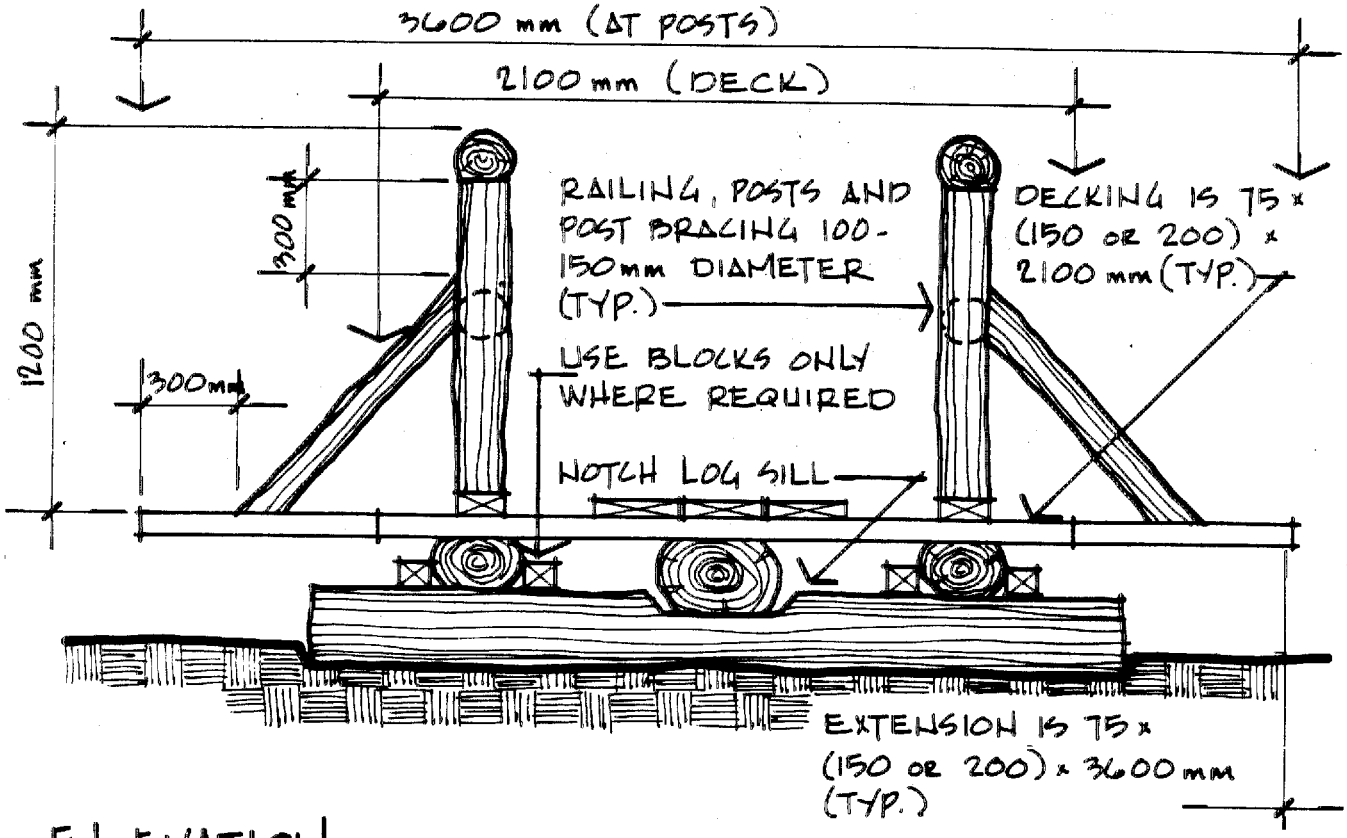


NOTE: PLACE NARROW END OF ONE LOG BESIDE BUTT END OF OTHER LOG. NEVER NOTCH LOADBEARING LOG.

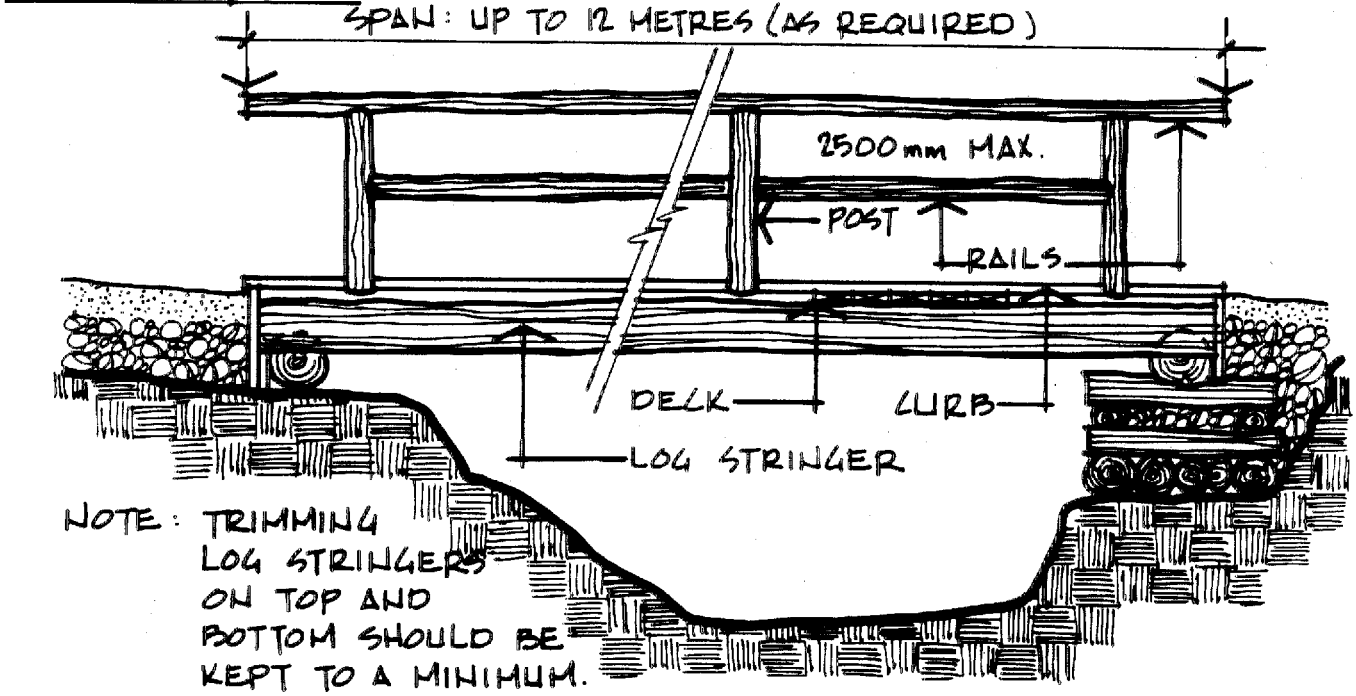
SPLIT LOG BRIDGE

SECTION

NOTE: THIS BRIDGE TO BE USED ACCORDING TO SPAN TABLE.



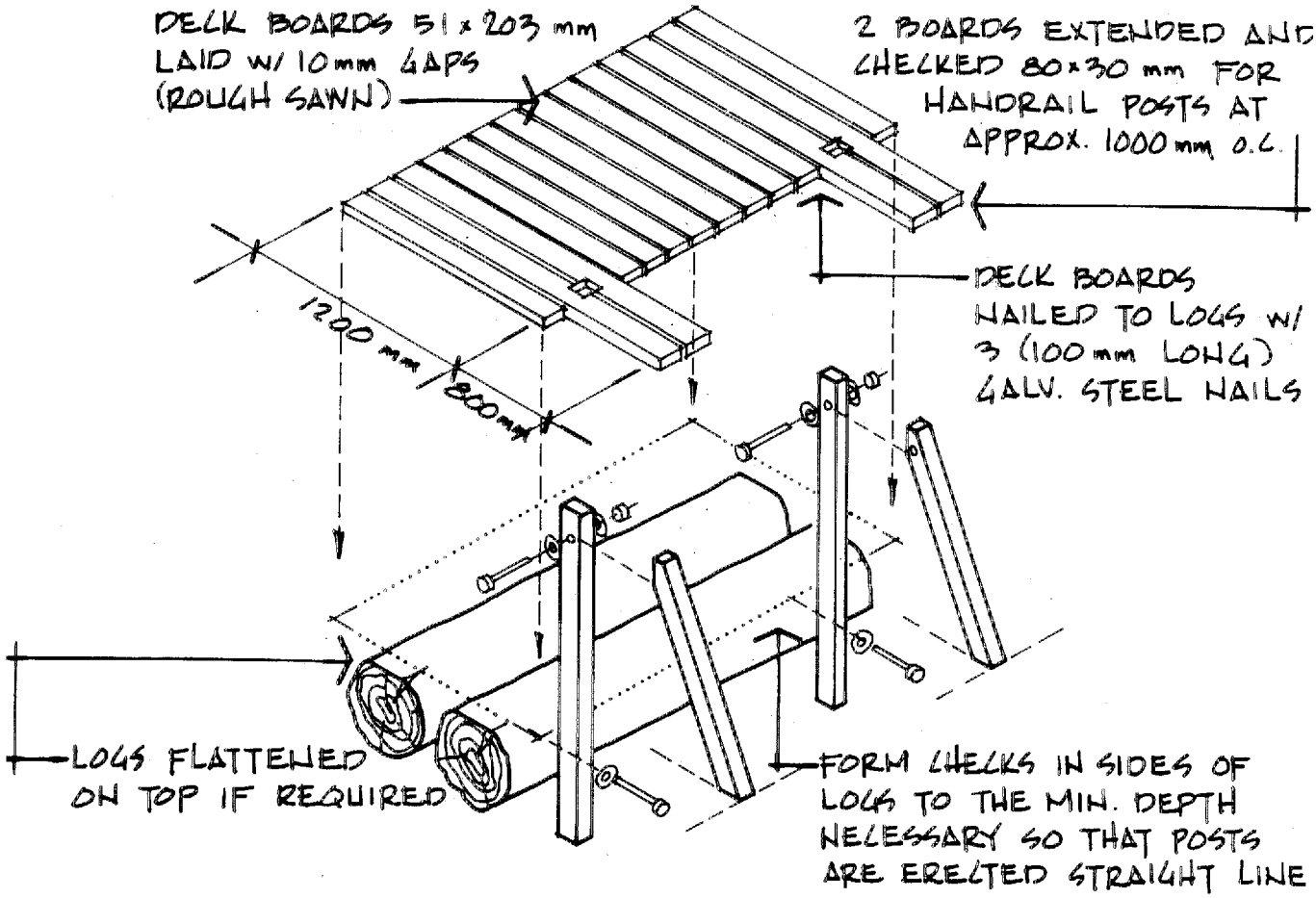
ELEVATION



NOTE: TRIMMING LOG STRINGERS ON TOP AND BOTTOM SHOULD BE KEPT TO A MINIMUM.

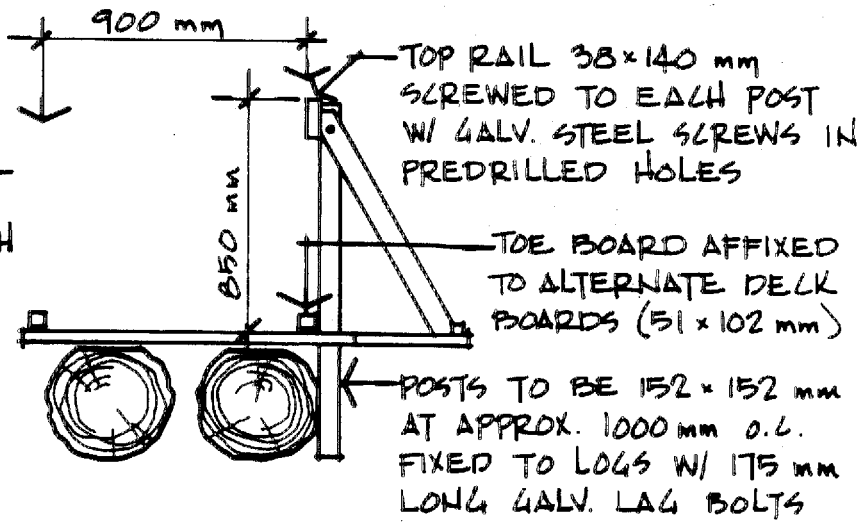
HORSE BRIDGE

AXONOMETRIC



SECTION

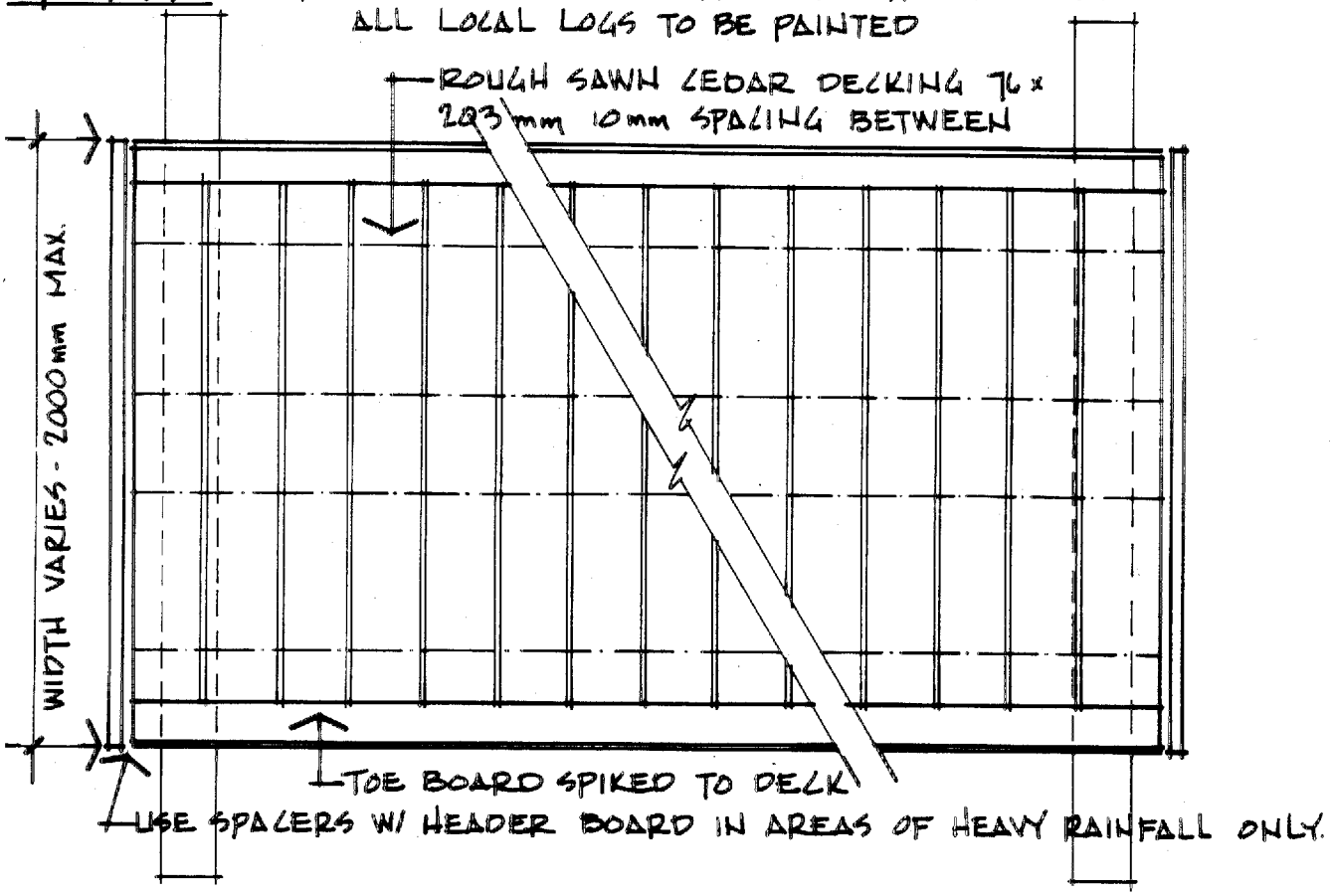
OPTIONAL ONE HANDRAIL 850 mm HIGH OR TWO HANDRAILS 1000 mm HIGH OR NO HANDRAIL DEPENDING ON LOCATION.



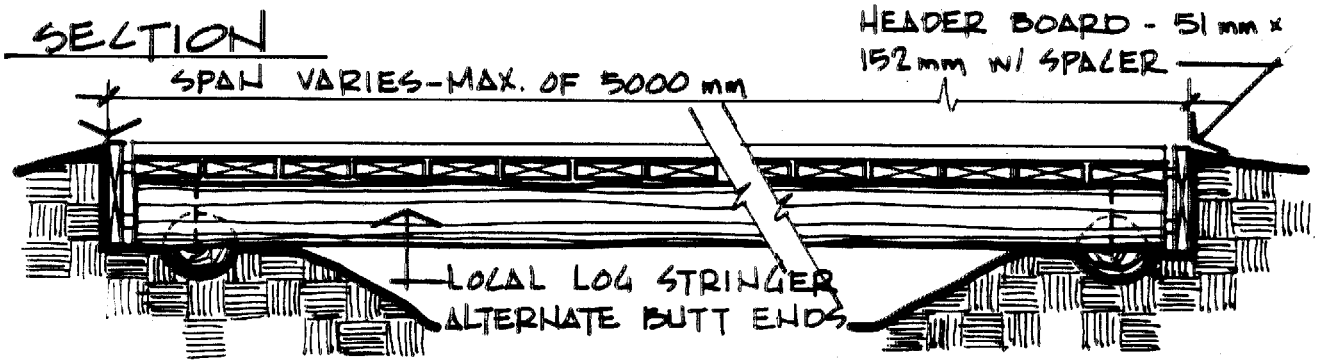
LOG BRIDGE W/ TIMBER DECKING

PLAN

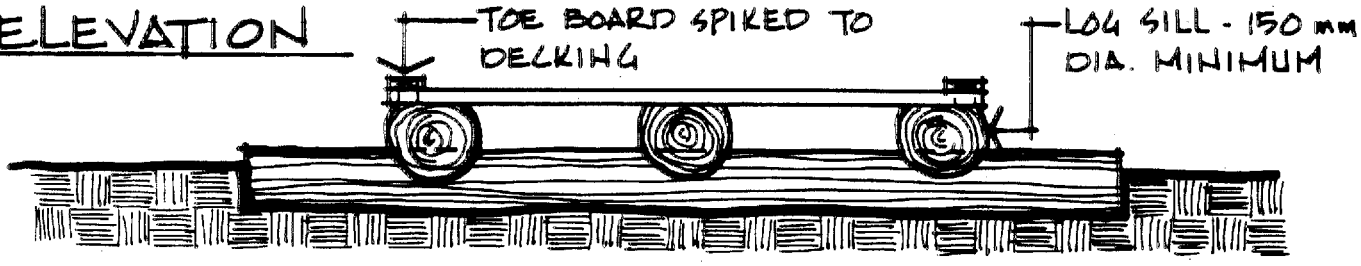
NOTE: ALL TIMBER TO BE PRESSURE TREATED AND ALL LOCAL LOGS TO BE PAINTED



SECTION

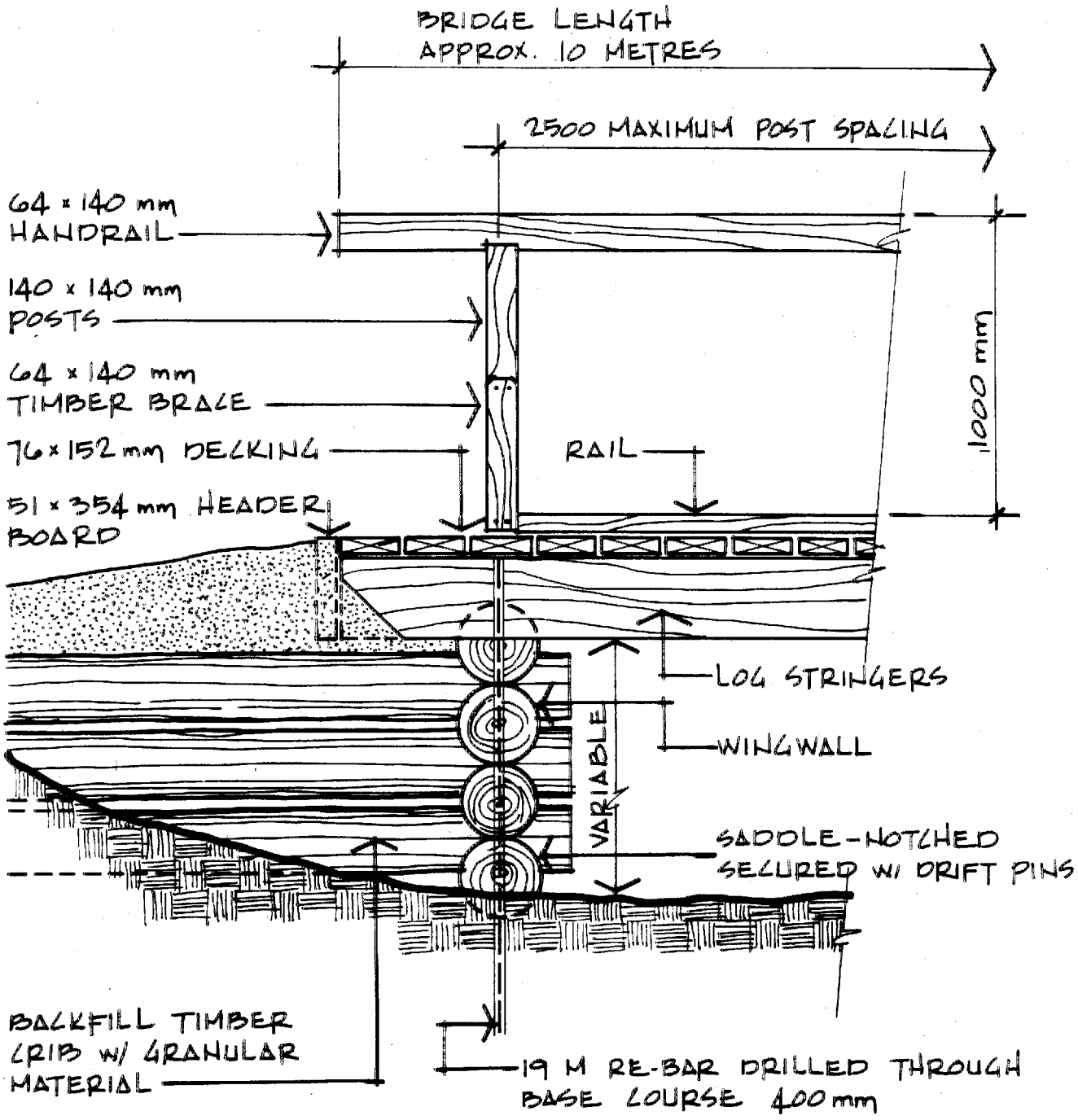


ELEVATION



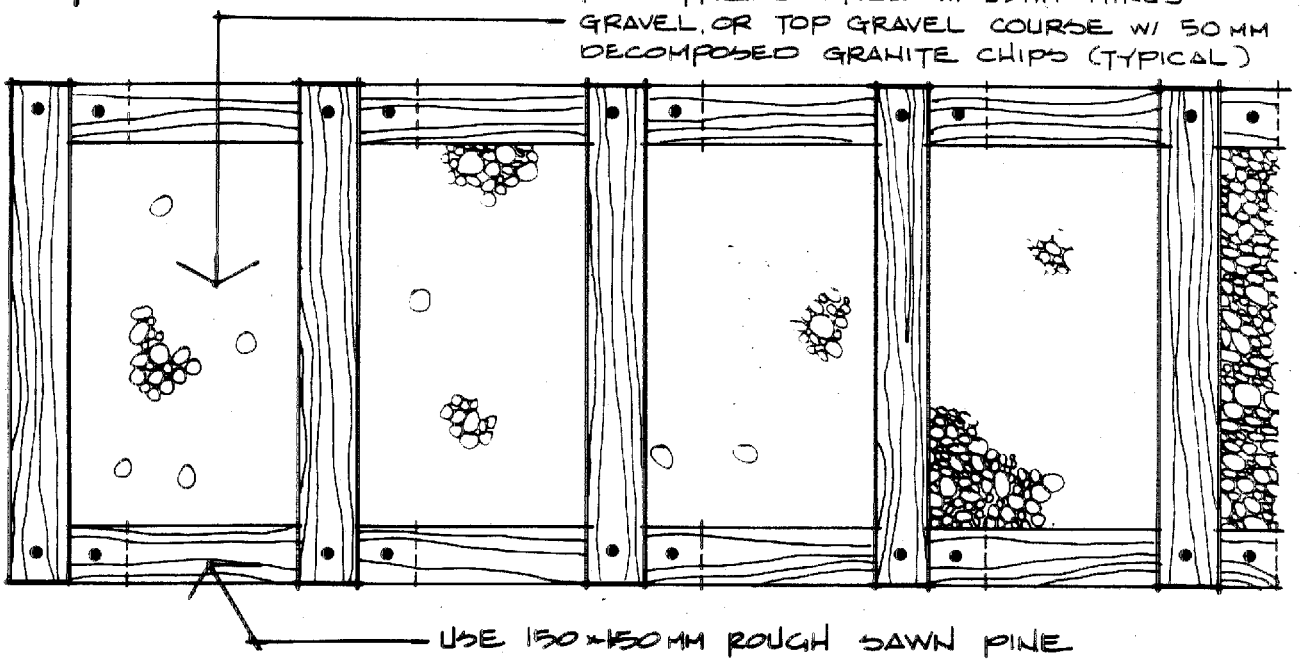
THREE LOG BRIDGE W/ DECKING

ELEVATION

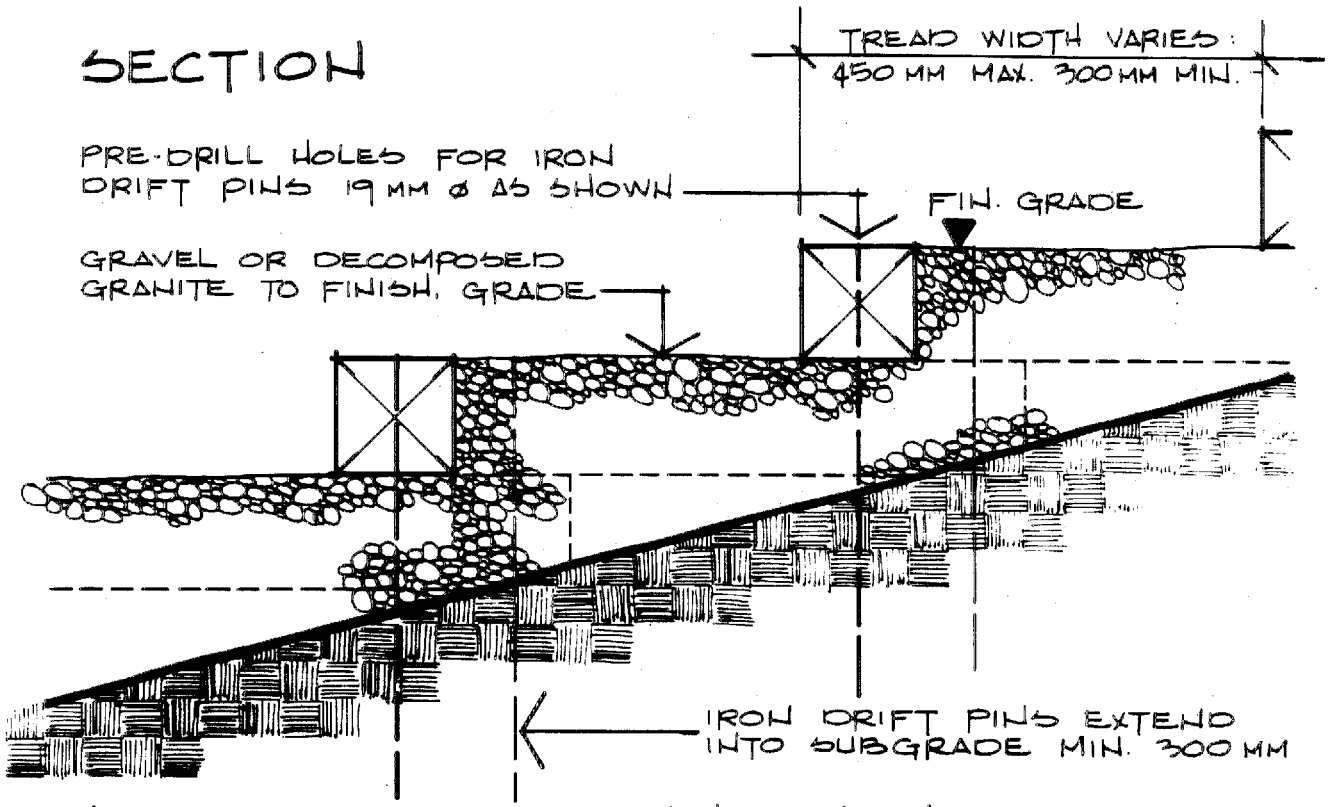


TYPICAL BRIDGE END CRIBBING

PLAN



SECTION



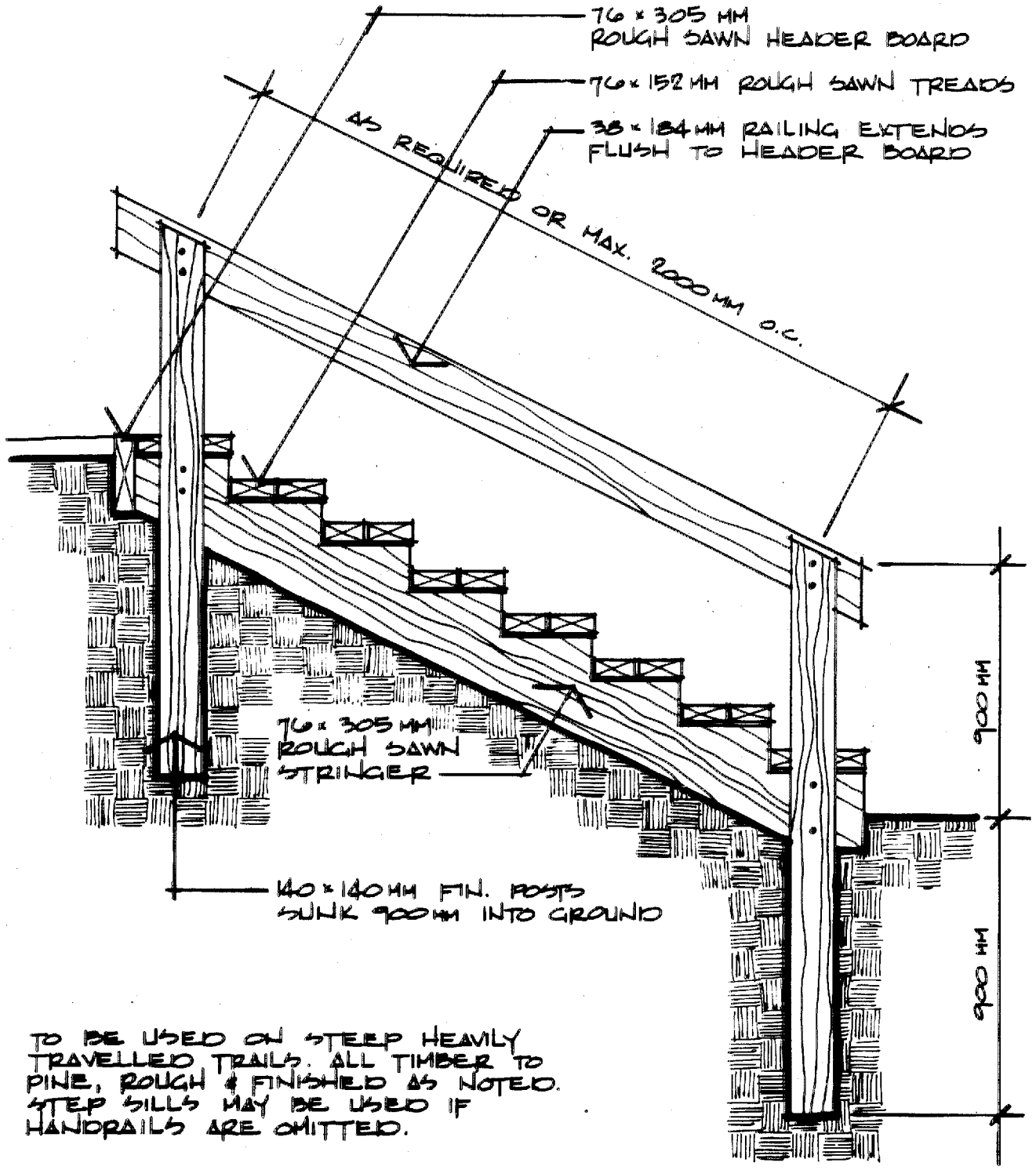
NOTE: ALL WOOD TO BE ROUGH SAWN PINE

TIMBER STAIRS

FOR USE ON LOW ANGLE SLOPES WITH LOOSE SANDY SOIL.

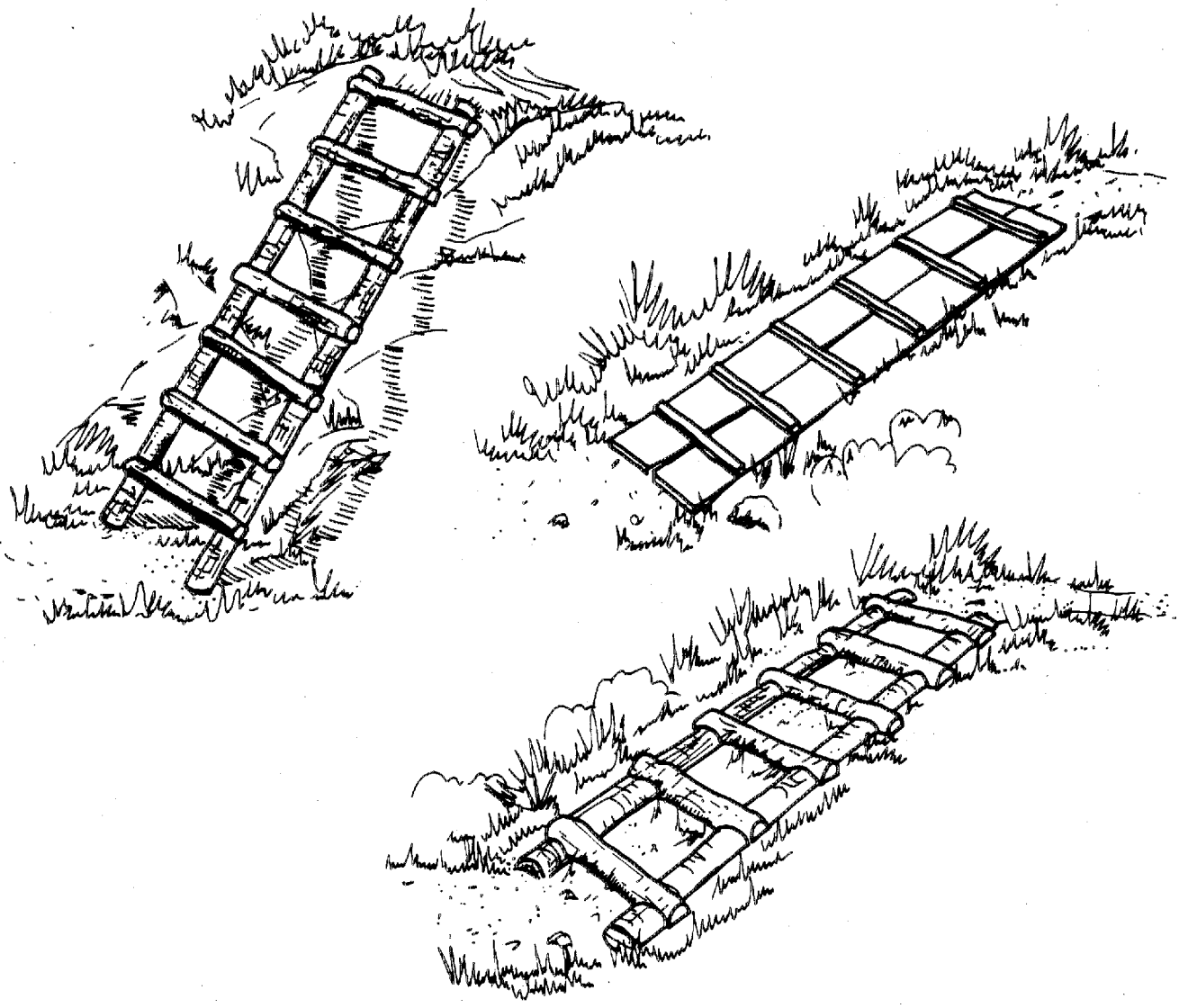
FOR GREATER STRENGTH USE TIMBER LAP JOINTS.

ELEVATION

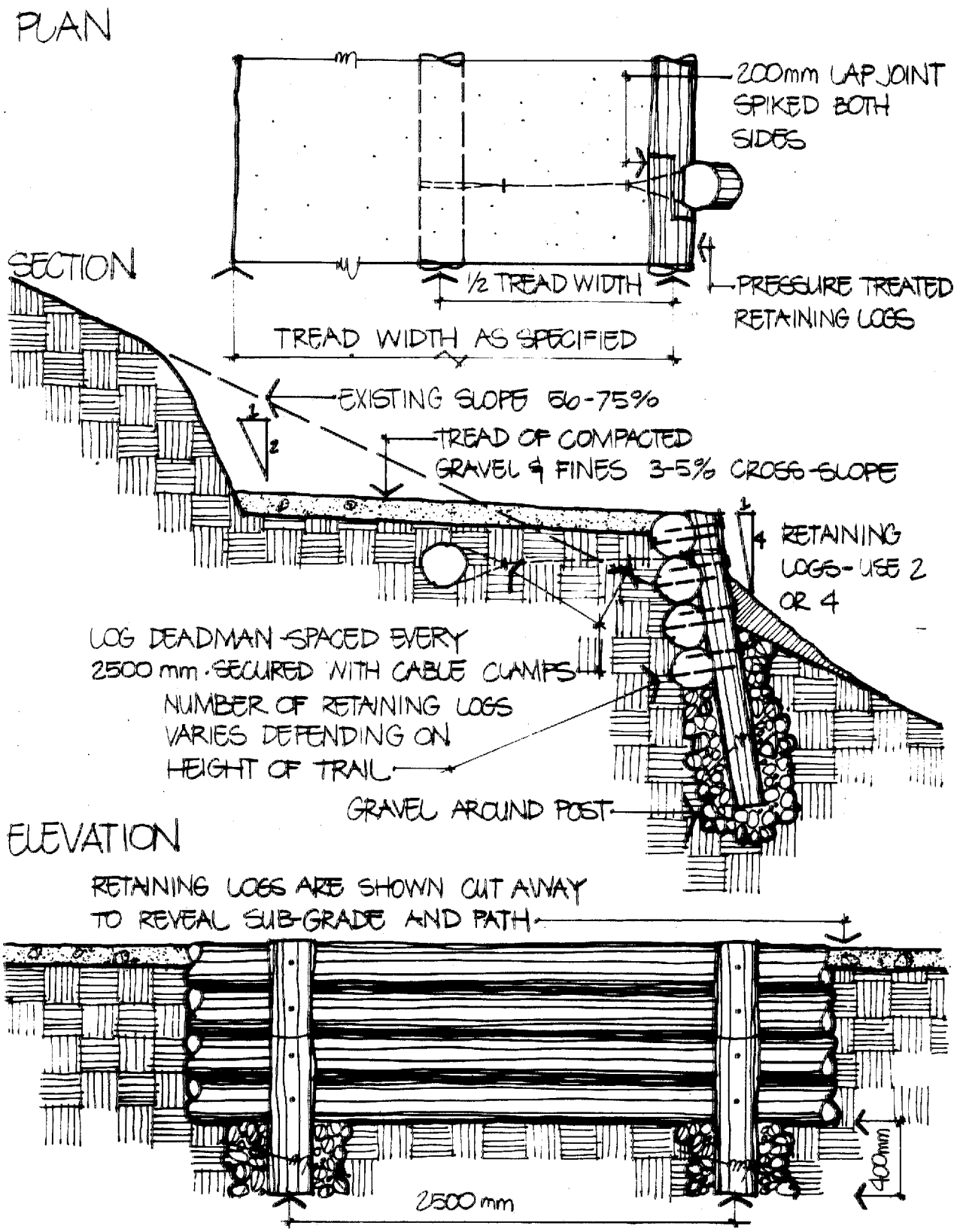


TO BE USED ON STEEP HEAVILY TRAVELLED TRAILS. ALL TIMBER TO PINE, ROUGH & FINISHED AS NOTED. STEP SILLS MAY BE USED IF HANDRAILS ARE OMITTED.

TIMBER STEPS WITH OPTIONAL HANDRAILS

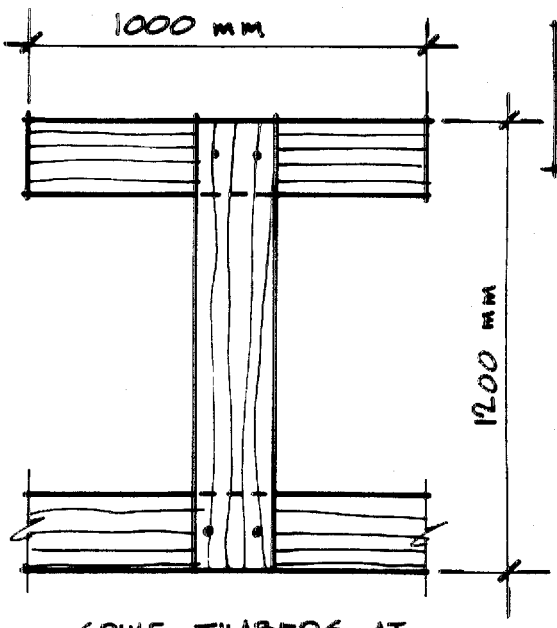


LADDERS

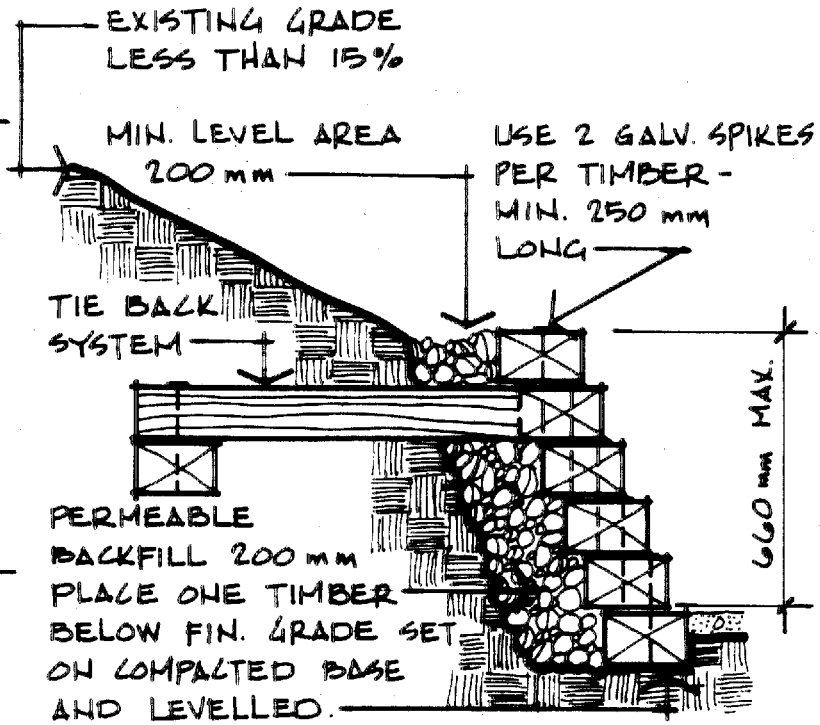


LOG RETAINING WALL

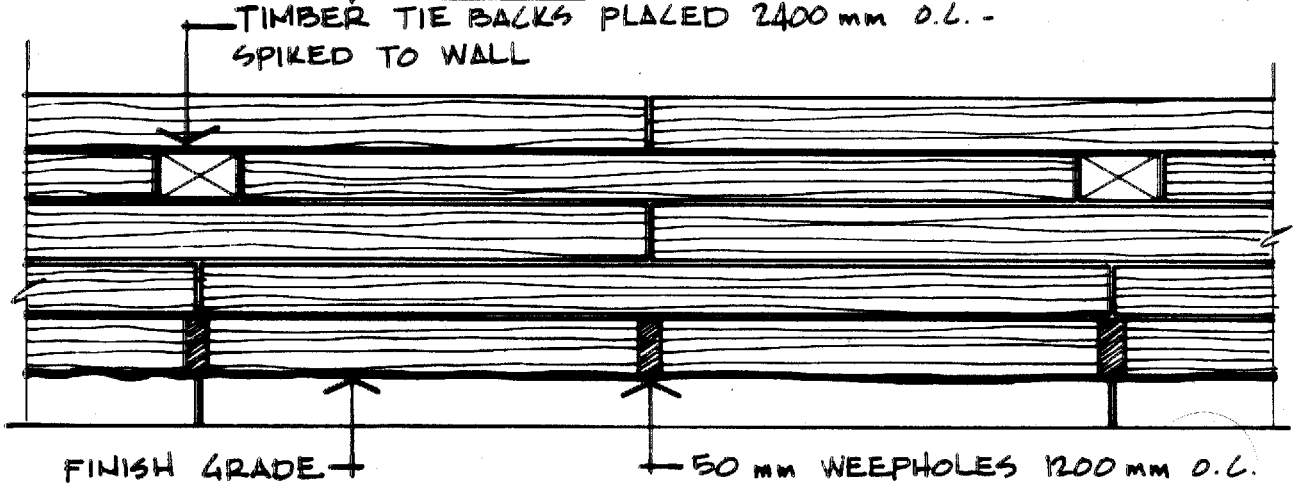
PLAN OF TIE-BACK



SECTION OF WALL



ELEVATION OF WALL

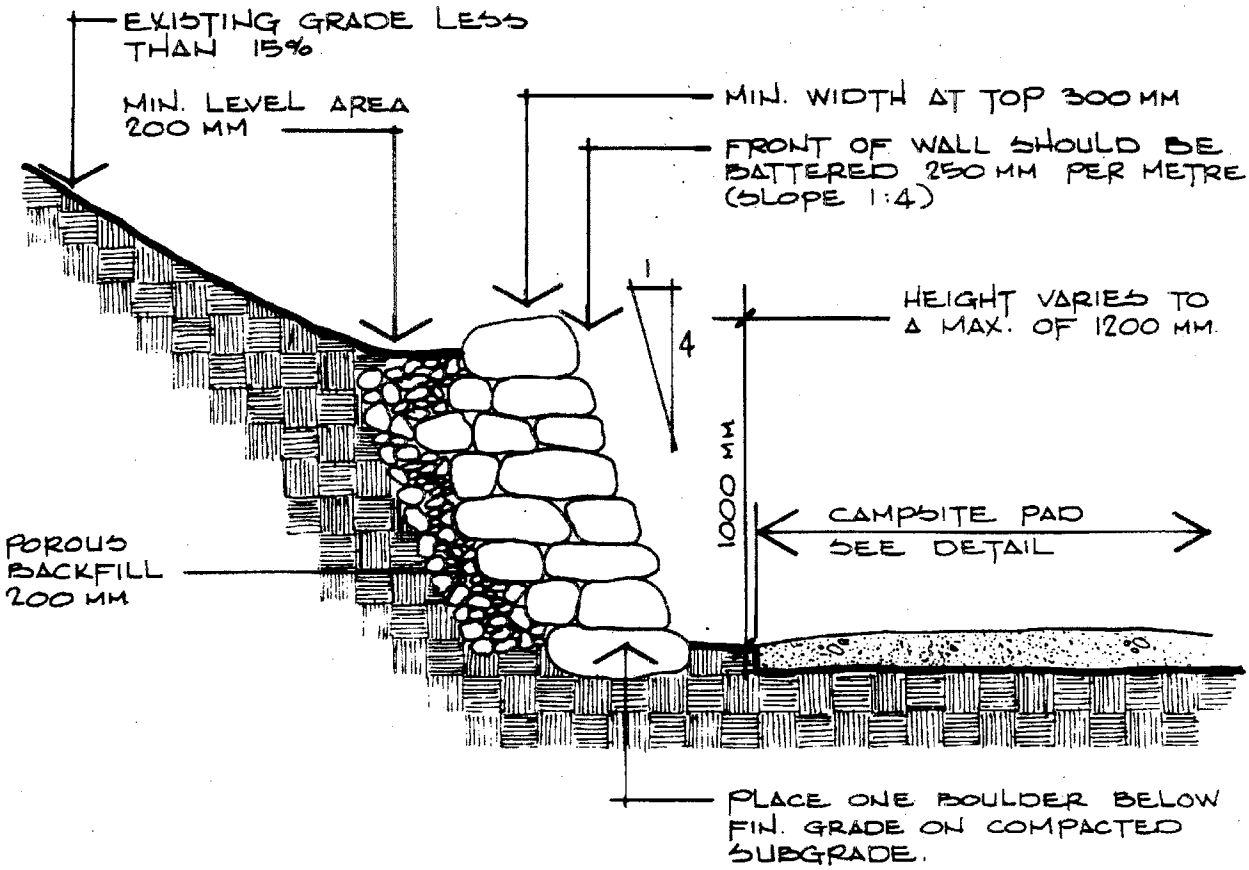


NOTE: TIMBER WALLS TO BE USED ON HEAVILY TRAVELLED TRAILS NEAR ROAD ACCESS - NOT FOR BACKCOUNTRY. CONSTRUCT ON STABLE SLOPES OF 15% OR LESS. IF WALL IS OVER 1 METRE HIGH, CONSULT AN ENGINEER. ALL TIMBER TO BE PRESSURE TREATED 152 x 203 mm (OPTIONAL).

TIMBER RETAINING WALL

SECTION

NOTE: DRY STONE WALLS TO BE CONSTRUCTED ON STABLE SLOPES OF 15% OR LESS.

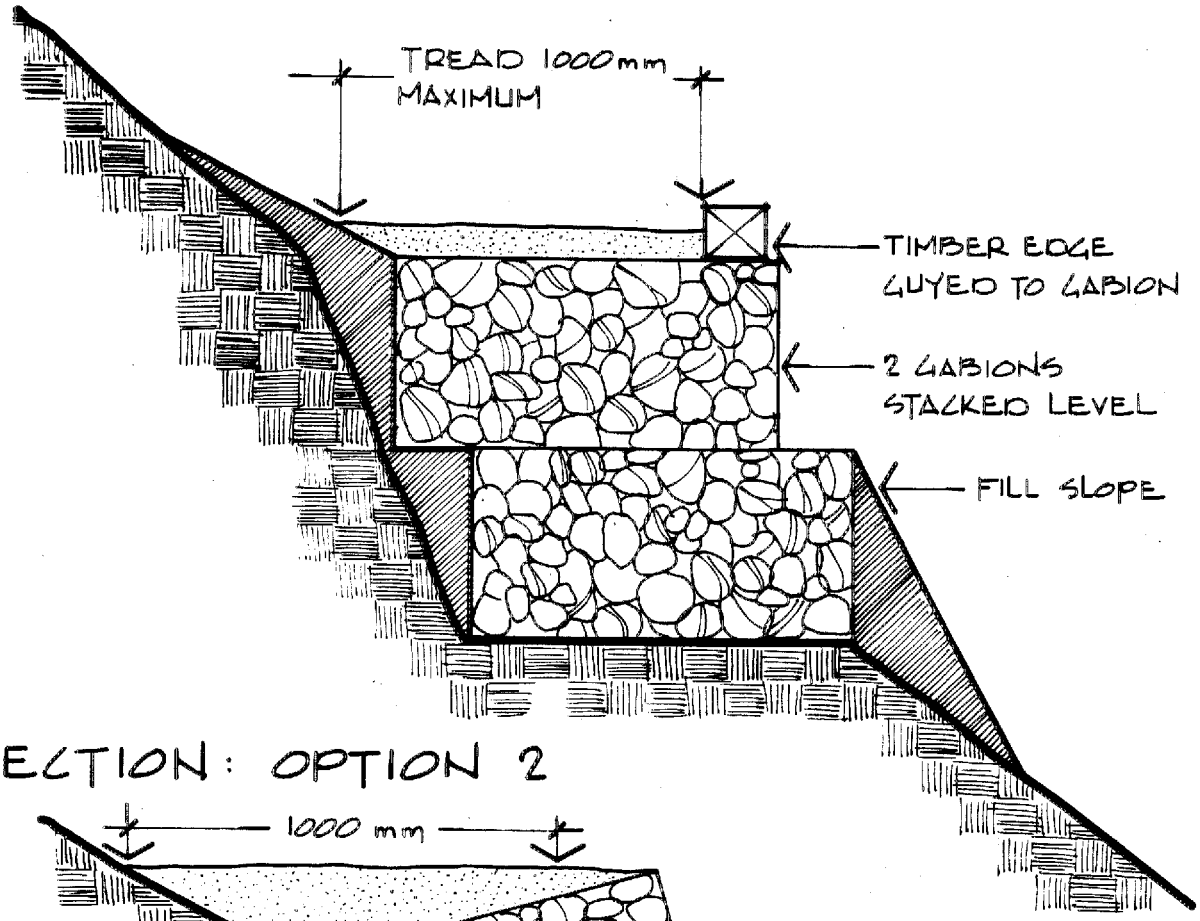


NOTE:

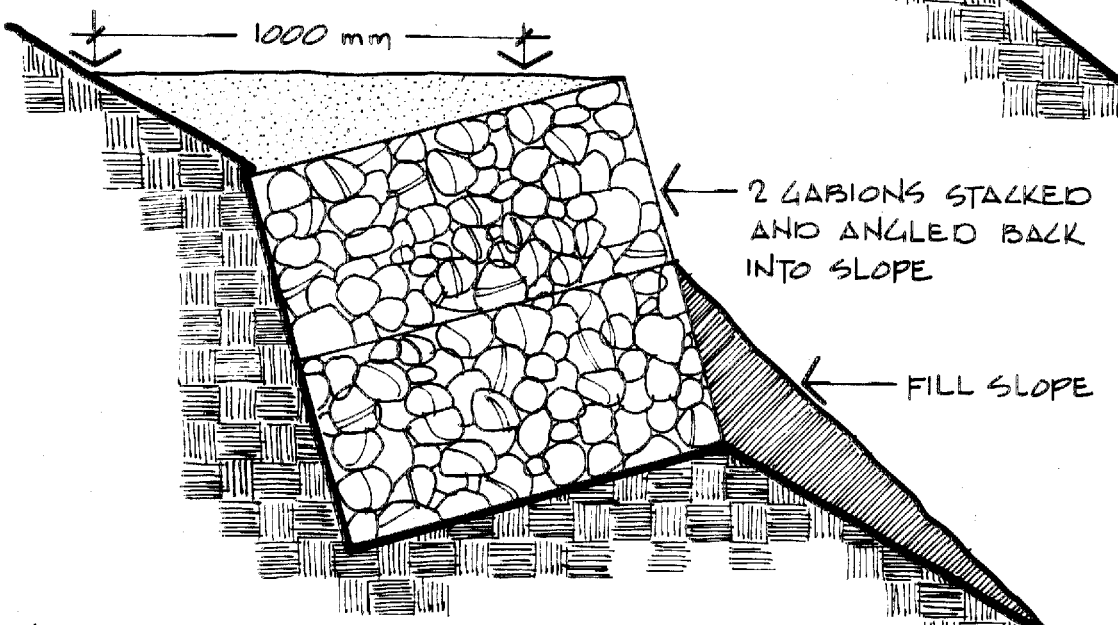
TO ENSURE SOLID CONSTRUCTION: PLACE PROPORTIONATELY LARGER ROCK AT BOTTOM OF WALL. GRADE SIZES SO THAT SMALLER ROCK IS AT CENTRE & LARGER ROCKS ARE AGAIN AT TOP. ENSURE EACH LAYER OF ROCK IS STABLE PRIOR TO BACKFILL. DO NOT MIX ROUND ROCK WITH SPLIT IN SAME WALL.

DRY STONE WALL

SECTION : OPTION 1



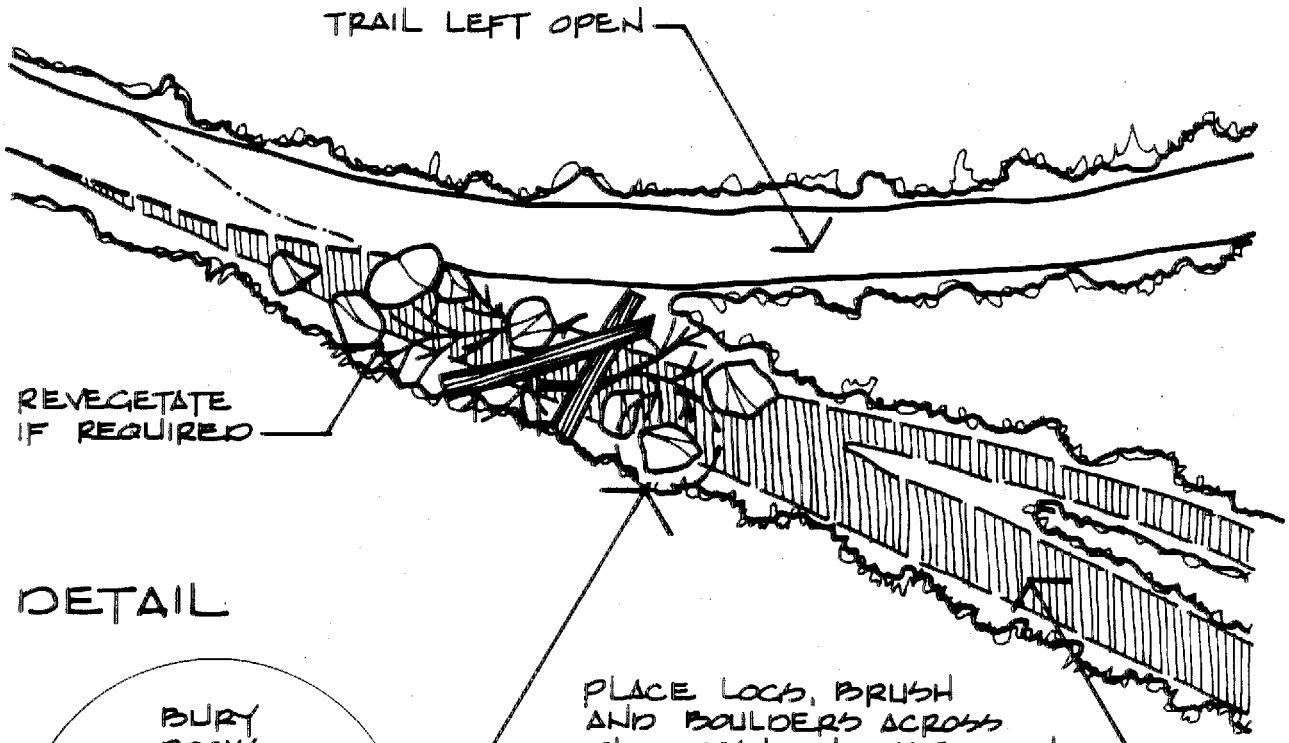
SECTION : OPTION 2



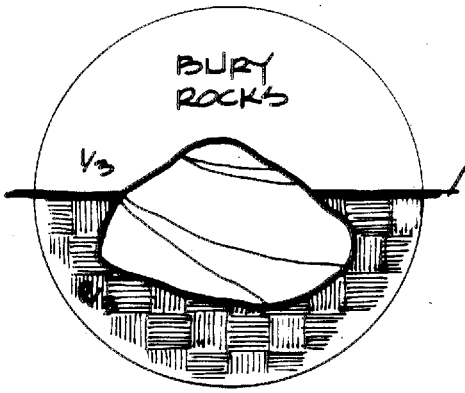
NOTE: THESE STACKING GABIONS TO BE USED ONLY WHERE OTHER RETAINING WALLS WILL NOT PROVIDE A STABLE TRAIL SURFACE ON STEEP SLOPES.

GABION RETAINING WALL

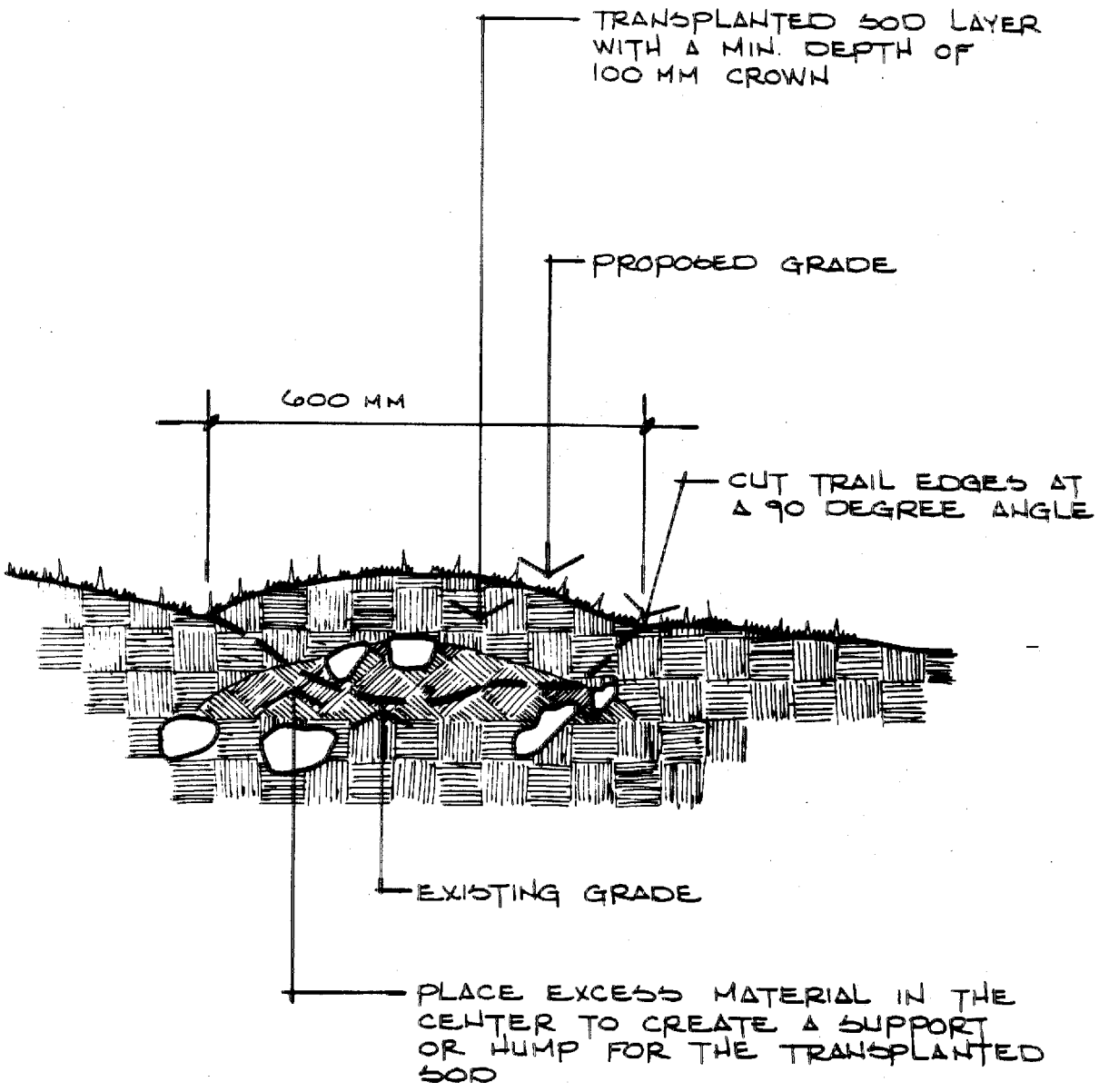
PLAN



DETAIL

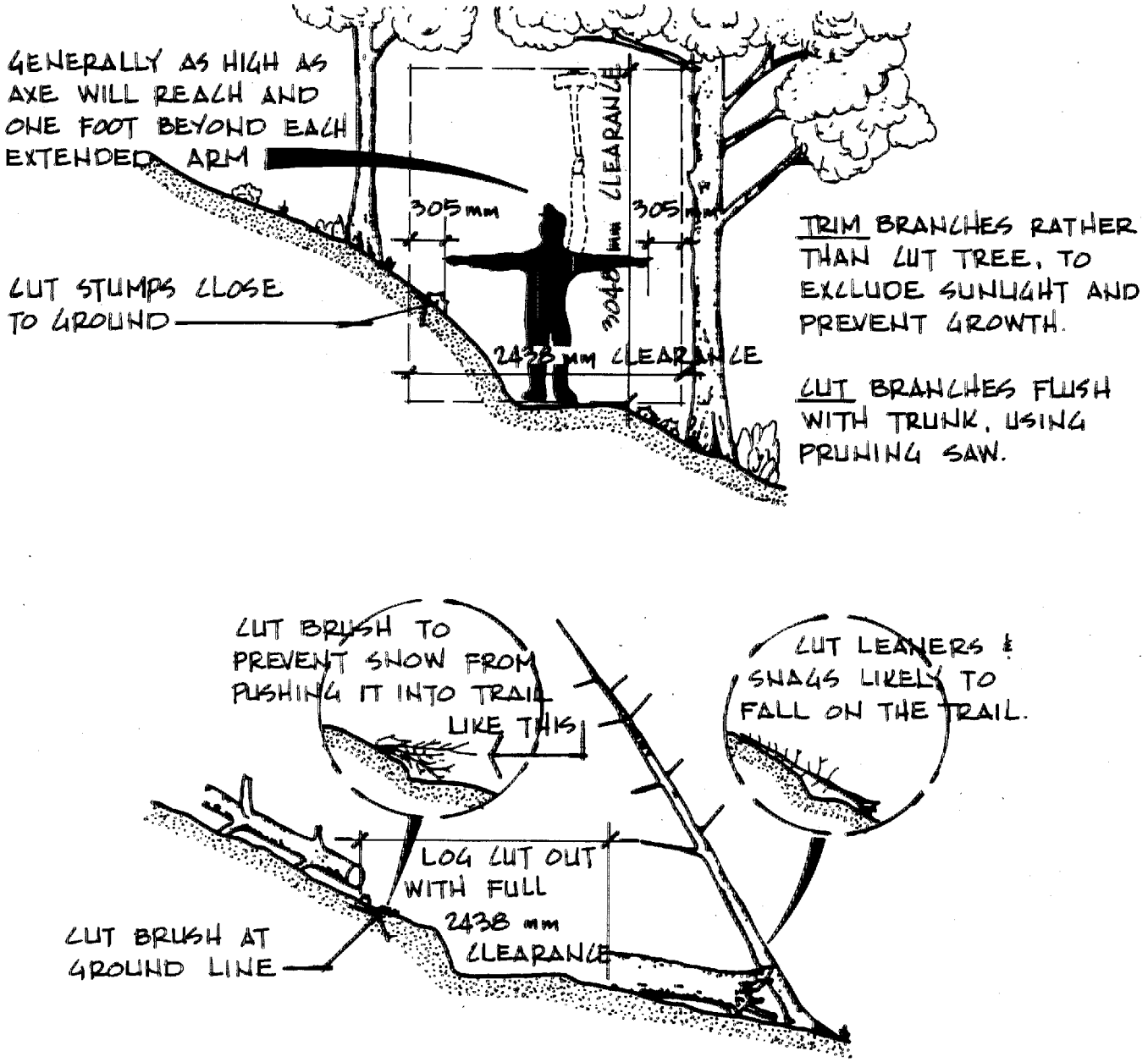


TRAIL CLOSURE & SCARIFICATION



NOTE: INSTALL NATIVE SOD MATERIAL AT A MIN. OF 100 MM WIDER THAN WIDTH OF AREA TO BE REHABILITATED. GENTLY TAMP DOWN TRANSPLANTED SOD AND FILL ALL VOIDS WITH ORGANIC MATERIAL SO THAT ROOTS ARE NOT EXPOSED TO THE AIR.

NATIVE SOD TRANSPLANTING



CLEARING NEW GROWTH