MOUNT RAINIER TRAILS MANAGEMENT HANDBOOK

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I. INTRODUCTION

This "Trails Management Handbook" presents guidelines for foot and horse trails. It has been prepared to assist NPS employees in selecting trail locations; in designing trails; in preparing the bases of trails, using various construction techniques; in following sign specifications; in choosing drainage methods; in considering overnight trail facilities; and in maintaining trails. Developing a well-planned trail will enhance and reinforce the visitors' experience.

Trails are not simply avenues for getting from one place to another; they offer visitors to the national parks opportunities to participate in numerous recreational activities. Trail users have special interests that are manifested in their desires to pursue specific trail-related activities. Whether viewing beautiful scenery, testing outdoor skills, escaping the confines of a structured environment, socializing with other users with similar interests, or even becoming better informed, the degree to which these pursuits are satisfied is a measure of the appropriateness of a trail.

Providing quality recreational opportunities while protecting the resource is a major trail management concern and challenge. Mode of travel, trail environment or setting, physical demands on the user, imposed controls, expectations of the user, and volume of use are translated into trail planning objectives and management criteria.

In addition, a trail should be designed and constructed to produce minimum disturbance to the natural environment, to ensure the safety and enjoyment of the users, to protect adjacent resources, to consider the aesthetic quality of an area, and to adequately function for the intended use. Long-term planning is needed to accomplish these goals. Anticipation of a potential environmental impact should be reflected in proper trail planning and development to minimize adverse effects or eliminate them entirely.

The guidelines are also presented to assist in trail management decisions. A supervisor in charge of a trail project, given the guidelines and the objectives of trail management, will make the appropriate decisions related to the specific trail that is being considered.

The topics discussed are in the normal sequence in which trail development occurs. Employees are encouraged to submit any comments as to the applicability or completeness of the information contained in this handbook.

For definitions of unfamiliar terms, please refer to the glossary in the back of the handbook.

Review and modification of this handbook is to be accomplished annually by April 1 under Maintenance Division leadership.

New trails will be constructed only with the permission of the Superintendent. New trails will be constructed in the Wilderness only when it is in the interest of resource protection and enhancement of Wilderness values or public safety. Where sections of trails are destroyed or damaged by natural events trail crew leaders may reroute up to several hundred feet of trail where it is not feasible

to rebuild original sections. Longer sections must have the approval of the Superintendent. Mitigation actions will be developed by an interdivisional team including representatives from Maintenance, Rangers and Natural Resource Planning, and the Safety Officer (as appropriate) for sections of trail where safety problems or major resource damage is occurring and routine maintenance is ineffective. Any upgrading of trail types must have prior permission from the Superintendent.

Much of the material included in this handbook is adapted or taken directly from the NPS Trails Management Handbook by Lennon Hooper, Denver Service Center Trails Coordinator.

Administrative Use of Mechanized Equipment

Use of mechanized equipment will be in accordance with Office Order 87-1. Justification for use of mechanized equipment in the Wilderness is required in accordance with the "minimum tool" guidelines stated in the Wilderness Plan. Annual Mechanized Equipment Use Reports will be prepared by the Maintenance and Ranger Divisions on their respective activities and will include, for each case, justifications used in determining that mechanized equipment was the minimum tool. This includes use of helicopters, chain saws, generators, etc. These reports will be submitted to the Superintendent by December 1 of each year.

II. SAFETY MESSAGE

The NPS "Safety Management Handbook," Occupational Safety and Health Administration regulations, and other federal agency safety standards should be used for safety guidelines in trail work. New employees will be given safety instructions and be trained or tested to ensure that they are physically able to competently use all of the tools on the job.

Trail crews frequently work in isolated areas where medical facilities are not readily available, and transportation of an injured person is often difficult and dangerous. Good safety practices demand that each crew member keep in good physical condition and maintain a high level of safety consciousness at all times, in camp as well as on the job. One member of the crew should be assigned the responsibility for safety. In addition, every employee must be his or her own safety inspector on the job, work in a safe manner, and point out unsafe practices to other crew members.

THINK SAFETY

In Mount Rainier National Park there is no trail maintenance or construction job that is important enough to sacrifice safety. Your health and the visitor's safety are too important to overlook any aspect of safety.

III. LOCATION GUIDELINES

The specific objectives of trail location are to design a trail that produces a minimum impact on the land, to choose a corridor that is visually pleasing, to take advantage of natural terrain and vegetation, and to provide a trail that requires minimum maintenance.

In addition to a knowledge of the location objectives, a trail locator should envision the completed trail while proceeding along a selected corridor. A mental perspective is gained through experience in laying out trails, in supervising or observing construction, and in critiqueing the final product against the location criteria. A well-located and well-designed trail should reflect the mood and atmosphere of the area it traverses.

A trail locator should also be aware of the terrain, vegetation, soil types, weather (wind, rain, snow), drainage patterns, and cultural resources along and adjacent to a trail corridor. All of these factors and many more directly influence where the trail should be located and subsequently how well the trail will function.

GENERAL CRITERIA

The following general guidelines are to assist in selecting a trail location:

Existing trails should be integrated with new construction as much as possible providing old trails were properly laid out and have good drainage.

The route should be planned for minimum maintenance while providing maximum ecological variety (i.e., use forest edges bordering meadows, rather than crossing meadows, when possible).

Location should be suitable for both winter and summer activities to the degree that visitor or management needs, terrain, and climatic patterns will allow.

Access points to trailheads should be provided as feasible.

Exposure on high elevation ridges may be necessary and scenic but not mile after mile.

For interpretative purposes, the trail should meander to take advantage of scenic panoramas and historic, cultural and natural resources.

Main trail networks should be located to disperse visitors away from fragile or heavily used areas.

Aerial photography should be used to locate features of scenic, scientific, and recreational values. An aerial flight over a proposed trail corridor would also be helpful (in accordance with park minimum tool guidelines).

SPECIFIC CRITERIA

The following specific guidelines must also be considered when selecting a trail location:

Wildlife

Areas of critical or sensitive habitat will be avoided.

Trails should skirt areas where big-game species concentrate; however, trails may contain vistas, observation points, or overlooks for observing wildlife at a distance.

A trail will avoid areas where potentially serious impacts on plants or animals may occur.

Soils

Trails should be located on stable soils except where short sections, up to 50 yards, could be structurally contained and/or a relocation could create more conflict in construction and maintenance.

A trail should be routed around extended bedrock areas except where grade or possible scenic features make a crossing desirable.

Soil maps should be developed and used to locate unstable soil areas and to identify feasible areas for trail location and construction.

Some soils are not suitable for trail tread, and alternative material must be provided (see Chapter V).

Road and River Crossings

Special attention should be given to the problems that traffic and traffic-related noise could create for hikers and horse riders.

When roads are crossed at grade, adequate sign marking and visibility must be provided.

Scenery and Drinking Water

A trail should be located to overlook streams and lakes but not be directly adjacent to the water's edge.

Meander trails should provide water access points for visitors, as well as for pack and saddle stock. Water should be available every one to four hours of travel.

Safety Hazards

Talus slopes or rockslide areas should be avoided.

Avalanche zones should also be avoided.

Abrupt or unexposed cliffs should be avoided.

Areas with concentrated numbers of snags should be avoided if possible. If not, plan during construction to remove snags that are adjacent to the trail in accordance with the park hazard tree plan.

A trail should, if possible, avoid areas of erosion, snowbanks, bogging, or icy surface potential.

Severe high wind corridors and lightning prone areas should be avoided.

Natural shelters along trail should be used.

Bridge crossings should be avoided if a relocation of a trail could make the structure unnecessary.

Natural or existing features should be used to allow visitors an easy and quick crossing without breaking the continuity of a trail.

Trail crossings over or under roads, aqueducts, underpasses, bridges, and power transmission lines should be made at right angles to minimize cost if a structural installation is necessary and to avoid prolonged visual contact with those features.

A trail should enter and leave water on a descending and ascending grade parallel to the shoreline to prevent water from draining down the trail.

Stream fords should be over cobblestone-sized (or smaller) rocks. Any abundance of 10-inch diameter (or larger) rocks that make horse crossings dangerous should be removed or avoided.

Alignment

The ideal alignment should offer visitors the best views from the trail.

The alignment should follow the contours of the land and be generally curved. Sharp angular turns over 50 degrees and long straight stretches should be avoided.

Hillside alignments should, whenever possible, angle across the natural slope and take advantage of natural drainage to minimize the need for major drainage modifications. Proper drainage is a long-term investment, which pays off in reduced future trail maintenance.

The most desirable alignment for a switchback uses a topographic feature as a turning point to prevent cutting across the natural terrain.

Provisions for screening and protecting the switchbacks with trees or brush should be incorporated into the design when the trail cannot be constructed around a natural topographic feature.

A trail should not appear to be carved out of a hillside.

Grade

A clinometer or Abney level should be used to determine grades. (Do not set by guesswork.)

Trail grades should be contoured to avoid steep topography where possible.

As a general rule, a grade should not be steeper than 15 percent (15-foot rise in 100 linear feet). Grades of less than 7 percent are ideal. See page 31 for further description (Type B).

Generally, steps are recommended for any short stretches where a grade is steeper than 25 percent. (Steps are not recommended on horse trails.)

No grade should be so steep that erosion is a continuous problem.

Trails should not be located at zero grades, if possible, because some grade is desirable to provide for proper drainage.

A grade should undulate gently to provide natural drainage and to eliminate monotonous level stretches and long steep grades that are tiring to trail users.

Grades should be reduced at approaches to switchbacks, and the turns should be as nearly level as practical.

A trail designed especially for hikers could incorporate short sections of steps or steeper grades within the controls indicated if these will not cause undue disturbance and adequate drainage can be provided to prevent erosion.

Major consideration must be given to soil types, climatic conditions, volume and type of use, and location when planning grades to ensure minimum trail erosion.

Any new trail construction proposed over and above short or minor reroutes, may require NEPA and/or XXX compliance documents. Rudimentary training will be presented by the Regional Archeologist to sensitize crew leaders to cultural evidence.

IV. DESIGN GUIDELINES

The design of trails should be in keeping with the purpose of a trail. In general, a trail should be designed to produce minimum disturbance to the natural environment. A trail design should also consider the safety and enjoyment of the users, the volume and type of traffic, the protection of adjacent resources, and the aesthetic quality of an area. The design should also incorporate features to minimize adverse impacts on the environment, result in a trail of high quality and durability, and require the lowest cost to maintain.

SPECIFIC DESIGN ELEMENTS

Dimensions

Trail dimensions should be based on the type and volume of use anticipated, on the stability of native materials, and on the type of terrain along the route. Generally, a trail tread width should not be less than 18 inches (minimum) for foot trails (except for Type C trails) and 24 inches (minimum) for horse trails. Additional width could be required to reduce impacts from heavy traffic.

The following exceptions to the above trail dimensions should be noted.

Along a precipice, steep hillside, or hazardous area, where possible a trail base may be wider to allow safe use of the trail.

A tread at least 36 inches wide should be used for special trail sections, such as fords through small streams or built-up sections across flat areas.

Switchback landings and graded trails should be designed to minimize the amount of excavation and the amount of bank that has to be cut.

Clearing Requirements

Clearing requirements vary with the intended trail use.

Bushes and trees should be cut flush with the ground, and then exposed stumps should be covered with soil. Trees and stumps should be removed if the tree roots will interfere with grading.

Clearings at waterholes, resting places, and scenic points should be wide enough to allow stock to pass if riders of a party are dismounted.

Chain saws should not be used to clear limbs because of safety and noise factors and the likelihood of scarring tree trunks. Tree limbs should be cut flush to the tree and then scattered away from the trail. The butt ends of limbs should face away from the trail. Limb stubs should be painted to hide tree scars if desirable in scenic locations. Every effort should be taken to make the scene look natural, with minimal impact from man.

Trail Structures

Structures should generally be of quality material to permit long life and be designed to harmonize with the surrounding environment.

Minor structures such as corduroy, puncheon (elevated sections), retaining walls,and foot bridges (under 30 feet) could be built of suitable native material in accordance with material stipulation (Chapter V). When native material is used, the site from which it was removed should be left with as natural an appearance as possible.

Bridges located in high volume areas should be solid and have hand railings so children cannot easily slip through.

Wheelchair accessibility, where provided, requires a smooth transition from the trail surface to the bridge.

In the designated Wilderness, structures should be limited to those necessary for user safety, built from natural material when possible, and must conform to the requirements of the Wilderness Act.

If a bridge is not necessary for horses to cross a stream, a large log with a hand railing may be provided for trail users.

The Denver Service Center will provide special designs for crossings of rivers when needed.

Trail Surface

When native soil cannot support the traffic, tread-surfacing material should be used which blends with and preserves the natural environment. This material should also be used to minimize severe conditions of erosion, dust, mud, or loose rock.

User Facilities

Trailhead loading docks, sanitary facilities, parking areas, and water supplies should be given individual analysis and design. If it is administratively decided to construct such facilities, local trail clubs may be helpful. Also, the Denver Service Center may provide plans and guidance.

Revegetation

During the design process, adequate revegetation should be planned for cut-and-fill slopes, borrow pits, or other areas where surface vegetation has been removed. Follow-up action should be included to ensure complete revegetation. Seed mixes, volume of application (pounds per acre), and season of application should be keyed to local conditions.

V. BASE CONSTRUCTION GUIDELINES

The existing ground surface should not be unnecessarily disturbed to obtain a trail base, especially on flat areas. On level ground, the trail base should be formed by building up rather than cutting down. All duff should be removed before making cuts or fills for the tread.

Construction of hillside trails usually requires grading a shelf for the trail, but if the existing surface is flat and provides a suitable tread, it should be left undisturbed. Hillside excavation may not be necessary on slopes less than 10 percent.

On slopes, grading should start at the upper slope stake and continue down to the finished grade. The usual procedure is to scratch a continuous line between the upper slope stakes, using a shovel or Pulaski. Excavation should begin along this line. The working surface should be kept level or slightly in-slope until the final grade is reached. On slopes 20 percent or over, the trail base should be constructed totally in native soils. Fills on slopes greater than 20 percent are hard to maintain, and fills on slopes that exceed 40 percent are often unsafe for horse traffic. They tend, when wet, to overload the downslope, leading to soil creep and slump not only in the fill section but also in the underlying slope, and to extensive shear-cracking in the tread. (Some park specifications require full-bench construction on sideslopes of over 20 percent.

A soil berm along the outside of a trail should only be used when the trail fill consists of loose, disintegrated granite or other unstable material that may erode easily. The use of a soil berm is related to special handling of surface runoff drainage (see Berm Surface illustration). In areas with annual precipitation, the outer edge of the trail should be at least 2 inches lower than the inside.

A rock berm should be used for safety purposes on horse trails where the sideslope is 80 percent or greater to keep the horse from walking on the outer edge. The trail base should also be widened to provide an adequate tread area. If soil or rock berms are used, more frequent maintenance is usually required to keep the berm intact.

Every effort should be made to locate a trail around problem areas. Constructing a trail in lowland areas normally requires special construction techniques, such as turnpike, puncheon, or corduroy.

Material Sources

Whenever possible, material will be hauled in. However, material will be stored only when necessary; out of sight of main travelways, and where damage to vegetation is minimal. Materials will not be stockpiled for more than two years. All construction debris/materials will be removed when maintenance is complete.

Use of appropriate natural materials such as wood will be encouraged in the Wilderness. Use of manmade materials such as fiberglass or metal culverts, is acceptable only where they will not remain visible. Where gravel is used it will be incorporated into the trail and not predominantly on the surface.

When there are no alternatives to the use of on-site materials the following priorities will be used for selecting materials for trail maintenance and construction.

Rock: Use of more than one cubic yard of rock must be approved by the Superintendent.

Any rock removed from subalpine or alpine areas must be approved by the Superintendent.

Sources of rock in amounts up to approximately one cubic yard from the same general location may be used in the following priorities:

1. Rock removed from clearing and cleaning tread, travelways and ditches and from restoring designated backslopes.

2. Talus slope rock (fist size or larger).

3. Floodplains where the bed is approximately 50% or more rockcovered and where removal will not disturb vegetation or cause erosion and result in sedimentation into surface waters.

4. Scree slopes (rock smaller than fist size).

5. Rocks on forest floor.

Wood: On-site sources of wood will be used in the following priorities:

1. Trees cut when clearing travelway or left from unneeded structures.

2. Down trees.

3. Standing trees no more than 6" diameter breast height. These will be cut flush to the ground.

4. Larger trees may be utilized only with approval of Superintendent.

Soil: No soil will be removed from vegetated areas. Sources of soil will be used in the following priorities up to one cubic yard (use of more than one cubic yard or sources other than those listed below must have prior permission from the Superintendent). Top soil and duff will not be removed since these serve as seed banks. Underlying mineral soil may be removed but top soil and duff must be replaced.

1. Sluffs on trail; silt runoff from drainage facilities; excavated soil from cleaning or construction facilities; soil from restoring backslopes or berms.

2. Sand or silt from floodplains where vegetation is not disturbed and where removal will not result in sedimentation of surface waters; and not from within 200 feet of inlets and outlets. No material will be removed from lakes.

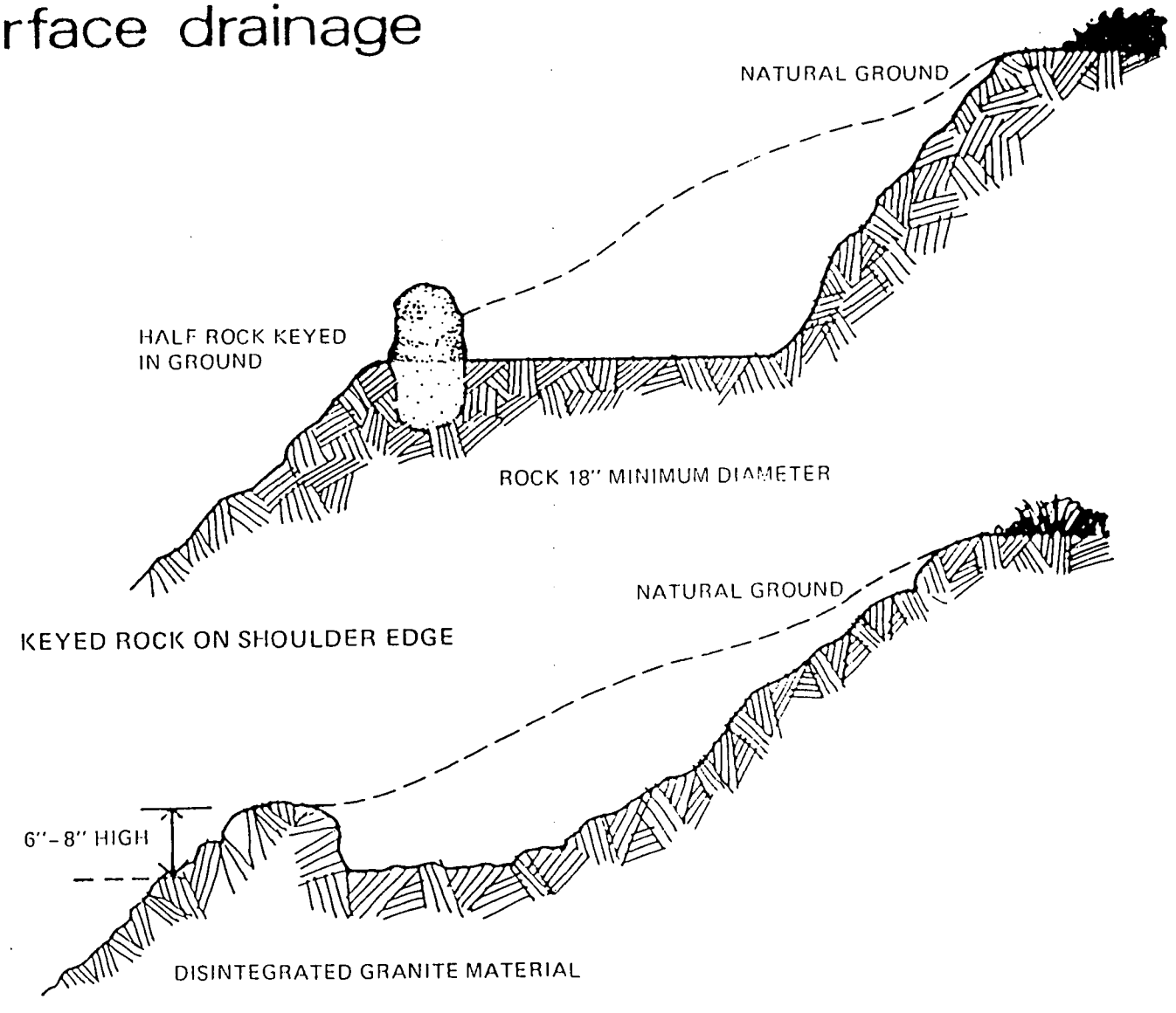
3. Soil may be removed from the lower 2/3 of root balls of fallen trees. The upper 1/3 of the rootball and soil should be left in tact to provide a seedbed for plants based on performance studies in Olympic National Park. Soil should not be removed from the hole created by the overturned tree since this habitat is an important component of the forest ecosystem.

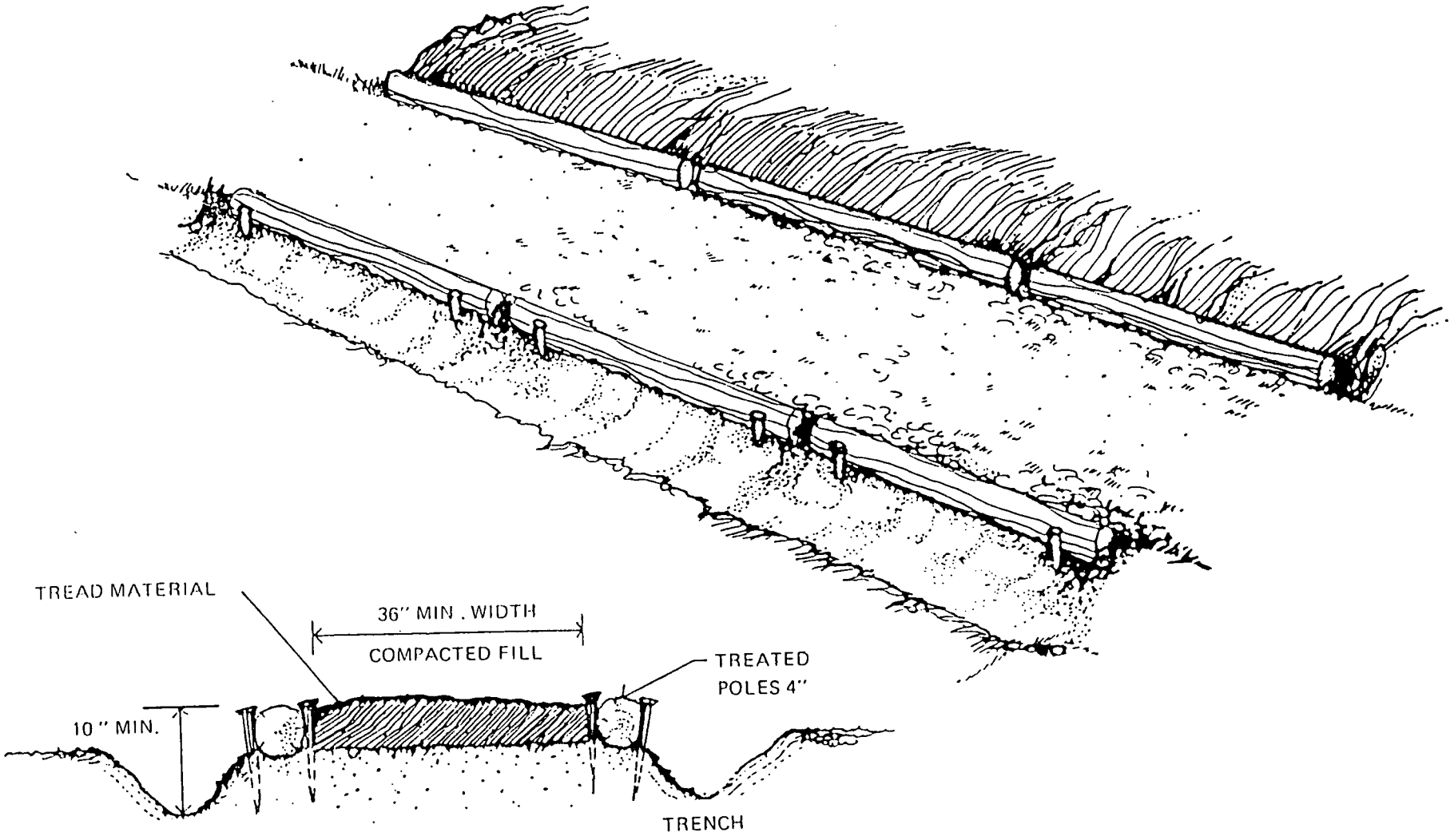
TURNPIKE CONSTRUCTION

Turnpiking is a process of using material from parallel side ditches to build up the trail base (see Turnpike Section illustration). This process should be used primarily in flat areas that are wet or become wet during the rainy season. The most important consideration should be to get the water level down below the trail base and carry the water under and away from the trail at frequent intervals. When ditch material is of poor boggy soil, it may be necessary to import better material in accordance with minimum tool guidelines to build up the base. Blasting techniques may be used to form these ditches. Only properly trained and certified personnel may be permitted to do the blasting.

Small boggy areas in the trail should be filled with large, flat rocks,, if practical. This is an effective way to treat these areas, but to give a satisfactory footing the rocks should be covered with gravel or another stable material as a tread.

berm-surface drainage





turnpike section

PUNCHEON CONSTRUCTION

Puncheon construction uses sawed timber or native logs (in accordance with stipulations noted under Material Sources, Chapter V) to elevate the trail tread above wet areas when it is not feasible to use a turnpike process (see Built-up Puncheon illustration).

Puncheon consists of a deck, or flooring, approximately 4-feet wide using treated planks or adzed logs laid on stringers. The stringers should be set on mud sills and should generally be placed at each edge of the widened trail at about 3-foot centers. The mud sills should be set at right angles to the trail at 6- to 8-foot intervals. Proper drainage should be provided under the stringers and mud sills.

The puncheon should be leveled from side-to-side, and the entire structure should extend far enough so that soft spots or jump-offs do not develop at the ends. Approaches to each end should be installed on a modest grade, not to exceed 5 percent. In backcountry areas, a step up may be used.

The decking should be securely spiked to the stringers, and a binding pole or guard should be spiked along each edge to keep traffic in the center of the puncheon. Where practical to do so in areas with less than 60 inches of rainfall a year, the utility and life of the structure can be increased by covering the deck with a layer of dirt to cushion the traffic and safe wear on the deck planks caused by shod horses.

If surfacing is required, whenever possible, material will be hauled in. Gravel should be loaded by hand and hauled by duffel carrier, wheelbarrow, or packhorse panniers, when mechanized access is not possible and practical.

The depth-and-width of surfacing should be determined in each case based on the quality of the material and the use anticipated on a trail. As a general rule, 3 inches of gravel should last three to five years, allowing for 10 to 15 horses per day over the trail.

RETAINING WALLS (CRIBBING)

Retaining walls are structures of wood or stone designed to stabilize a trail base on a sideslope. Sound durable rocks having a good bearing surface are the preferred structural material. Native logs or other untreated timber would be used only if rock is not readily available and only when sideslopes do not exceed 50 percent. A solid foundation on earth or rock is a must to obtain a rigid, safe retaining wall.

The thickness of a rock retaining wall at the base should be at least one-half the height of the wall, or a minimum of 2 feet if the vertical height is less than 5 feet.

Joints in the walls should always be staggered at least 6 inches or more horizontally. At least one-fourth of the front and rear faces of the wall should be headers having a length of at least two and one-half times their thickness. All headers should be laid with their greatest dimension extending into the wall

and never parallel to it except at corners. Here, alternating headers should cross. All projecting points should be removed from the top and the bottom of the main rocks so that each is laid with good bearing on the broadest face. The outer face of the wall should have an inward slope of at least 3 inches to every foot of height. The wall should have a front and rear face well-tied together with header stones of suitable size.

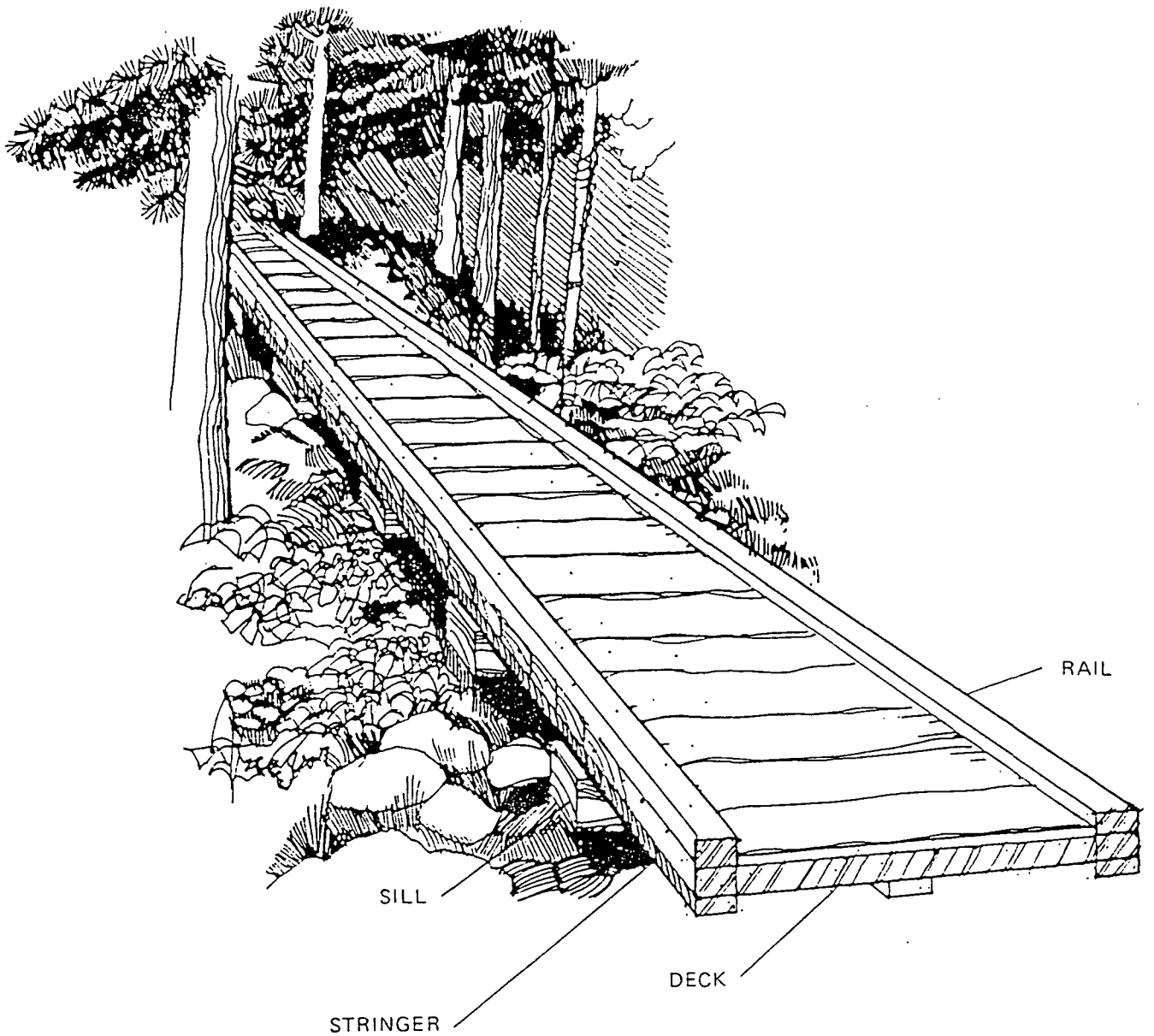
Drainage is required around, beneath, or through the retaining wall so that water will not accumulate behind it.

SWITCHBACK CONSTRUCTION

Switchback construction is a method of gaining required elevation in steep country without making the trail too steep or when there is a limited working area. The technique is to reverse trail direction as often as necessary to achieve the required elevation gain (loss) while maintaining grade. Switchbacks also help prevent erosion by reducing the required steepness of the climb and by providing plans for water to leave the trail.

When switchbacks are necessary, the turns should be constructed as flat as possible. On sideslopes of less than 20 percent, the switchback should be treated as any other section of the trail by following a long radius curve. If this results in the centerline grade being steeper than desired, the radius should be shortened, and a conventional 8-foot radius switchback should be built, with the grade of the upper and lower legs meeting at the radius point. Excavation should start along the upper leg and should be carried down to grade at the radius point before starting the lower leg. In order to provide properdrainage, the upper leg should be cut well out beyond the radius point, then shaped, and the turn area completed (see Switchback illustration). When possible the frequency and visibility of turns should be limited to avoid shortcutting. Also, the layout should vary.

Rock or log barriers should be installed between the lower and upper legs of the switchback. Provide 15 to 30 feet of barrier back from the turning point to prevent foot or horse traffic from cross-cutting inside the switchback, creating ruts followed by erosion.

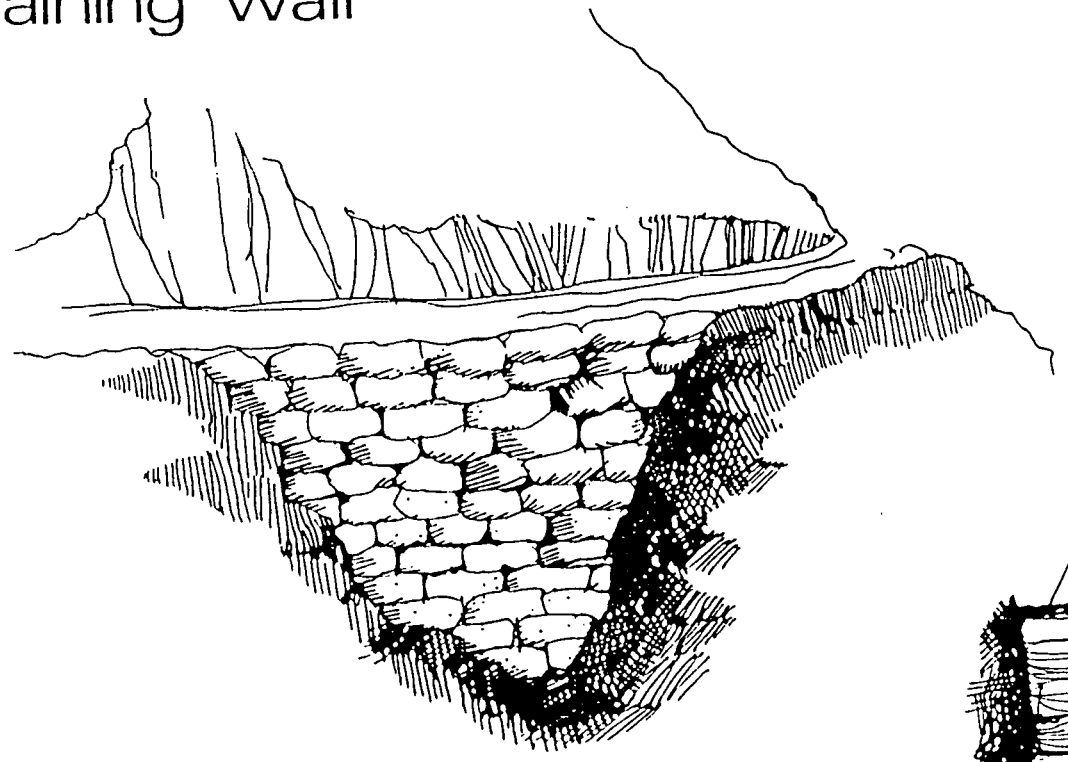


NOTE: This illustrates the highest materials standard permitted for Type B or C trails. More primitive materials are encouraged.

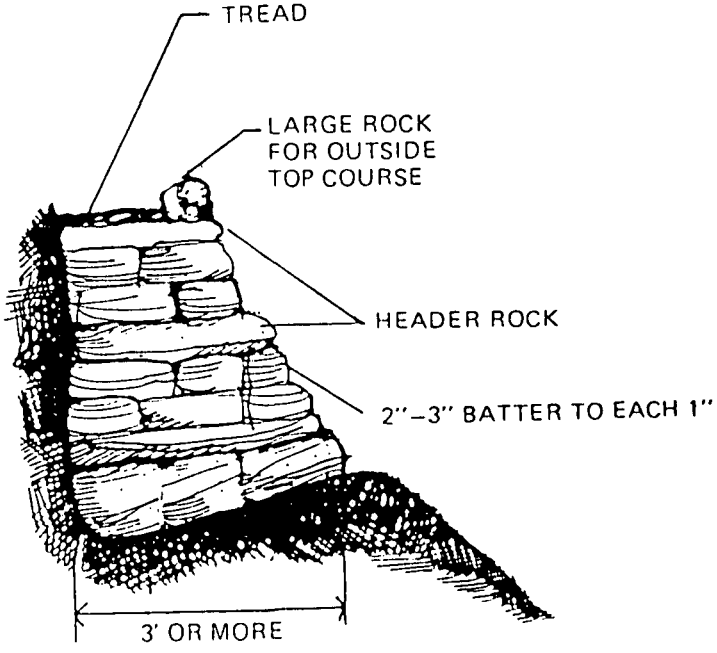
built up puncheon

USING DIMENSION LUMBER

retaining wall

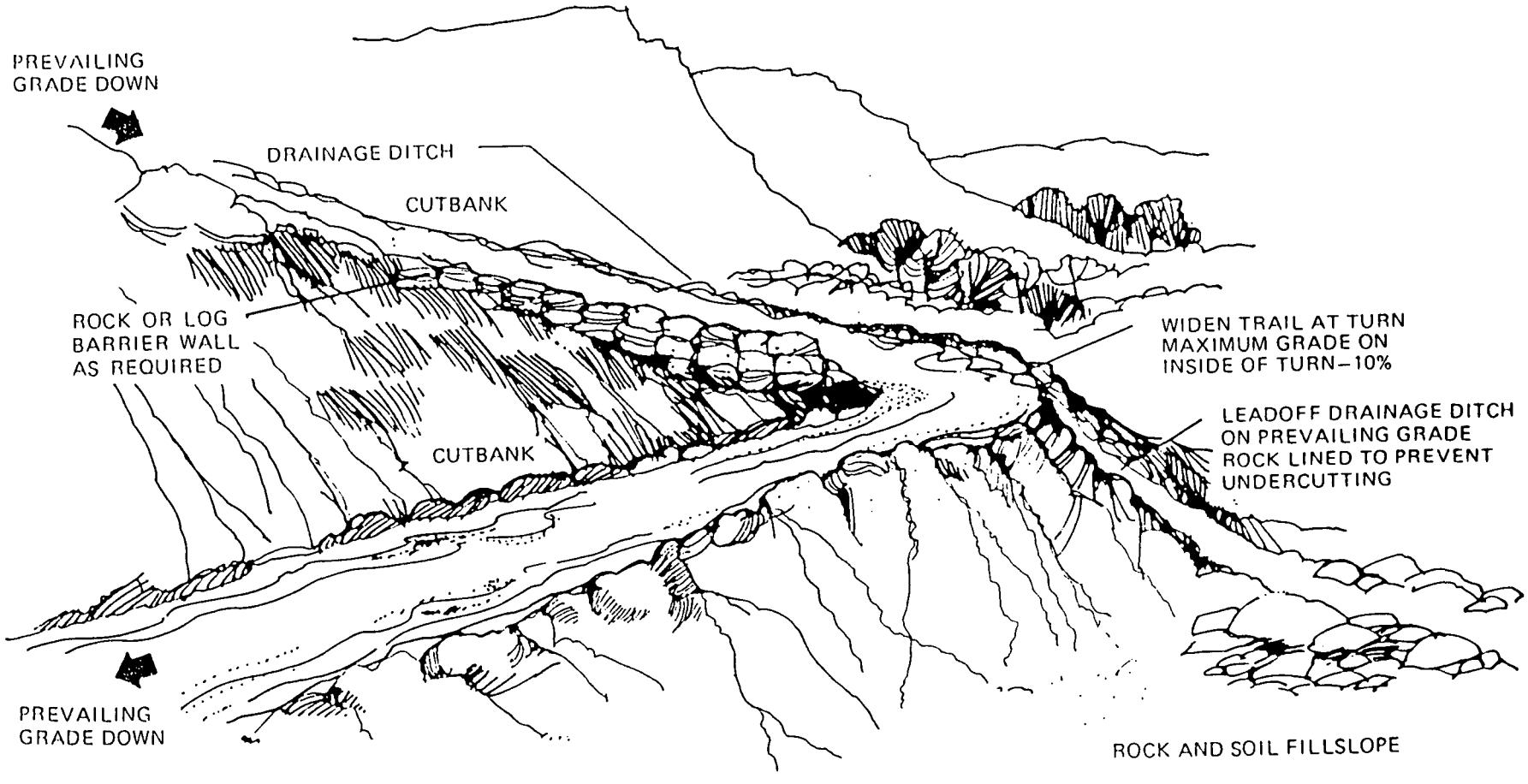


PREPARE A FOOTING IN SOLID EARTH OR ROCK
USE LARGEST ROCKS ON BOTTOM
FOR HEADERS' USE LARGE LONG ROCKS



CROSS SECTION

switchback


PREVAILING
GRADE DOWN
DRAINAGE DITCH
CUTBANK
ROCK OR LOG
BARRIER WALL
AS REQUIRED
WIDEN TRAIL AT TURN
MAXIMUM GRADE ON
INSIDE OF TURN–10%
LEADOFF DRAINAGE DITCH
ON PREVAILING GRADE
ROCK LINED TO PREVENT
UNDERCUTTING
CUTBANK
PREVAILING
GRADE DOWN
ROCK AND SOIL FILLSLOPE

VI. SIGNING

Signs shall meet the standards established in the park's Sign Plan.

VII. DRAINAGE GUIDELINES

No factor in trail construction is more important than proper drainage. Many sections of trail have been damaged or destroyed by erosion that could have been prevented. All drainage should be planned far ahead of construction.

DRAINAGE METHODS

Perhaps the most troublesome drainage problem in trail construction is subsurface water. The best solution for extensive subsurface water on flat ground is to relocate the trail on a hillside, if possible, and bypass the trouble. If this is not practical, the next best solution is to lower the water table and permit the ground above to dry out sufficiently to support the trail loads. As a last resort, puncheon or turnpike construction should be used to raise the trail level.

In some cases, drainage ditches can be dug to divert subsurface water into a stream. Drainage ditches should be designed and built to provide continuous service without unusual maintenance. Perforated culverts, or French drains, should be used when open ditches are not practical.

Minimize the use of inside drainage and inside drainage ditches. Proper location of trails and the use of proper backsloping and outsloping will negate the need for almost all inside drainage.

Surface water will flow along a trail and erode the trail surface if allowed to accumulate above a certain critical combination for soil type, slope, and velocity. Any provision for the discharge of surface water should include precautionary measures to prevent silting, erosion, or gullying of areas off a trail. Rock placement at the discharge point should help dissipate the water and stop erosion.

Surface water can be diverted by outsloping, grade dips, water bars, culverts, ditches, and by varying the trail grade when it is constructed. Approximately 1/2 to 1 inch per 18 inches of slope across the trail tread is normally sufficient, but this should be based on a specific soil type. The best method to use when dealing with surface water would be to reduce the length of time running water is allowed to stay on the tread by increasing the frequency of structures designed to remove water.

Outsloping

Outsloping is most satisfactory when used in combination with grade dips and should not exceed 1 inch in 18 inches. Outsloping of the tread is probably the best, most commonly used method to divert surface water. This method requires periodic maintenance to prevent the formation of a rut or channel in the trail.

Grade Dips (Coweeta Dips)

Grade dips are sections of trail where a short piece of the trail, generally 5 to 15 feet, has been built with a grade slightly adverse to the prevailing grade of the trail (see Grade Dips illustration).

The trail should be outsloped at a low point in a dip to divert the water from the trail. Grade dips are most satisfactory when they are built as part of the original construction and when the designed grade allows for the adverse grade. They are cost-effective in controlling erosion and reducing the monotony of long-sustained grades. They are far more maintenancee-free than water bars. In some cases the upper portion of a grade dip may be too steep for proper maintenance. An alternate method in this case is to build water bars.

Water Bars

Effective water bars minimize the speed, volume, and distance travelled by water down a trail. The actual number and spacing of water bars depends on the steepness of slope, the amount of water entering a trail, the construction of the tread (hillsides or steps), and the availability of places to divert water. Generally, the greater the slope and the more water channelled by a trail, the greater the need for water bars. Placement should be near the top of the slope to catch water before it gains momentum.

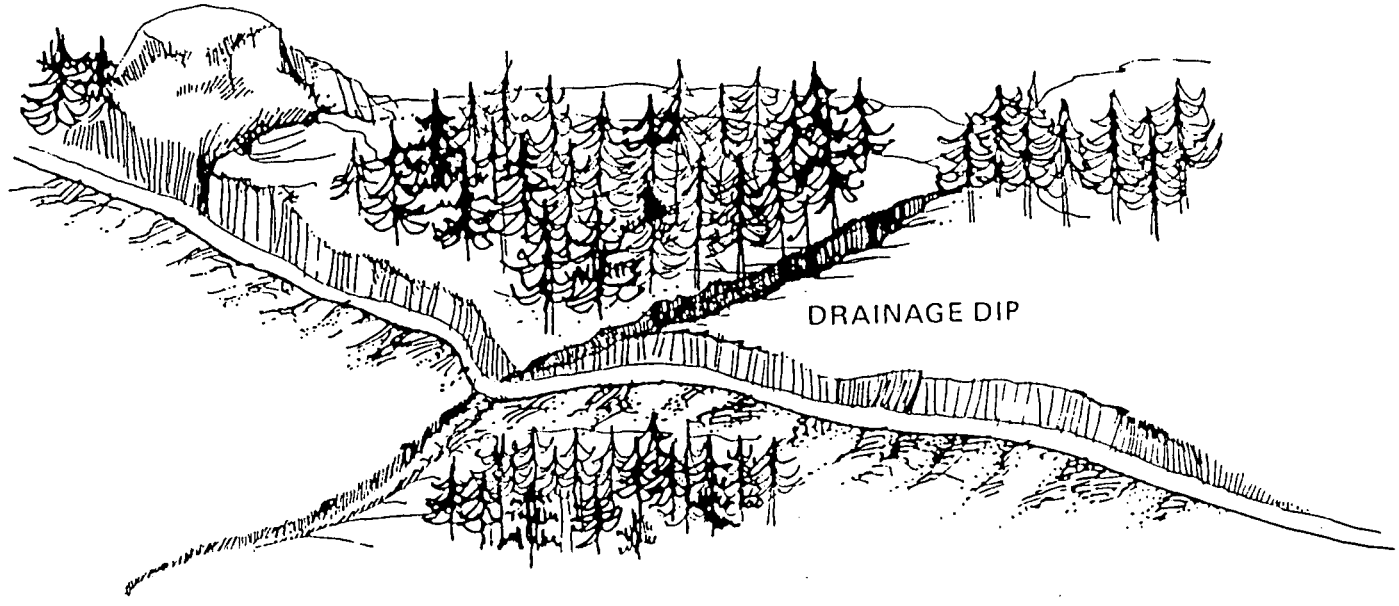
To build either a rock or log water bar, a trench should be dug across the trail at a 30- to 45-degree angle. Bars placed at less than 30 degrees may slow water too much, causing the bar to clog with silt and debris. Bars placed at 30 to 45 degrees or more tend to clean themselves as water flows freely off the trail. Bars placed at more than 45 degrees produce scour erosion along the bar face. The trench should be free of rocks and roots (see Rock Water Bar illustration).

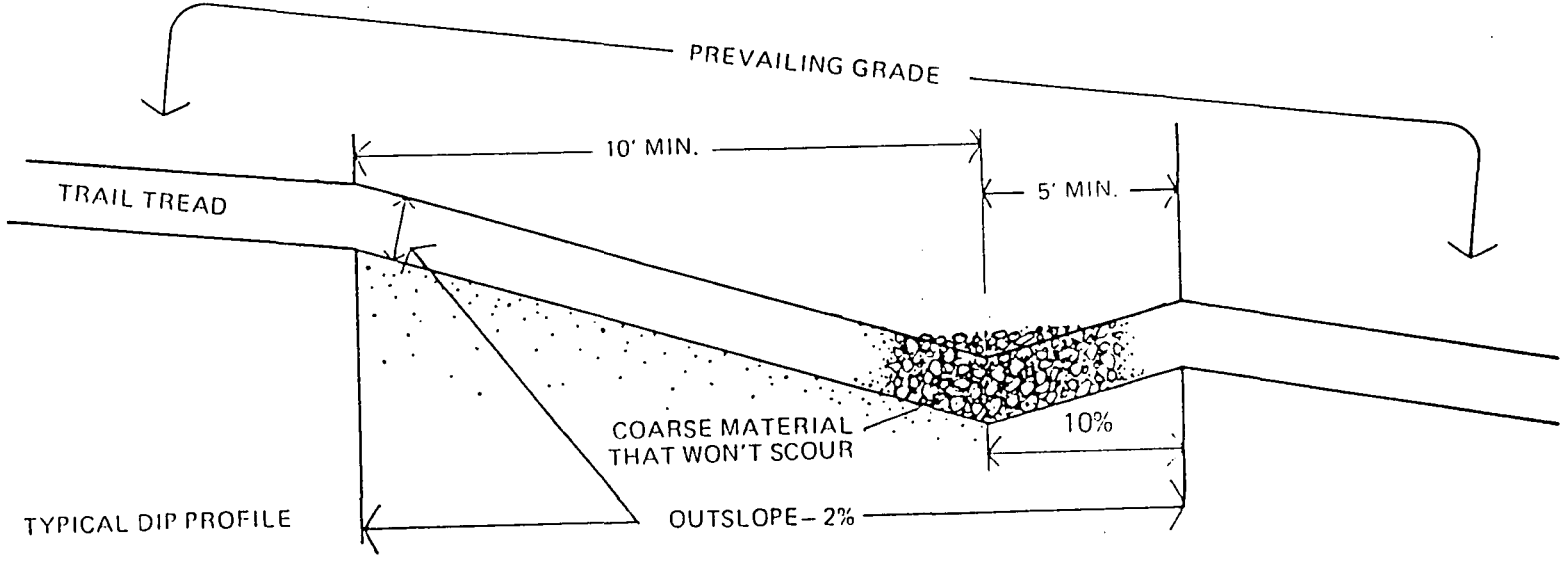
If using wood, a log should be placed in the trench, with over half of its diameter below the tread. The log should be solidly placed, if possible, wedging it between rocks and a ledge. If using stakes, the uphill side of the log should be notched before installation to accept each stake driven. Set into the log in this way, the stakes should not catch debris that could clog the water bar (see Log Water Bar illustration). Water bars are normally found only on general hiking trails.

Culverts

Culverts are primarily used to pass water under and across a trail. Culverts are most effective in natural drainages where minimum excavation is required. In flat lowlands requiring turnpike tread sections, culverts act as equalizing channels to reduce the damming effect of the built-up tread.

Culverts should be made of natural materials in Wilderness, where possible. However, culverts may be metal, concrete, wood, rock, plastic, or any other suitable material (see Log Culvert and Rock Culvert illustrations). Culverts should be installed with a gradient of at least 2 percent and properly bedded to ensure continued performance. The exception would be flatland application. A minimum of 6 inches of soil (free of sharp rocks) is recommended for pipe cover. Pipe diameters less than 12 inches may present frequent cleaning problems.



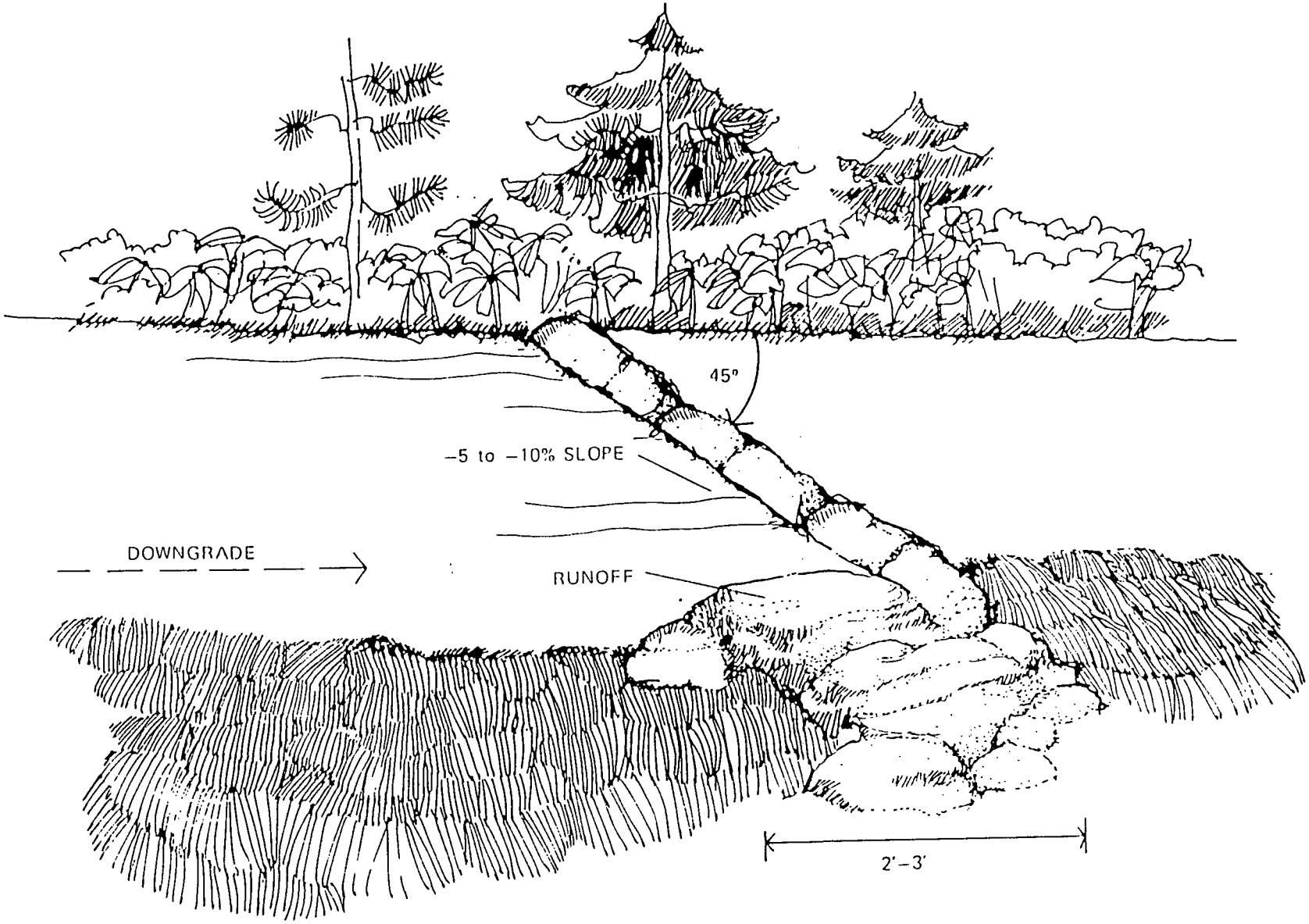


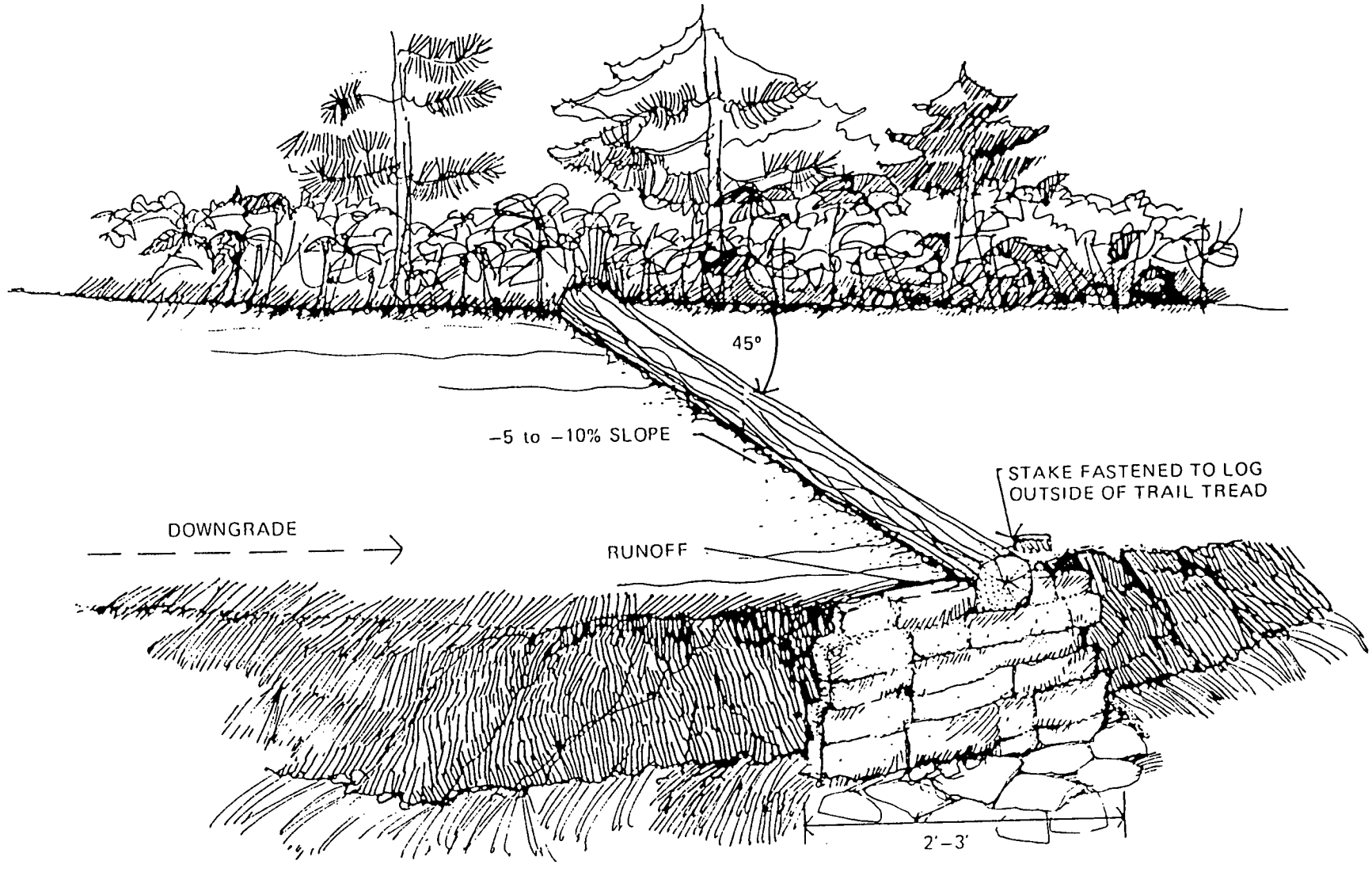
TOP VIEW

grade dips

DRAINAGE DIPS

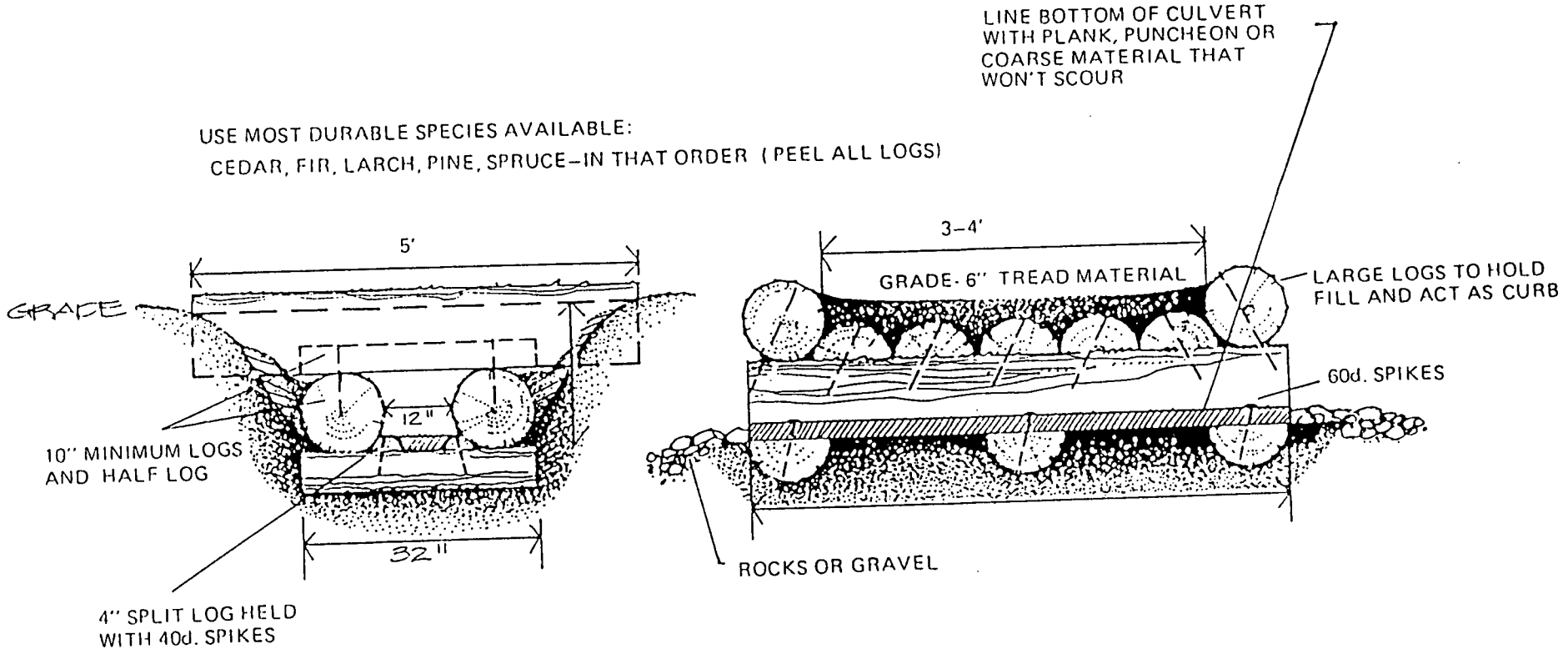
rock water bar

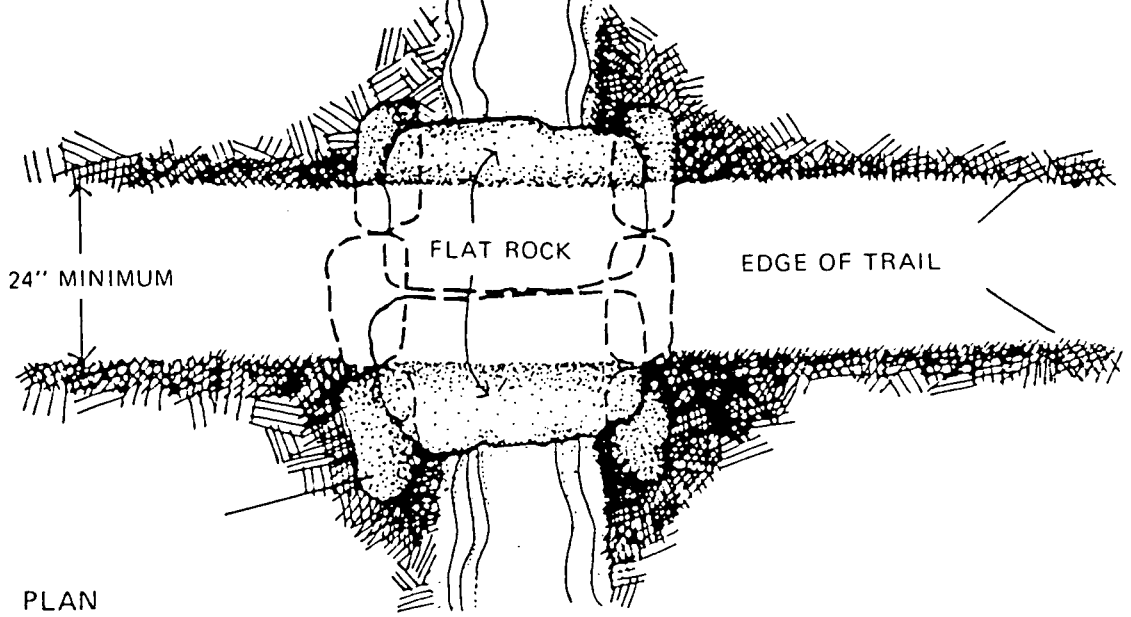




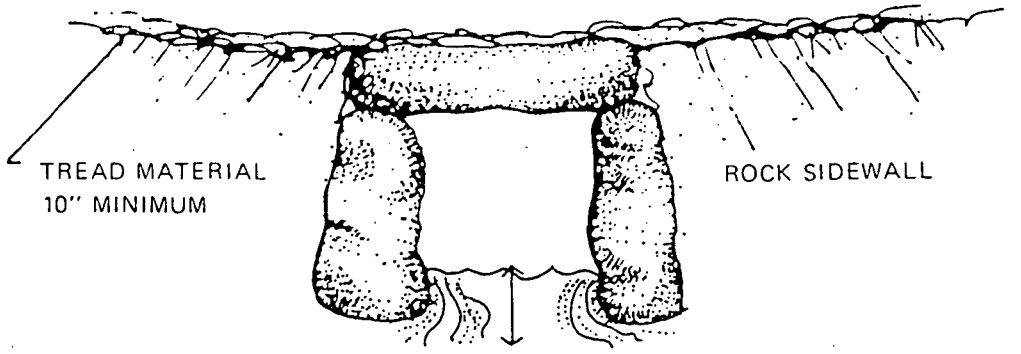
log water bar

log culvert

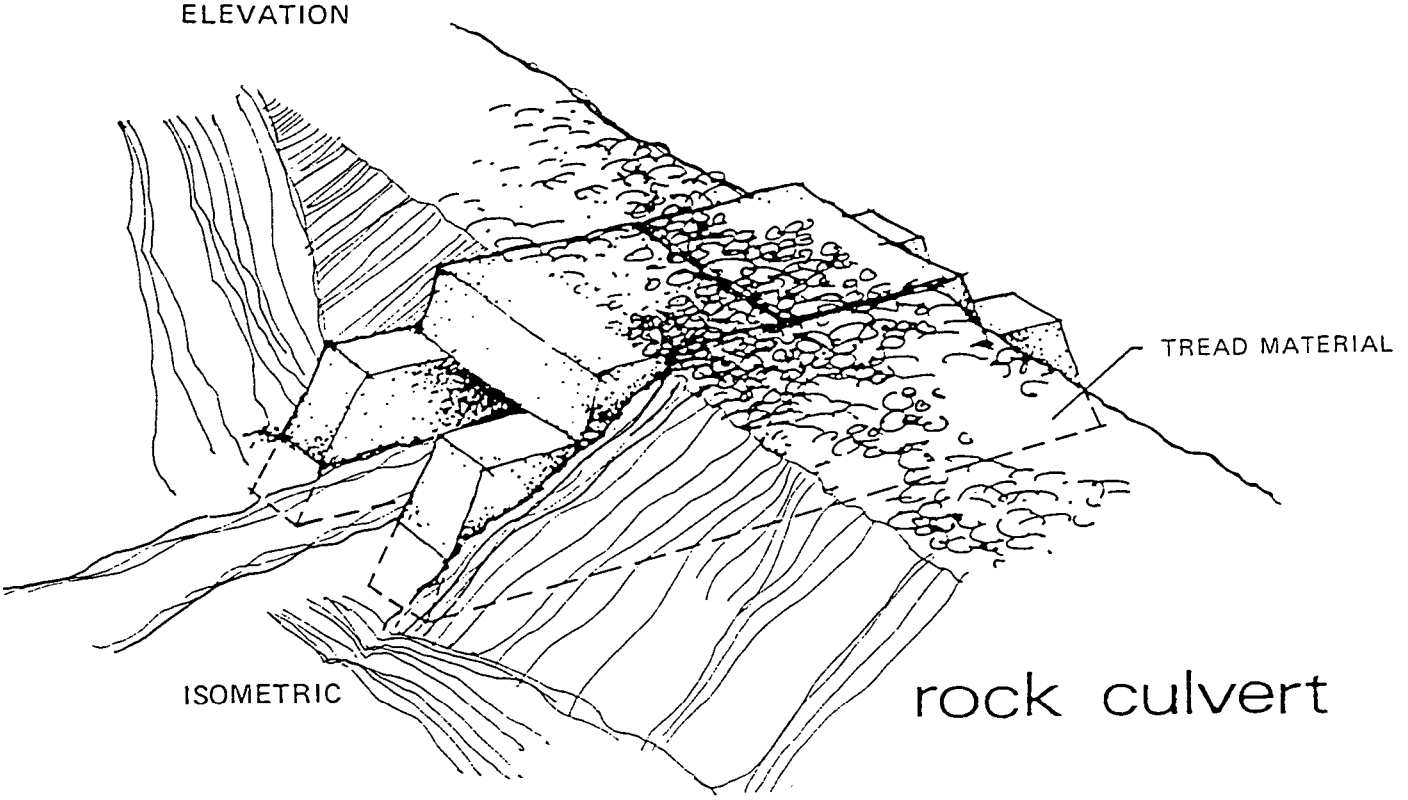

USE MOST DURABLE SPECIES AVAILABLE:
CEDAR, FIR, LARCH, PINE, SPRUCE–IN THAT ORDER (PEEL ALL LOGS)
5'
GRADE
12"
10" MINIMUM LOGS AND HALF LOG
32"
4" SPLIT LOG HELD WITH 40d. SPIKES
END
LINE BOTTOM OF CULVERT WITH PLANK, PUNCHEON OR COARSE MATERIAL THAT WON'T SCOUR
3–4'
GRADE- 6" TREAD MATERIAL
LARGE LOGS TO HOLD FILL AND ACT AS CURB
60d. SPIKES
ROCKS OR GRAVEL
SECTION



PLAN



ELEVATION



rock culvert

Rock Drains

Rock, or French drains consist of a systematically placed row of rocks graduated in size (largest on bottom) in a boggy or springlike water source, usually below the surface. This structure, in effect, collects the water in the trail area and transmits it under the trail base, normally permitting a dry trail surface. If an adequate volume and graduated size of rocks is available within a reasonable distance of the planned trail, rock drains are a cheap and effective way to drain small wet areas of a trail. The drain should be on a gradient to be effective (2 percent minimum, more if drained area will permit).

CRITERIA FOR FORDS AND BRIDGES

New bridges will not be constructed over minor streams in the Wilderness. Existing bridges over minor streams in the Wilderness will be removed when due for major rehabilitation or replacement. Bridges are provided in the Trail and Alpine Zones of the Wilderness only where they are essential for resource protection or where a significant safety hazard exists during the normal use period.

Fords

Fords normally represent natural sites where convenient crossings may be made. Some improvement of the stream channel may be required to provide good footing. Often fords are necessary in conjunction with a foot bridge for pack and saddlehorse use (see Foot Bridge illustration). Fords should not be located where the water flow is swift or if water depth exceeds 2 feet during the normal season of use. Safety of the user is a major concern in determining whether to use a ford or a bridge.

In fast-moving streams, the tread across a ford can often be improved by moving the larger rocks into a line across the stream parallel with the trail and below the downstream edge of the crossing. This technique allows sand and gravel to deposit above the barrier and develop a smooth level tread. In all stream crossings for stock, larger rocks should be moved out of the way to improve footing for horses.

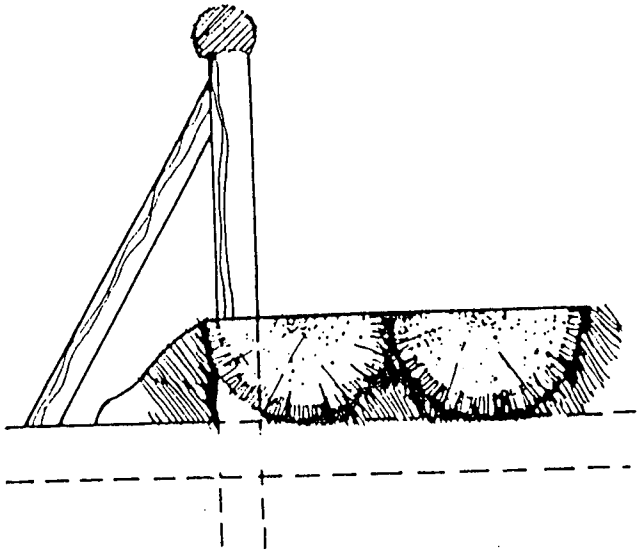
Bridges

Some form of bridge construction may be required on most trails to provide safe and convenient passage over and across areas where earthen trail tread construction is impractical. Safety of the user is a consideration in any bridge design.

The basic difference between a horse and foot bridge is the load-carrying ability and width of the structure.

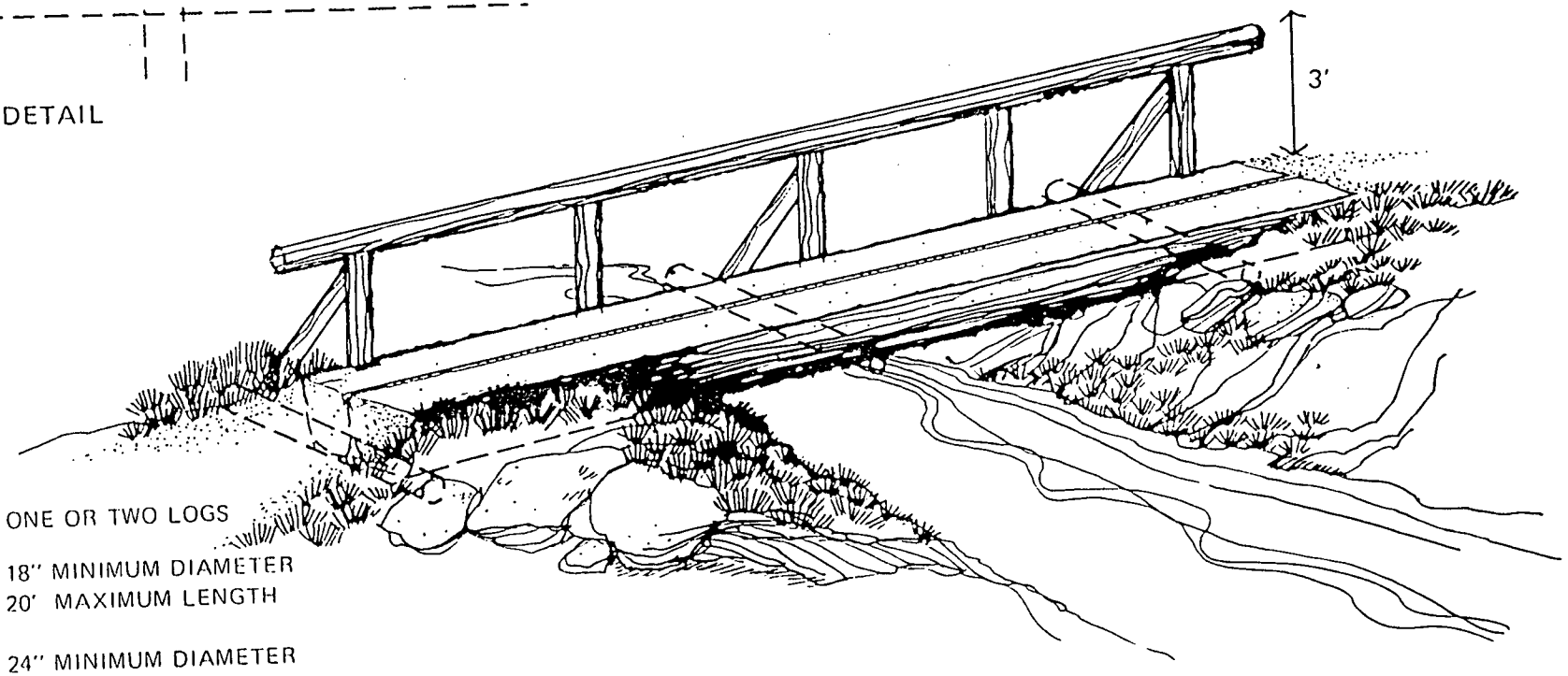
In designing a bridge, its height above the stream should be determined by the passage of water, ice, and debris. Only bridges built with an adequate opening to accommodate each year's floodwaters will survive. Occasionally, cribs can be avoided if a high bank, large rock, or ledge happens to be in the correct location. Most sites require two cribs, one on each side of the stream.

In building a wooden bridge, high standard of workmanship in the selection, fabrication, and fitting of logs could mean the difference between an unsafe or short-lived and a long-lived bridge. If possible, the logs should be cut a year in advance. In order to reduce cracks or splits, the logs should be seasoned with the bark on them and peeled immediately before use. During the seasoning period, the logs should be set on blocks to keep them from contact with the ground. Adequate equipment should be on hand for moving and handling the logs. No misfit joints or uneven bearing surfaces should be allowed; these factors could detract materially from the life of a bridge. When repairing or replacing a bridge, the job is not completed until the replaced or unused material is properly disposed of. Left over material at the site can remain an eyesore to backcountry users for years to come. Any replaced or unused native material should be hauled to a wooded area out of sight of main travelways and allowed to return to the ecosystem. Non-native material such as lumber, nails, spikes, and wire should be removed and hauled away.



BED ENDS ON ROCK OR
LOG ABUTMENT

DETAIL



ONE OR TWO LOGS

18" MINIMUM DIAMETER
20' MAXIMUM LENGTH

24" MINIMUM DIAMETER
30' MAXIMUM LENGTH

footbridge

VIII. MAINTENANCE GUIDELINES

Maintenance begins immediately following trail construction and continues until such time as the trail has been obliterated. The objectives of trail maintenance are to provide for user safety, user access, and convenience; to protect adjacent resources; and to preserve trail investment. Based on the objectives, the priorities for performing maintenance work are as follows:

Unsafe conditions should be corrected, or the use that normally would be permitted on a trail restricted. Safety conditions are always a first priority.

Resource and trail damage should be prevented.

The intended convenience and comfort of the trail user should be considered.

Determent of maintenance activity to a later fiscal year would allow little resource or trail damage.

RESPONSIBILITY

The Maintenance Division Trail Crew will be responsible for monitoring and maintaining Type A and B trails. The Ranger Division will be responsible for monitoring damage to Type C trails. Where major mitigation actions are necessary, the Trail Crew will assist. All major restoration/mitigation projects will be evaluated through the annual Resource Priority Setting meeting using the approved Ranking Criteria.

The Maintenance and Ranger Divisions are also responsible for submitting their Annual Mechanized Equipment Use Reports to the Superintendent by December 1 of each year.

MAINTENANCE PROCESS

To ensure that the maintenance objectives are met, a systematic maintenance process should be followed. This process has been developed to provide guidelines for effective maintenance planning, scheduling, performance, and evaluation.

The park's trail inventory consists of a park trail data inventory and a map (see Appendix I). The trail inventory gives an overview of the park's entire trail system with a breakdown of trail types and maintenance levels.

Steps in the maintenance process are as follows:

A trail log should be prepared for each trail (or segment) in a park.

Condition/corrective surveys should be performed on each trail (or segment), usually annually, according to the trail's priority.

An annual trail maintenance plan should be prepared, again by priority, using trail needs noted in the condition/corrective surveys. Projects should be prioritized at the annual trails meeting.

Continuous updating of the trail inventory is a most important function of this process. Information in the trail log and the surveys can be used for this purpose.

Trail Inventory and Log

Inventory

The official trails inventory for Mount Rainier National Park will be maintained on the park's Geographic Information System.

The trail log is a separate inventory system. The log consists of a complete inventory of physical features within or adjacent to a trail (see Trail Log example). Typical inventoried data in a trail log should include such features as the following:

type of terrain	retaining wall	intersection	fence
ground cover	puncheon section	bridge	sign
% of side slope	turnpike section	drainage dip	cairn
trail tread width	rock section	water bar	gate
grade	drainage ditch	culvert	vista
surfacing and depth	stone barrier	stream ford	stile
switchback	barricade	underdam	shelter
climbing turn	turnout	steps	special features

The trail log is normally prepared only once in the life of a trail; however, changes in trail location, addition or deletion of trail structures, combining with adjacent trails, or abandonment of various sections of a trail would require updating the trail log.

The log should be prepared in sufficient detail to allow for appropriate trail maintenance decisions. Using a measuring wheel (cyclometer), trail features should be located and described to the nearest foot (if needed) in the trail log. Measurements should commence at the beginning terminus of a trail. The trail log should be kept as part of an individual trail file.

An accurate and well-prepared trail log will pay dividends many times the original cost of gathering data. This inventory is imperative to trail maintenance planning. Without the log, an effective or efficient trail maintenance system cannot exist.

Maintenance Levels. The maintenance level assigned to a trail depends on land management objectives, purpose of the trail, volume and type of traffic, existing trail standards, and fund availability. The maintenance level is used to define and predict the type, amount, and frequency of maintenance work required to ensure continued service of the resource to the extent required for the allowed use.

TRAIL LOG AND CONDITION/CORRECTION SURVEY

Park ROMO Trail Name and No. Glacier Creek #25

Dist. F/Range Length 6.5 Mi. Page 1 of 5

Maint. Level: 3 Type of Trail: B

Logged by: A. Hagood | Surveyed by: P. Swaringen

Date: 8/13/82 | Date 10/18/82

Sta.	Feature	Condition/Correction	M.H./Equip.
0.00	Trailhead sign: Distance to overlook	Sign needs painting	
0.76	Water bar	Replace log	
1.67	Rock wall	Rebuild top Large rock available	Jackhammer
3.41	12" CMP culvert	Clean inlet & outlet	
4.68	Drainage dip	Clean before season	

Each trail (or segment) should be assigned one of the following maintenance levels:

Level 1 - Trails are maintained for high use. These trails are the major trails in the park, usually connecting visitor facilities and other primary points of interest. Use is heavy. Tread is smooth and even. Trail may be used by wheeled vehicles such as carriages or wheel chairs (example - Paradise Meadow Trail).

Level 2 - Trails are maintained for concentrated use. Traffic is medium to heavy. Tread is maintained at a high standard for convenience and comfort. The prepared, hardened surface may be used by wheeled vehicles such as strollers (example - Sunrise Meadow trails).

Level 3 - Trails are maintained for intermediate use. Traffic is medium. Tread is maintained for user convenience. These trails are designed for any permitted mode of travel. Trail is maintained to the degree that its infrastructure is preserved under normal environmental conditions. Natural surface contains some roots and rocks (example - Wonderland Trail).

Level 4 - Trails are maintained for semi-primitive use. Traffic is low to medium. Tread is often not smooth, having dirt and rock surface. Level 4 trails are maintained for either pedestrian and/or horse use. Natural surface is generally rough and uneven (examples - Kautz Creek or Bench Lake).

Level 5 - Trails are maintained for primitive use. Traffic is low. These foot trails require custodial care. Maintenance is required only for resource protection (example - Knapsack Pass, Grindstone).

Types of Trails. Each trail (or segment) should also be designated according to the following types:

Type A - Paved Trails - Paved trails are marked routes that are improved and maintained for foot traffic. A paved trail in a park usually reaches many of the main visitor attractions and serves as a terminus for primary or wilderness trails. Minimum tread width is usually 24 inches, and overall grade is less than 10 percent. For grade distances less than 150 feet, grade should not exceed 15 percent. Type A trails are to have the highest maintenance level.

Type B - Primary Hiking Trails - Trails that are improved and maintained to accommodate foot and horseback traffic but contain an overall lower construction standard than type A trails. These trails serve scenic areas, fishing areas, and access points. These highly developed trails contain the necessary bridges, corduroy elements, drainages, and shelters where needed. The tread does not have to meet the maximum standard and may be limited to the space required to form a single-file trail except on grades where the maximum is justified. The overall grade is less than 15 percent. For distances less that 150 feet, grade should not exceed 18 percent.

Type C - Way Trails - Way trails are unsigned and generally unimproved except for some clearing and for work for resource protection. These trails are normally used by experienced trail users, for access to cross-country areas, for

certain routes for mountain climbers, and administrative purposes. Bare width of trail will normally not exceed 18". Type C trails have the lowest maintenance priority except where resource protection is concerned. These trails will not be signed and will not be published on public information brochures or maps. Visitors requesting permits for crosscountry areas with type C trails should be given information regarding their location.

Type D - Walks - Walks include sidewalks, boardwalks, gravel, and bituminous trails that interconnect developed areas, or serve as short scenic walks, and interpretive trails. These walks are normally for foot and wheelchair travel and are usually built to high standards.

Type E - Other - Other trails include designated snowmobile, and ski (crosscountry) trails. Type E trails are not shown on the inventory map (Appendix I).

After the physical features of a trail have been inventoried and a maintenance level and the type of trail have been designated, the condition/corrective surveys should be prepared. These surveys are vital to the maintenance process. Without them, trail maintenance decisions would be based on assumed data and guesswork.

CONDITION/CORRECTIVE SURVEYS

The trail log should be used as a working tool for the condition survey. Often the initial condition survey is performed at the same time the log is prepared. A condition survey identifies, and documents the physical conditions of a trail including all structures and facilities and lists the deficiencies that will require maintenance efforts (see Trail Log and Condition Survey example).

Trails in a heavy use category require condition surveys annually or more often, whereas those that receive less use may only require infrequent inspections. When identifying trail deficiencies, the maintenance objectives, maintenance levels, and operational status should be considered.

Generally performed at the same time as the condition survey, the corrective survey documents the maintenance activities required to remedy the deficiencies identified in the condition survey. This basic information, coupled with maintenance activity specifications, yields manpower, equipment, material costs, and scheduling data for maintenance work.

MAINTENANCE ACTIVITIES

The following checklist groups general maintenance activities under broad trail maintenance areas. Some of the more common maintenance activities that could be required to remedy the deficiencies documented in the corrective survey are as follows:

Trail Maintenance-Vegetation

Brushing clearing areas
Logging out
Hazard tree removal
Litter cleanup
Slope revegetation
Backslope grooming
Vista maintenance

Tread Maintenance

Grading tread
    slough and slide removal
    slump repair
    grubbing rocks, roots, stumps
Spot surfacing
Surface replacement (similar material)
Surface repair and removing loose rocks

Drainage Maintenance

Cleaning and repairing structures
    culverts
    underdrains
    water bars
    grade dips
    drainage ditches
Replacement of existing drainage structures
    culverts
    underdrains

Installing additional drainage structures
    water bars
    culverts
    rock drains
    water bars
    grade dips

Structure Maintenance

Bridge repair
Cribbing and retaining wall repair
Barrier and guardrail repair
Steps and terrace repair
Fence, gate, stile repair
Shelter repair

Sign Maintenance

Sign repair and rehabilitation
Sign replacement
Blaze and trailblazer repair and replacement
Cairn repair
Barricade or closure device repair

In order to provide more details of the maintenance activities, the following guidelines are presented under each broad category.

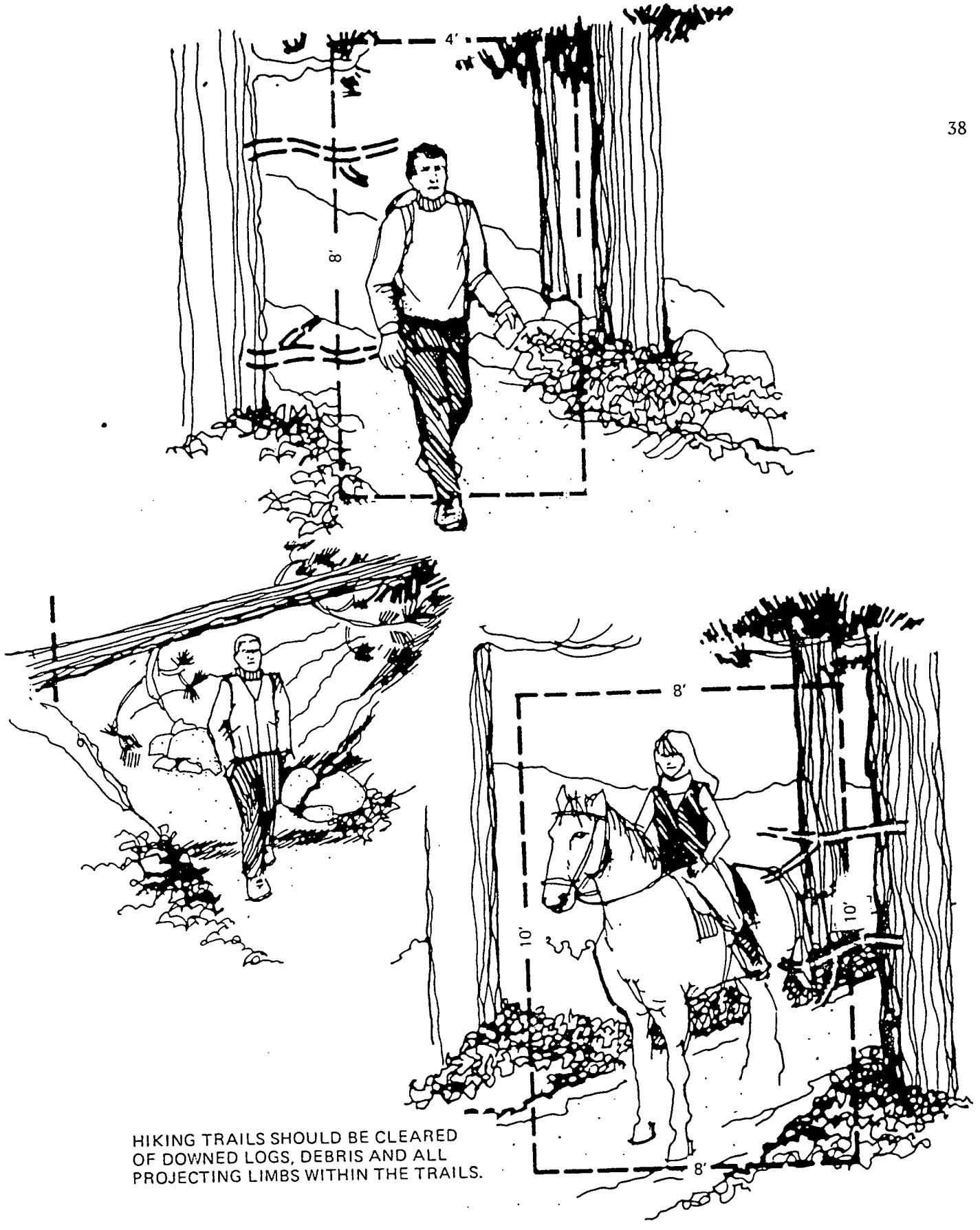
Trail Maintenance-Vegetation. All side branches extending into the trail corridor should be cut flush with the parent branch or stem, leaving no stubs and allowing for natural healing to take place. Paint should not be used for tree wounds (see the "Clearing Requirements" section for an exception to this statement.

Trees and brush outside the tread should be cut as close to the ground as possible, leaving no sharp-pointed stumps or stems. Herbicides should be used only for stump treatment on trails. Strict adherence to the manufacturer's directions is required.

Small trees and shrubs within the tread should be grubbed out to prevent tripping, and holes should be filled and compacted.

Any fallen tree lying on or over a trail should be removed, or if a large tree, the portion lying across the trail. When cutting a log, the cuts should be made at a sufficient angle to permit the cut section to be rolled free with minimum effort. Generally, the uphill cut should be made first to permit the lower section to hold the upper portion from sliding onto the trail and possibly injuring the workers whose footing is unstable for the upper cut. If possible, the entire windfall or the portion below the uphill cut should be rolled below the trail (see Travelway Clearing illustration).

In order to remove hazardous trees in high use and backcountry camping areas, all dead or dying trees that have a possibility of falling across the camping area or trail should be removed in accordance with the park's hazard tree plan.



HIKING TRAILS SHOULD BE CLEARED OF DOWNED LOGS, DEBRIS AND ALL PROJECTING LIMBS WITHIN THE TRAILS.

travelway clearing

Weeds and light new growth may be left along trails because they soon disappear. Debris from clearing and pruning should be disposed of by chipping or removed from the trail corridor. Debris should be considered for control of traffic or erosion. Slash should be scattered on the downhill side of a trail.

Tread Maintenance. When tread repair is needed, it should be restored to the original design condition, free of rolling stones, rock points, stumps, and shrub roots. Attention should be given to dips and outsloping. High standard treads should be smooth and firm. Paved treads may require patching or sweeping.

Drainage Maintenance. No factor in trail maintenance is more important than proper drainage. Many sections of trail are damaged or destroyed by erosion that proper drainage could have prevented. Trails should be routinely inspected to ensure that all culverts, waterways, and dips are clear of debris and ready to function properly at all times, especially during the rainy season or spring runoff. Drainage structures constitute the largest simple capital outlay item, and proper and careful maintenance is both necessary and rewarding in labor, material, money saved, and in the number of days the trail may be kept useable by the public. If repairs are necessary, they should always be performed to their standard construction specifications.

Structure Maintenance. Bridges and dams should be inspected annually. Minor maintenance of structures should be accomplished by a trail crew. Deficiencies requiring major efforts should be planned as a separate project.

The major consideration in structure maintenance is safety. Unsafe structures must not be allowed to remain unattended. If work must be deferred, alternative trail routes should be provided to temporarily bypass the hazard.

Snow Problems

When snow remains on trails during the normal trail use season, travelers may unknowingly trample vegetation or cause erosion by avoiding a long snow covered section of trail. Wands with flagging attached can be placed to keep travelers on the snow. As meltout occurs wands should be relocated as directly over the trail as possible so that as travelers tramp a defined trail in the snow that will eventually be worn and melted down to the maintained tread and not on vegetation. Wands will be removed and packed out when not needed. Flagging will not be tied to trees or bushes. Traveler created paths that are causing resource damage will be blocked.

ANNUAL MAINTENANCE PLAN

After the trail log and the condition/corrective surveys have been completed and the trail inventory updated, the Chief of Maintenance should use the information from these sources to produce an Annual Maintenance Plan. Annual Maintenance Plan should be prepared after annual trail meeting. Because the National Park Service is faced with the problem of apportioning a limited amount of manpower, finances, and time, it is imperative to effectively plan and schedule the maintenance work in order to optimize limited resources for the most cost-effective results.

The annual plan should define and schedule required maintenance activities, manpower, equipment, material, and cost for the fiscal year. This final determination is derived by integrating (1) the trail inventory and trail log (what and how much is out there), (2) the condition survey (present physical condition of the trail facility), (3) the corrective survey (maintenance activity needed to correct deficit facilities), and (4) the estimated unit costs for accomplishing the maintenance work.

A good maintenance plan will provide positive support for budget requests. The plan should also assist the Chief of Maintenance to evaluate performance against maintenance work standards. The plan should also be used to identify more efficient maintenance methods and to update costs and base data.

When preparing the annual maintenance plan, long-range goals for maintenance, reconstruction, and construction over a five- to ten-year period should be considered. Without these long-range goals, the annual plan would tend to lack consistency and direction, becoming a reaction response to immediate problems without regard to long-term priorities. Long-range goals are absolutely essential to efficient utilization of cyclic maintenance and construction funds and the use of volunteer groups on any appreciable scale. The long-range goals should be realistic, embracing not only what needs to be done but also the probable means of accomplishment.

COST ESTIMATING

Providing reliable cost data for maintaining trails is essential for planning work on existing and future trails. Park managers have the responsibility of determining the amount of money needed to maintain a satisfactory trail system within the park they manage.

Cost of trail maintenance varies greatly depending on type of trail, usage, remoteness, location, difficulty of terrain, and many other factors. Usually the minimal cost for maintenance of a foot trail is about $400 per mile per year. Depending upon the type of trail and maintenance needed, this cost can exceed $5,000 per mile.

Material Sources

Refer to Chapter V.

GLOSSARY

ABUTMENT	The foundation of either extreme end of a bridge that supports the superstructure (sills, stringers, trusses, or decks).
BACKSLOPE	The cut bank formed by the excavation extending upward from the tread.
BASE	The primary excavated bed of a trail upon which the tread, or finished, surface lies.
BERM	The ridge of dirt or rocks placed on the outside of the trail base.
BRIDGE	Any structure spanning and permitting passage over a river, stream, chasm, canyon, or road.
CAIRN	A constructed mound of rock located adjacent to a trail. Used in open alpine areas or mountain areas where the tread is indistinct.
CLINOMETER	Instrument used for measuring angles of elevation or inclination.
CORDUROY PUNCHEON	A log structure laid on the ground for the purpose of crossing swampy areas. Usually consists of stringers, decking, and often a soil or loose gravel tread on top of decking.
DECK OR FLOORING	That part of a bridge structure that provides direct support for trail traffic.
DRAINAGE, CROSS	Running water in swamps, springs, creeks, drainages, or draws that the trail must cross.
DRAINAGE, SURFACE	Rain or snow runoff from the surface of the tread.
DUFF	Organic matter or a deep mat of tree needles or leaves in various stages of decomposition on the ground of a forest.
FORD	A natural stream crossing improved sufficiently for use by saddle or pack animals and trail users.
GRADE DIP	A reverse in the grade of the trail accompanied by an angling outslope that will divert water off the trail.

GRADE, MAXIMUM	The steepest grade permitted on any part of a trail.
GRUBBING	To dig, to clear of roots, to uproot shallow roots near or on the ground surface; also grubbing of tree stumps..
HEADER	A long, uniform stone laid with its end towards the face of a retaining wall or crib used intermittently to structurally tie in the other rocks laid in the wall.
MEASURING WHEEL, OR CYCLOMETER	An instrument that measures circular arcs. A device that records the revolutions of a wheel and hence the distance travelled by a wheel on a trail or land surface.
OUTSLOPING	A method of base grading that leaves the outside edge of the trail lower than the inside.
PUNCHEON	See Corduroy.
RUN PLANK	Usually wood planks laid lengthwise (along the axis) on top of bridge decking used as the tread surface.
SIDESLOPE	The natural slope of the ground measured at right angles to the centerline of the trail, or the adjacent slope which is created after excavating a sloping ground surface for a trailway, often termed a cut-and-fill-slope, left and right of the trail base and tread.
SILL	A crosswise member at the top of an abutment or pier that supports the stringers, beams, or trusses.
SKEW	Deviation from a straight line; slant.
SPECIFICATIONS	The standard of workmanship and type of materials for all component parts of a trail base, trail tread, clearing, grade, bridge, culvert, puncheon.
STAKES, GRADE AND SLOPE	Stakes set by the trail locator to establish the elevation and cross section of the completed tread.
STAKES, LINE	Stakes set by the trail locator to establish the centerline of the trail.
STATION	One hundred feet measured along the centerline of the trail.
STILE	A step or set of steps for passing over a fence or wall.

STRINGER	The lengthwise member of a structure that supports the bridge deck.
SWITCHBACK	A sharp short radius curve in a trail that is used on hillsides to reverse the direction of travel and to gain elevation.
TRAILHEAD	The start or end of a trail often accompanied by various public facilities, such as a horse unloading dock or chute, parking areas, toilets, water, directional and information signs, and a trail use register. A picnic or campground may also be a part of the trailhead facility.
TREAD	The surface portion of a trail excluding backslope, ditch, and shoulder. The tread surfaces could include native material or gravel surface crushed to size. Another tread surface could be soil cement, which is a combination of local trailbed soil mixed with a cement to form a hardened soil cement trail tread. Asphalt is a various combination of asphalt mixes with a controlled blend of small crushed gravel or screened pit run gravel to provide a hard surfaced trail tread.
WATER BAR	A device for turning water off the trail, usually made of logs, stones, soil cement, or by contouring the native material within the trail prism. An enlarged modification of a dip installed at an angle across the trail base, with approximately a 30-degree skew.

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n.d. "Trails South." Atlanta, Georgia: Southern Region.

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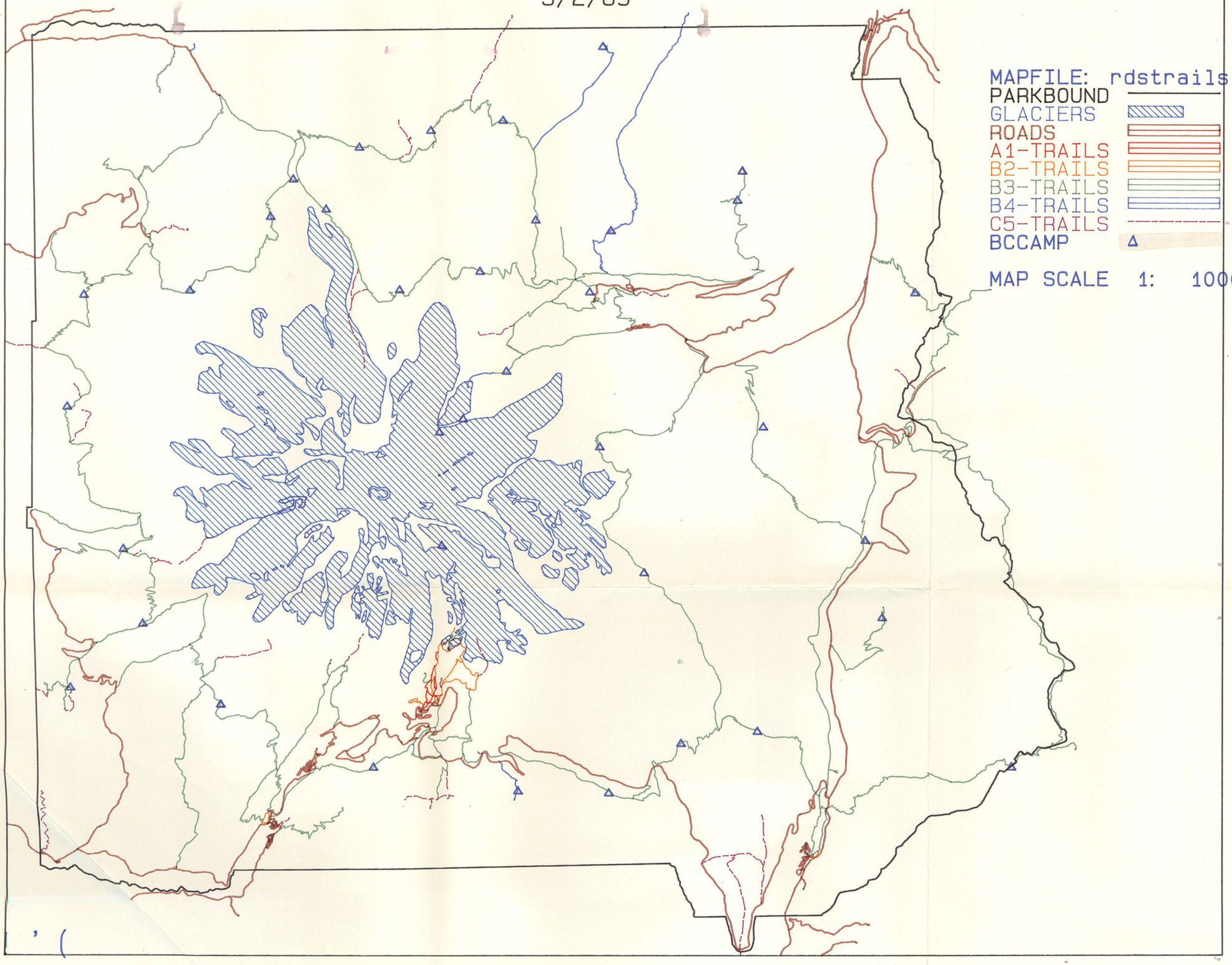
APPENDIX 1
MOUNT RAINIER NP TRAIL SYSTEM INVENTORY
5/2/89



MAPFILE: rdstrails
PARKBOUND
GLACIERS
ROADS
A1-TRAILS
B2-TRAILS
B3-TRAILS
B4-TRAILS
C5-TRAILS
BCCAMP

MAP SCALE 1: 100000

NARRATIVE LIST OF TRAILS

Trail Name	Maintenance Level	Description
Alta Vista	A1	Begins Paradise upper lot, ends Alta Vista viewpoint 1.2 mi.
Avalanche Lily	A1	Begins Paradise upper lot, runs diagonally uphill toward sw, ends on Skyline Trail above Henry Jackson MVC.
Deadhorse Creek	A1	Begins at Nisqually Vista junction, ends at junction with Skyline Trail 1.8 mi.
Glacier Vista	A1	Short loop overlooking Nisqually Glacier, beginning and ending on Skyline Trail
Guide House	A1	Begins behind RMI guide house, ends Skyline Trail
Waterfall	A1	Begins on Skyline, ends on Deadhorse Creek Trail
Golden Gate	B2	From Skyline at Golden gate, cutting down to end on Skyline near Myrtle Falls in Edith Creek basin. 1.0 mi
Hot Springs Interp. trail	B2	Begins at Ohanapecosh Visitor Center, ends on Silver Falls loop. .44 mi
Kautz Creek overlook	B2	Begins at road, ends at creek overlook. 0.01 mile
Mowich Lake access trail	B2	Begins on shoulder of road, ends at the lake. 0.22 mi
Nisqually Vista	B2	Begins and ends as a loop at Paradise lower lot. 0.88 mi
Pebble Ccreek	B2	Begins at junction with Skyline, ends at Pebble Creek crossing.
Skyline Trail	B2	Loop trail beginning and ending at Paradise upper lot. 5.3 mi
Tipsoo access Trails	B2	From Highway 410 to Tipsoo Lake.

Trail of the Shadows	B2	Loop trail beginning and ending across from National Park Inn at Longmire. 0.63 mi
Box Canyon Picnic Area	B3	Begins at Box Canyon picnic area, ends on Wonderland Trail along Stevens' Creek. 0.7 mi
Burroughs Loop	B3	Begins between first and second Burroughs Mtns, ends at old Sunrise Campground
Burroughs Mountain	B3	Begins at junction north of Burroughs, ends at Glacier basin. 4.89 mi
Cowlitz Divide Ollalie Creeek	B3	Begins from Silver Falls loop, ends in junction with Wonderland trail on the divide. 4.3 mi
Crystal Lake	B3	Begins on highway 410, passes by upper and lower Crystal Lakes, ends at Sourdough Gap junction with the Cascade/Pacific Crest Trail.
Eagle Peak	B3	Begins near Longmire Campground, ends at Eagle Peak saddle, though current official designation is to tree line. 3.6 mi.
East Side Trail	B3	Begins at Tipsoo Lakes, ends in junction with Silver Falls loop. 7.2 mi
Emmons Vista	B3	Begins Sunrise parking lot, ends at Emmons vista. 0.15 mi
Glacier Basin	B3	Begins at White River campground, ends at Glacier Basin. 3.37 mi
Green Lake	B3	Begins on shoulder of Carbon River Road, ends at Green Lake. 1.75 mi
Grove of the Patriarchs	B3	Begins and ends as a loop at Steven's Canyon entrance. 1.3 mi
Hidden Lake	B3	Begins on Palisades Trail, ends at Hidden Lake.
High Lakes	B3	Extends from Mazama Ridge Trail near Faraway Rock on the east to the Low Lakes Trail as it begins to descend to the Valley Road, on the west.

Kautz Creek	B3	Begins on Paradise Road near mudflow pull-out, ends at Indian Henry's junction.
Lake George/ Gobblers Knob	B3	Begins at Round Pass parking area ends on Gobbler's Knob. 2.4 mi
Laughingwater Creek	B3	Begins on Hwy 123, ends at Pacific/ Cascade Crest Trail cutoff. 7.3 mi
Lower Lakes	B3	Begins at Paradise upper lot, ends at junction of Wonderland at Reflection Lakes. About 1.8 mi
Mazama Ridge/ Lakes	B3	Begins at junction with Skyline ends at Stevens Canyon Road. 3.1 mi
McClure Rock	B3	Begins at junction with upper Skyline, ends on Mcclure Rock.
Mildred Point	B3	Begins at junction with Van Trump park trail, ends at Mildred Point at the Kautz Glacier overlook (at large bare ground area).
Mirror Lakes	B3	Begins at junction with Wonderland at Indian Henry's, ends at Mirror Lake but continues as way trail to Pyramid Peak.
Moraine Trail	B3	Begins at junction with Deadhorse Creek Trail, ends on Nisqually (lateral) moraine.
Mount Fremont Lookout	B3	Begins at five-point junction of Wonderland Trail, ends at Fremont Lookout tower. 1.32 mi
Mystic Lake Patrol Cabin Access Trail	B3	From Wonderland at east end of Mystic Lake to the patrol cabin.
Naches Loop/Dewey Lake Overlook	B3	Begins at Chinook Pass, includes a short section of the Cascade Crest Trail, ends on highway 410 at Tipsoo Lake. 3.0 mi
Narada Falls Trail	B3	Begins at junction with lower Lakes Trail, ends at junction of Wonderland below Narada. 0.87 mi.
North Puyallup/ Klapatche	B3	Begins at Klapatche Point, continues to junction with Wonderland at North Puyallup crossing (along route of former last 2.7 mi of West Side Road).

Northern Loop	B3	Begins at junction near Carbon Glacier terminus, ends at Sunrise. 26.62 miles.
Owyhigh Lakes	B3	Begins on White River Road, passes near Owyhigh Lakes, ends on Hwy. 123. 9.65 mi
Pacific/Cascade Crest	B3	Drawn from Sheep Lake (northern one south to Crag Lake near Three Lakes cutoff. Park portion begins at Chinook Pass, ends at Three Lakes junction. 11.2 mi
Palisades	B3	Begins at Sunrise Point, ends at upper Palisades camp. 3.32 mi
Paul Peak	B3	Begins at junction with Wonderland, ends at Paul Peak picnic area. 3.1 mi
Pinnacle Peak	B3	Begins on Stevens Canyon Road at Reflection Lakes, ends at Pinnacle Saddle. 1.3 mi
Rampart Ridge	B3	Begins at junction with Trail of the Shadows, ends at junction with Wonderland trail. 2.9 mi
Round Pass	B3	Begins at Round Pass, ends on South Fork (Puyallup) trail. 0.59 mi
Shadow Lake Loop	B3	Loop trail: from Sunrise Campground sites to shore thence to end at junction with Wonderland.
Shriner Peak	B3	Begins on highway 123, ends at Shriner Peak lookout. 4.2 mi
Silver Falls Loop	B3	Begins on loop b at Ohanapecosh (on old Hot Springs Road), ends at NW end of bridge over Ohanapecosh River. 2.5 mi
Sourdough Ridge	B3	Extends about 3.18 miles from 5-way intersection east to Sunrise Point. Includes spur from picnic area up to trail proper.
South Fork (Puyallup)	B3	Begins on West Side Road, ends at junction with Wonderland Trail. 1.6 mi
Spray Falls	B3	Begins on Spray Park Trail, ends at falls viewpoint.

Spray-Seattle Park loop	B3	From junction with Wonderland near Mowich Lake through Spray and Seattle Parks to junction with Wonderland near Cataract Creek. 8 mi
St. Andrew's/Klapatche Park	B3	Begins on the West Side Road, ends at junction with Wonderland Trail at Klapatche Park. 2.7 miles
Sunrise Rim	B3	Begins at Emmons Vista, travels west to junction with Wonderland Trail
Tahoma Creek	B3	Begins at (now extinct) picnic area off West Side Road, ends at junction with Wonderland Trail. 2.1 mi
Tipsoo Lake	B3	Tipsoo Lake Trail (around lake) and trail to Chinook Pass parking area. About 1.25 mi total
Tolmie Peak	B3	Begins: junction at Ipsut Pass, ends: at Tolmie Peak. 1.7 mi
Upper Skyline	B3	Begins at Panorama Point overlook, runs east to regain Skyline at east end of big (permanent or mostly permanent) snow fields.
Van Trump/Comet Falls	B3	Begins: on Paradise road, ends: junction with Wonderland on Rampart Ridge. Van Trump (maintained) Trail included. 5.7 mi
Wonderland Trail	B3	Loop trail circumnavigating the mountain, mostly at or just below tree line. 90 miles.
Chenuis Falls	B4	Begins at log barrier at parking lot, ends at guard rail at the falls. 0.36 mi
Denman Falls	B4	Begins on West Side Road, continues 0.27 mi to Denman Falls.
Eleanor Lake	B4	Begins on Northern Loop at Grand Park, ends at Lake Eleanor, 3.4 mi.
Huckleberry Creek	B4	Begins at junction with Sourdough Trail, ends at Huckleberry Creek ranger cabin. 7.94 mi
Inter Glacier	B4	Begins in Glacier Basin, runs south and west to Inter Glacier.

Snow Lake	B4	Begins Stevens Canyon Road, ends at Snow Lake. 1.1 mi
Aurora Peak	C5	Begins at junction with Wonderland Trail immediately east of Klapatche Park, runs straight up Aurora Peak to summit. Has been stabilized.
Backbone Ridge (formerly maintained)	C5	Begins on Cowlitz Divide/Wonderland at Olallie jct., forks to meet Stevens Canyon Road on both sides of ridge, runs south on ridge to park boundary + beyond.
Bench Lake Access	C5	Short segment from Snow Lake Trail to south shore of Bench Lake.
Cliff Lake Way Trail	C5	Begins near pond east of shelter site, ends at Cliff Lake.
Curtis Ridge Way Trail	C5	Begins in two locations on Wonderland in Moraine Park, follows Curtis Ridge continuously, exits onto upper Carbon Glacier. Approx. 2 mi total
Deadwood Lakes Way Trail	C5	Begins at junction with Cascade/ Pacific Crest trail, ends at Deadwood Lakes.
Goat Lake Spur Trail	C5	Begins junction on Gobbler's Knob Trail, ends at park boundary (then continues into GPNF) 0.39 mi inside park.
Golden Lakes Jeep Trail	C5	Eastern extension of a jeep trail that begins in MBSNF and runs west to end at its junction with the Wonderland Trail north of Golden Lakes.
Ice Caves/Paradise Glacier Trail	C5	Begins on Skyline near Sluiskin Falls, ends at Ice Caves (or Paradise Glacier/snow field).
Independence Ridge Way Trail	C5	Formerly maintained trail beginning on Northern Loop, ending on Independence Ridge.
Lake George Shore Trail	C5	Runs on east and west sides of lake, disappears in rock cliffs at south end of the lake. (begins at north end)

Lake Louise Access Trail	C5	Begins across from pullout on Stevens Canyon Road, ends on east shore of Lake Louise.
Mountaineers Trail to Pinnacle Glacier	C5	Begins at creek access/crossing approx. 1/4 mi. up Pinnacle Peak Trail, ends above Pinnacle Glacier at window in rock on east shoulder of Pinnacle Peak.
Natural Bridge Way Trail	C5	Begins on way trail to Independence Ridge, ends below the Natural Bridge. Formerly maintained.
Plummer Peak Way Trail	C5	Begins at junction with Tatoosh traverse way trail at the tarn, ends on summit of plummer peak
Pyramid Peak Way Trail	C5	Begins at Mirror Lake, runs through Indian Henry's Hunting Ground, ends on Pyramid Peak.
St. Andrew's Lakeshore Trail	C5	Forks off way trail to Tokaloo Rock, ends on Wonderland Trail.
Sunrise Rim east to Park	C5	Begins at Emmons Vista, travels east travels east through Yakima Park south of Sunrise Road.
Sunset Peak Lookout	C5	Begins at junction with Wonderland, ends at site of Sunset Peak Lookout. (was maintained when lookout extant)
Tatoosh Traverse Way Trail	C5	Runs sporadically from Unicorn Peak west to Eagle Peak. Is presently drawn from the castle to the meadow below Lane Peak (above Cliff Lake).
Tokaloo Rock	C5	Begins at junction with Wonderland Trail at St. Andrew's Lake, has been stabilized to talus on the first bench up, then continues up the ridge.
Van Trump Park Way Trail	C5	Begins at "trail not maintained" sign near old cabin site, continues up ridge as a climbing route.
Way Trail to Knapsack Pass	C5	Begins at patrol cabin on Mowich Lake, ends at Knapsack Pass.

Way Trail up Third Burroughs Mountain	C5	Begins on Burroughs Mountain Trail as it descends from second Burroughs towards Glacier Basin, ends on third Burroughs summit.
Way Trails Along Nisqually River	C5	Begin on both sides of Suspension Bridge at Longmire, run about 70-80 yards up river.
West Boundary Trail	C5	From 4,200' on ridge west of Tenas Creek head south along boundary to Nisqually Entrance.
West Fork Trail	C5	Begins at junction with Northern Loop near Van Horn Falls, ends at north park boundary. 2.0 mi

NOTES: