UNITED STATES DEPARTMENT OF AGRICULTURE

FOREST SERVICE

F. A. SILCOX, Chief

FOREST TRAIL HANDBOOK

REVISED JULY 1935

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FOREST TRAIL HANDBOOK

1. PURPOSE.

The purpose of this handbook is, first, to state a general policy of trail construction and maintenance; second, to establish a uniform classification of National Forest trails according to their use; third, to establish standard specifications for each class; and, fourth, to describe and illustrate for purposes of reference and application, approved methods of location, construction, and upkeep.

SECTION I—POLICY AND GENERAL INSTRUCTIONS

2. RELATIVE NEEDS.

In making many of the National Forests more accessible, the first and largest need is for ways and secondary trails. The second important, but less urgent, need is for primary trails. To maintain the present degree of accessibility by adequate upkeep of existing trails is more important as a general rule than the building of additional mileage.

3. PROGRESS.

The progress made in trail work will depend, first, on the amount of money available, and second, on the capacity of the available organization to direct and control such work properly.

4. THE JOB.

Trail location and construction is relatively a simple job. Money, proper workmanship, common sense, abundant energy, and simple tools and equipment are the only requisites to good work. The employment of

location and supervising engineers and specially organized survey parties, and the use of precise methods involving technical practices such as accurate leveling, transit work, detailed field notes, and profile maps of location, have no place in the trail program.

5. PLACE OF FOREST OFFICERS.

Responsibility for selection of the projects, correct location, and adequate supervision must rest squarely upon the supervisor. Members of the regular forest organization or specialists designated by them will do at least the major part of the preliminary location work, and will give such supervision to crews as may be necessary to get the work done in accordance with established policy and practice.

6. USE OF HANDBOOK.

It is recognized that to prescribe rules or to outline methods of construction to cover all details, or to fit all the varying conditions encountered, is not possible. No attempt to do it has been made in this handbook. The points covered, and instructions given, are confined to the more obvious and major principles of trail construction. They are based on methods and principles which have proved their worth; furthermore, experience has proven their general applicability.

Field officers are not expected to memorize the contents of this handbook. It is expected, however, that they will always remember: First, the handbook is available; second, it is to be consulted and studied before starting a job; third, every man placed in charge of trail work will have a copy, supplemented by written instructions to indicate the parts of the handbook that are applicable to his job; fourth, the instructions it contains will govern on the job, unless physical conditions clearly prevent.

Burden of proof of inapplicability will always be upon the officer who is responsible for getting the work done. Officers should expect to be held personally responsible for unwarranted deviation.

7. PURPOSES OF TRAILS.

Trails will be maintained, reconstructed, and constructed in the interests of: (*a*) Fire control; (*b*) administration; (*c*) grazing; (*d*) recreation.

The objects of trail construction are (*a*) to provide safe and unobstructed passage of loaded animals and foot travelers at a walking gait and in single file; (*b*) durability designed to meet expected use and liability of damage from natural causes.

8. STANDARDS.

Standards of construction designated in this handbook are sufficient to accomplish the justified objects of trail work.

9. MAINTENANCE POLICY.

The desired standards of trail upkeep are those which are necessary to maintain the standard of construction established herein. Well-balanced work, not polish, is wanted. To underdo maintenance is bad. To overdo it is worse, because a dollar unspent remains available to correct mistakes, while more dollars spent than necessary are simply wasted.

Maintenance will include the removal of obstacles from primary trail beds to facilitate the operation of plows and drags wherever the use of such horse-drawn equipment is feasible from the point of view of economy and physical practicability.

10. SELECTION OF PROJECT.

New construction into inaccessible areas requiring fire protection takes priority in the use of funds over raising the standards of a usable existing trail. Consideration should be given to this when planning the reconstruction of a trail which can be reconditioned at a lower cost. Reconstruction of trails, other than those in highly recreational areas, should be avoided until all hazardous portions of the forests have been made accessible.

New fire control or administrative projects to warrant approval, will have to be based upon:

(*a*) Sound reasons for, and practicability of, reducing travel time into given regions.

(*b*) Sound reasons for making a country accessible to animals, which is now open to foot travelers only.

(*c*) Sound reasons for making particular places accessible to either foot travelers or horses.

Recreation trails will be constructed where the need is made clearly apparent by public demand or by existing heavy use of trails over which travel is very laborious or difficult, or where a desirable and justifiably greater use of the National Forests will very probably result.

Grazing projects fall into two classes:

(*a*) Development projects.

(*b*) Grazing administration projects.

Grazing development projects, to justify allotments, must be based upon one or more of the following reasons:

(*a*) Existing demands for additioual range which can be satisfied only by making unused territory accessible by construction of trails.

(*b*) Or, a demand which may be depended upon to materialize soon after the date of completion of a given project.

(*c*) To secure proper distribution of stock on allotments, parts of which are overgrazed while other sections are only partially utilized or totally unutilized because of genuine, not relative, inaccessibility. Do not build trails to overcome inaccessibility which may reasonably be met by better salt distribution or proper attention to herding by the owner or his employees.

(*d*) To make accessible, or to increase accessibility of, unused or slightly used regions of large extent in the interest of fire control, although the anticipated demand is more or less speculative but where nevertheless it may be good business to spend money on stock trails, driveways, and bridges in order to create conditions favorable to stock, as an inducement to owners to seek grazing privileges.

Other grazing projects, not of a development nature, will be approved upon showing of real need for:

(*a*) The building of stock trails (driveways) to protect existing roads or trails used chiefly for other purposes.

(*b*) The building of stock trails (driveways) or relocation in whole or in part of existing ones in interest of fire control.

(*c*) The building of stock trails (driveways) or relocation of existing ones to protect recreational use of the National Forests.

(*d*) Trails needed to facilitate the transportation of supplies used by stockmen.

The standard of stock trails should never exceed and should seldom equal the specifications for secondary trails.

11. TRAIL CREWS AS FIRE FIGHTERS.

Two principal factors are to be given consideration in laying out a season's trail program:

(*a*) The permanent forest benefit in terms of better fire control or administration, which the program will produce.

(*b*) The availability of men for fire fighters.

Under some circumstances it may be advisable to prolong work on a trail at the sacrifice of speedy completion, or to start work on a trail of secondary importance, in order to have a crew on the ground to form an essential part of the fire organization.

It is often important to schedule trail construction and repair projects to provide work before and after the fire season, for key members of the fire-control personnel.

Employ only men who are capable of doing fire-control work and with the definite and unmistakable understanding that they will become a part of the fire-control organization, ready and willing to go and fight fires either day or night. Train them as fire-control units.

Members of trail crews when on fire suppression or emergency guard work will be paid wages as prescribed by the Regional Forester. Special written instructions to way and trail foremen will cover this point.

During the fire season connect trail crews which are considered to be a part of the fire-control organization with the telephone system or supply them with radio if at all practicable. Supplementary instructions will state the hours of test calls throughout the day. Always equip crews with an adequate outfit of fire-fighting tools and with appropriate emergency rations for suppression work.

12. PLOWS AND SCRAPERS.

Use plows and V drags to the fullest practicable extent on construction and maintenance of those trails upon which grading is necessary.

The light reversible side-hill plow is the best known type. Various kinds of V drags are in use. One of satisfactory design is shown in figure 44.

If Service-owned animals are not available, and private stock cannot be rented conveniently, horses and mules should be purchased from trail funds where the use of plows and scrapers is good practice.

Regional Foresters are especially urged to get the instructions of this section into practice, if use of the equipment mentioned will help reduce costs.

SECTION II.—PLANS

13. TRAIL PLANS.

A trail plan should be developed for each forest as dependable data is gathered from knowledge acquired in the field. Make no attempt to complete the plan simply to have something of the nature to exhibit. Every trail constructed should justify its existence by the actual service rendered.

A standard form of plan complete in all details, will not be prescribed. The minimum requirement, however, for each forest is a map to be called, "The Plan and Progress Map." It should show the location of each

trail, with separate symbols for "proposed" and "completed." This map will be permanent. Roads may be shown on the map at the option of the Regional Forester.

SECTION III.—CLASSIFICATION

14. TRAIL CLASSIFICATION.

Forest Service trails will be classified in three groups: (*a*) Ways; (*b*) Secondary; (*c*) Primary.

(*a*) Ways are defined as plainly marked routes built primarily for foot travel, but constructed to specifications which will permit safe travel by heavily loaded pack animals.

(*b*) Secondary trails are defined as trails which will receive less use than that specified for primary trails, but which are built primarily for horse travel.

(*c*) Primary trails are defined as trails over which an average of more than one saddle or pack animal will pass each day during the field season.

Classify every proposed trail before its construction, and all existing trails in advance of reconstruction and maintenance. Specifications of work to be done will be based upon such classification.

In classifying trails, keep constantly in mind that past experience proves a tendency to overestimate probable use. Closest guarding of enthusiasm and judgment, also checking by higher officers, is necessary to hold future errors in classification to the minimum. The lowest standard fulfilling reasonably early need will be used. Officers having responsibility for trail planning and construction should expect to be called upon to justify the construction of higher-type trails when the probable volume of travel and character of use calls for trails of lower types. In many sections the need for usable ways through the woods still overshadows either primary or secondary necessities.

SECTION IV.—LOCATION

15. TRAIL LOCATION.

Before definitely selecting the route for a project, a thorough reconnaissance survey should be made. This will enable the locator to secure the best possible topographical, geographical, and fire-control service location. Hazard maps and other fire-control data should be checked previous to making the final selection. Too much emphasis cannot be given to the importance of this phase of trail work.

During the reconnaissance survey, always definitely select and locate control points, and get their elevation and approximate intervening distances.

The instruments needed in trail reconnaissance, in addition to the ordinary tools of a woodsman, are an Abney level or hypsometer for laying out grades and measuring slopes, and in certain instances an aneroid barometer for ascertaining elevations.

With the approximate distance and elevation between two control points known, add two ciphers to the elevation figures and divide by the distance expressed in feet to ascertain the approximate uniform grade between them. Example:

$$\text{Elevation difference, 1,250 feet} \left(\frac{125{,}000}{17{,}160}\right) = 7 \text{ percent approximate}$$
$$\text{Distance, 3¼ miles, 17,160 feet}$$

In trail location, as far as practicable—

Avoid:

(*a*) Swamps and boggy land.

(*b*) Creek bottoms and arroyos subject to damaging floods.

(*c*) Slopes subject to snowslides.

(*d*) Locations subject to snowdrifts.
(*e*) Slides (see fig. 1).
(*f*) Unstable ground.
(*g*) Steep slopes.
(*h*) Bluffs and ledges.
(*i*) Frequent crossings of streams where fording is difficult and impracticable.
(*j*) Location requiring construction of bridges and culverts.
(*k*) Heavy clearing.
(*l*) Switch-backs where practicable. In instances where the use of switch-backs is good business, make the legs as long as the topography will permit.

Favor:

(*a*) Southern exposures.
(*b*) Ridges.
(*c*) Benches.
(*d*) Natural openings.
(*e*) Open timber.
(*f*) Light stands of brush.

Items (*b*) to (*f*), inclusive, should be favored even at the sacrifice of grade.

Do not lose sight of the desirability of having trails pass camping places, horse feed, water, and points which furnish a broad view of the surrounding country. These items are of special importance to recreation and fire-control trails.

FIGURE 1.—Principles to be observed in locating trails: *A*, 15 percent grade to escape rock and hard land by climbing on to bench; *B*, Rocky and hard; *C*, Bend in trail to escape large rocks; *D*, 10 percent minus grade for 200 feet; *E*, 15 percent plus grade for 350 feet to shorten trail across canyon with flat bed; *F*, Rocky flat to edge of steep slate sidehill; *G*, 18 percent slope of sidehill, no grading; *H*, 20 percent grade for 500 feet to escape bluff; *I*, Bluff of rock; *J*, 30 percent slope, no grading; *K*, Reverse 8 percent for 50 feet on each side; *L*, Rocks, tan bark oak, and heavy brush; *M*, Open point, switch backs on 15 percent to 18 percent grade to escape rock and tan bark oak sidehill; *N*, Waterfalls and rapids; *O*, Solid ground; *P*, Camp; *Q*, Meadow.

Always bear in mind that trails are used by a class of travel that is but little affected by undulations and a steep pitch here and there, and that they are not associated with vehicles, the carrying capacity of which is limited by the steepest pitch. Remember, too, that trails are used by foot travelers and saddle or pack animals, traveling single file, and usually in a walk. Lay out trails accordingly, and never be influenced by the idea that later a trail may be converted into a road.

SECTION V.—ESTIMATES

16. COST ESTIMATES.

Accurate estimates of costs of proposed projects based upon knowledge gained by field investigation, and preferably upon data obtained from thorough reconnaissance, should ordinarily be made in advance of allotments. Estimates are expected to be more than mere guesses. A failure to arrive at a reasonably close approximation of the cost of a project is a reflection upon an officer's qualifications.

Ordinarily, proposed primary or secondary projects should be described in memoranda, boiled down to essential facts. The major elements to be considered and dealt with in a brief common-sense manner are:

(*a*) Purpose.
(*b*) Length of project.
(*c*) Classification, with reasons.
(*d*) Types of cover, expressed in miles of each type.
(*e*) Statement relative to amount of grading and blasting required.
(*f*) Number of bridges, brief descriptive of each, and materials available for construction.
(*g*) Number and description of signs needed.

(*h*) Organization of crew:
  (1) Size of crew proposed.
  (2) Transportation facilities needed.
  (3) Equipment needed.
  (4) Forage needed.
  (5) Camping plans.

(*i*) Period when work should be done.

The trail foreman should daily measure the completed trail and keep a current check of the cost of wages and materials as directed by the Regional Office.

SECTION VI.—CONSTRUCTION

17. SIZE AND ORGANIZATION OF CREWS.

Crews composed of 8 or 10 men, including foreman and cook, are the most economical on heavy construction. If work is to be rushed, use two or more separate crews of this size on sections worked from different camps rather than one large crew. On way trails, construction crews of from 2 to 4 men are generally most economical. Exceptions are those cases where a number of radiating trails can be worked from one camp.

Plan to have blacksmithing done by the foreman or the powder men rather than by any other workman.

Work swampers at least 2 days ahead of graders.

See to it that the line designating position of grade is at least 1 day ahead of graders.

Wherever practicable, work graders far enough ahead of rock men so that blasting will not interfere with graders. Assign graders to stations 25 feet, 50 feet, or 100 feet apart. Do not permit them to crowd up.

Work rock men and powder men behind graders. Do not blast stumps ahead of hand graders.

The trimmer men following the crew are to smooth up tread, install water breaks, decrease angle-of-back slopes where they are too steep, and cut any interfering brush left by the swampers.

The organization can be put into operation only after the job is well started. Entire crews might clear at the outset in order to get 3 or 4 days clearing ahead. Then all but the regular swampers will grade until the grading proceeds a safe distance ahead of the blasting work. After grading is well advanced, rock men and powder men can be assigned their job. In turn, the trimmers can take up their work.

For light work see organization under Maintenance.

18. CAMPS.

Keep camps as near as possible to the work and never more than 1 mile in advance of construction to enable the crew to work both ways from them.

The ordinary sanitary requirements of the Forest Service will be observed in all trail camps.

19. STANDARDS FOR WAY TRAILS.

Way trails will be constructed and maintained entirely for fire control purposes. The objects of way trail construction are:

(*a*) To prepare as rapidly as possible for the extreme fire emergency.

(*b*) To provide a system of ways sufficiently intensive to permit any part of a forest being reached to afford adequate protection.

In locating way trails emphasis should be placed on finding the cheapest route that will serve the desired ends. Way trails will not be located with the idea of using the same route for a higher class trail at a later date. Nevertheless, disregarding the principles of determining a location will not be tolerated. A reconnaissance of the country to be traversed should always be made, followed by the clear marking of control points and the placing of

marks (blazes, strips of cloth on brush, etc.) at intervisible points to indicate the general line to be followed by the way in connecting the control points.

Stakes should not be set for way trails except on the portions to be graded, and where rock or other obstacles make an exact location necessary.

Clearing for way trails should be of sufficient width to provide for the passage of loaded pack animals. Remove obstacles within reach of the extended arms of a man standing in the center of the trail. Overhead clearing to a height of 10 feet above the ground is sufficient. Only brush and small trees should be cut and these should be cut as close to the ground as can be done without increasing the cost. The object of the trail is to make certain of a passable route in the time of need. The amount of work done should be gaged accordingly.

Grading of way trails is not necessary except to provide footing for pack animals. All grading work should be cut to a minimum.

Ruling grades of way trails should be 15 percent. Grades over 15 percent to a maximum of 40 percent, within the limitations expressed in table 1, should be used to get the best location at the minimum cost.

TABLE 1.—*Permissible grades above 15 percent on ways*

Grade (percent)	Distance ordinarily permissible
16 to 25	One-half mile.
26 to 35	One-fourth mile.
36 to 40	100 yards.

Reverse grades up to 40 percent, at reasonable intervals, may be used.

Marking of way trails is of first importance. Way trails should be marked by signs, blazing, or otherwise, so that they can be readily found and followed by a fire fighter at night.

20. STANDARDS FOR SECONDARY AND PRIMARY TRAILS.

Do not start work on any trail until the route has been definitely chosen after careful reconnaissance and the main control points established. Never begin construction on any section of a trail until the location of that section has been marked on the ground by stakes or other plain markers.

21. STAKING.

At intervals of 25 to 50 feet where excavating is to be done, mark the grade line with stakes or some other form of durable indicators. Place the indicators on grade, that is, where digging work starts. In flats and along slopes under 30 percent, where a simple mark will take the place of grading, space stakes or indicators only close enough together to make or correct alinement of the trail and uniformity of the grade.

Wherever practicable, foreman or some other experienced man should scratch a narrow line between indicators or stakes. This should insure an evenly sustained grade. Mattock men or pick men should never start work before the grade line has been thus indicated. The foreman should see that graders always use this line as a base. (See fig. 2.)

22. GRADES.

No standard gradients are established. Use the grade up to 15 percent which will result in the least amount of construction, or shortest distance between control points. If the shortest route lies along a gradient in excess of 15 percent for more than one-half mile, cut the grade down to 15 percent by increasing the distance, but do not go below 15 percent.

To avoid expensive construction and to get the best location at a justifiable cost in ascending or descending, use of grades over 15 percent to a maximum of 30 percent within the limitation expressed in table 2 is considered

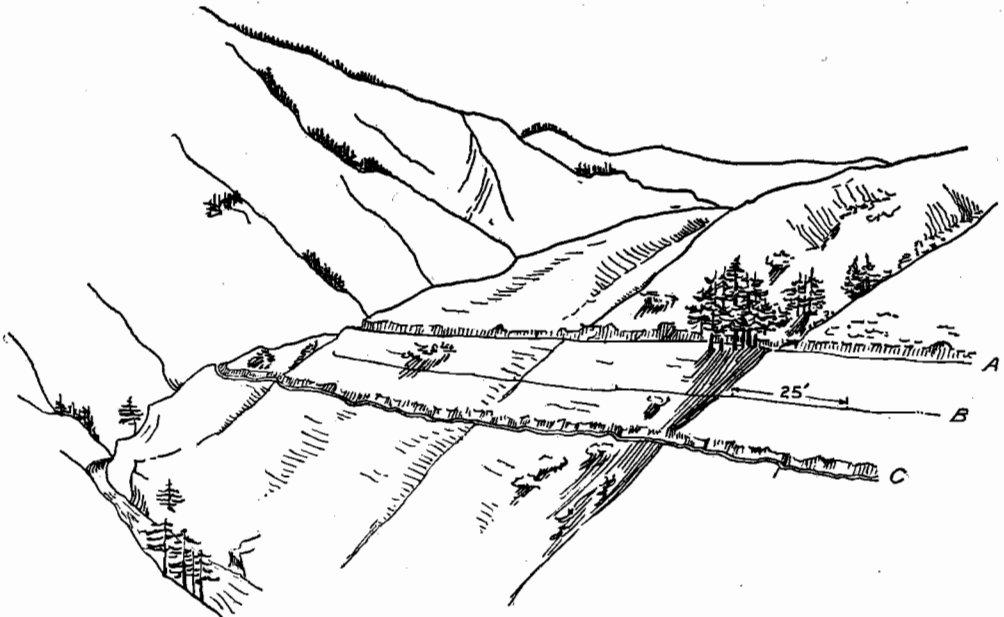


FIGURE 2.—Trails constructed from marked and unmarked grade lines.

to be good practice. To accomplish the same object, it is also good practice to use reverse grades up to 30 percent at reasonable intervals for distances which will not give a loss of elevation of more than 50 feet in one reverse section.

TABLE 2.—*Permissible grades above 15 percent on trails*

Grade (percent)	Distance ordinarily permissible
16 to 20	One-half mile.
21 to 25	One-fourth mile.
26 to 30	100 yards.

Along creeks of slight fall, or in paralleling the contour of a mountain, make no effort to maintain uniform grades if construction cost can be materially reduced without material decrease in rate of travel. By use of undulating grades to a reasonable extent, avoid bluffs, slides, and exceedingly steep slopes.

Along ridges and points, always use the crest of the ridge if its ups and downs do not exceed an approximate average of 15 percent for distances greater than those shown in table 2, or if the crest is not obstructed by a series of projecting bluffs or rocks.

23. CLEARING ON SECONDARY AND PRIMARY TRAILS.

Clear to a sufficient width and height to provide unobstructed passage of loaded pack animals and horsemen, even when the brush is loaded with snow. A rough rule of thumb generally applicable, but not always so, is to remove obstacles from either side within reach of the extended arms of a man standing at the approximate center of the tread or point of travel. Overhead clearing 10 feet from trail bed is the general working average required.

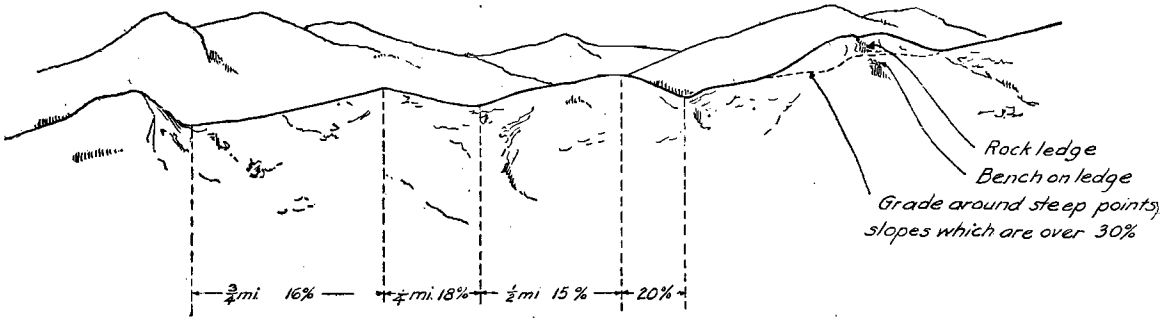


FIGURE 3.—Showing trail on top of a ridge.

Cut large trees only where location around them is impracticable. Always keep in mind the point of view of a forester as well as that of a trail builder.

Cut trees and brush as close to the ground as is practicable without unduly increasing the cost.

Do not blast stumps in advance of grading. Stumps at the top of back slopes should seldom be blasted out. Never blast stumps located at the outer edge of the tread. Cut interfering roots but leave the stump to serve as a support to the trail. (See fig. 4.)

In clearing right-of-way always fall timber downhill, where possible, and throw brush downhill if it is not to be burned.

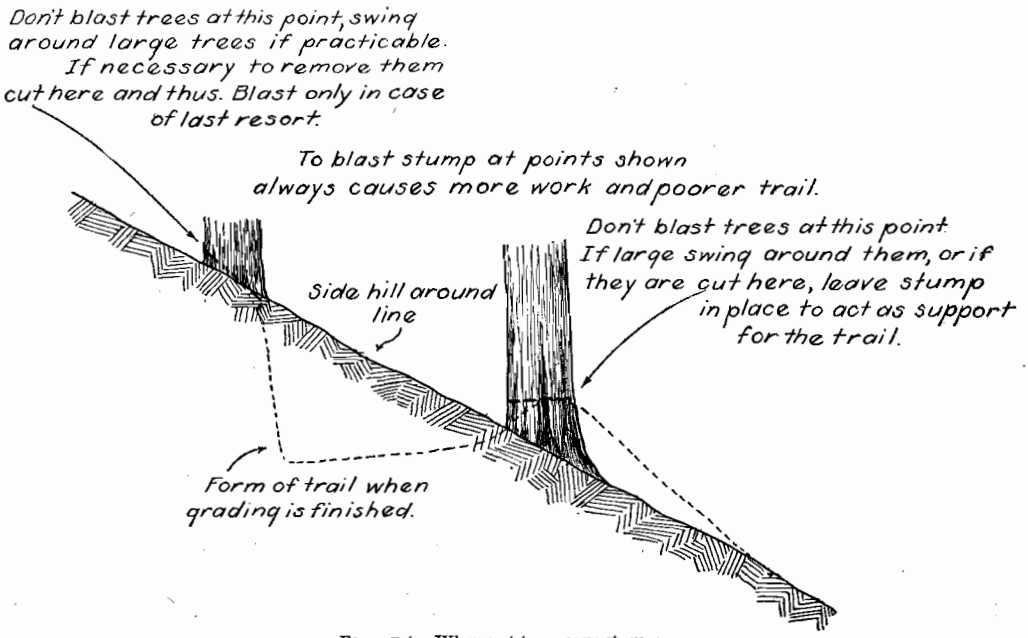


FIGURE 4.—When not to remove stumps.

24. BRUSH DISPOSAL.

Pile and burn brush, limbs, and tops under 4 inches in diameter on projects to be used largely by the general public, if in accordance with the prevailing timber sale practice. Wherever safe, burn at the time of clearing.

On recreational trails, all brush and debris must be disposed of by burning. If clearing has been accomplished during the fire period, the debris should be piled for later destruction.

On projects in more isolated regions to be little used by the public, dispose of the debris by lopping and throwing it downhill, or by roughly piling it beside the trail on level or nearly level locations. However, where the Regional Forester considers it sound practice to dispose of brush completely, pile and burn it. Brush should not be piled and burned merely for the sake of the brush-burning principle.

25. WIDTH OF TRAIL.

Width of trail means the distance from the inside edge to the outside edge of the trail. (See fig. 5.)

Table 2 and figures 6 to 10 indicate specifications and designs applicable to primary trails under varying slopes. Exception may be made only:

(*a*) Where a ditch is necessary to carry off seepage from springs. (See fig. 17.)

(*b*) On certain recreation trails where the Regional Forester can justify the construction of wider trails than described in the specifications and diagrams.

To warrant any exception, a showing must be made in every case that the exception is justified by some inescapable demand rather than upon a forest Officer's interpretation or opinion of what the recreationists want or need in the way of trails. Under normal conditions and circumstances, trails built upon the specifications for primary trails are adequate for all purposes including recreational use. Forest officers should educate the public in good trail economics and will never encourage extravagant ideas in trail construction.

It is recognized that completed secondary trails on steep slopes and rough ground may approach the stand-

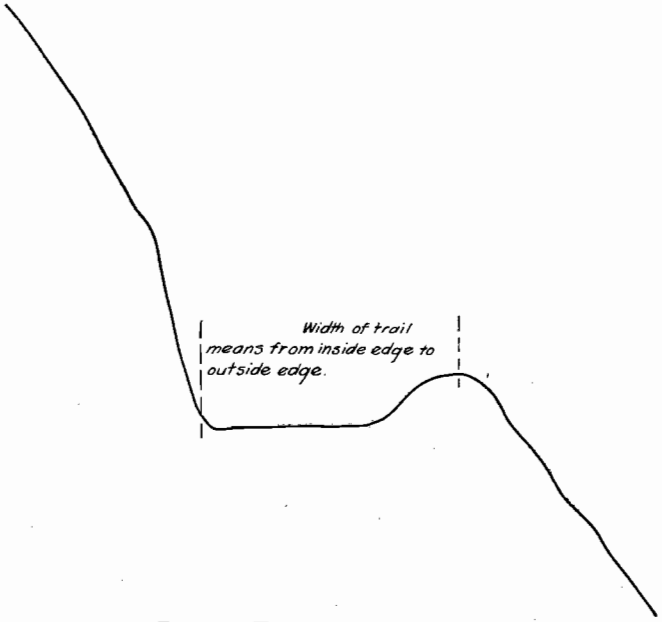


FIGURE 5.—How to measure width of trail.

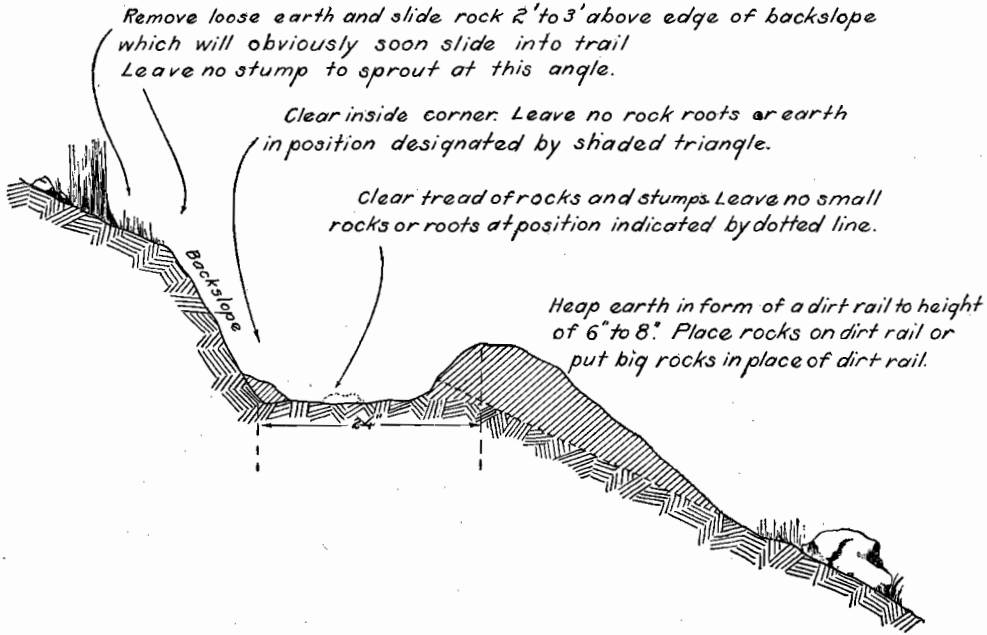


FIGURE 6.—Cross section of typical trail on slopes between 30 and 85 percent.

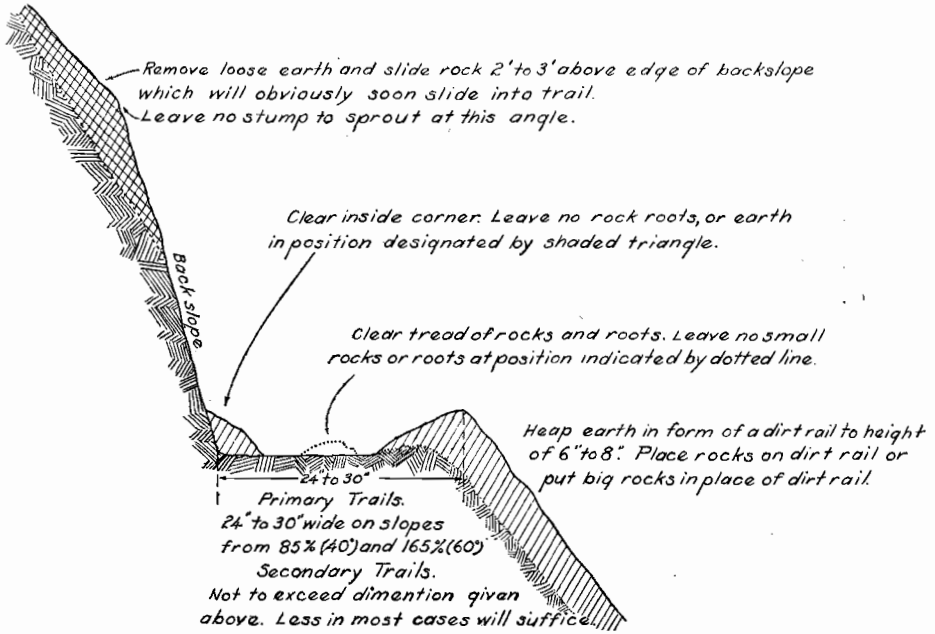


FIGURE 7.—Cross section of typical trail on slopes between 85 and 185 percent.

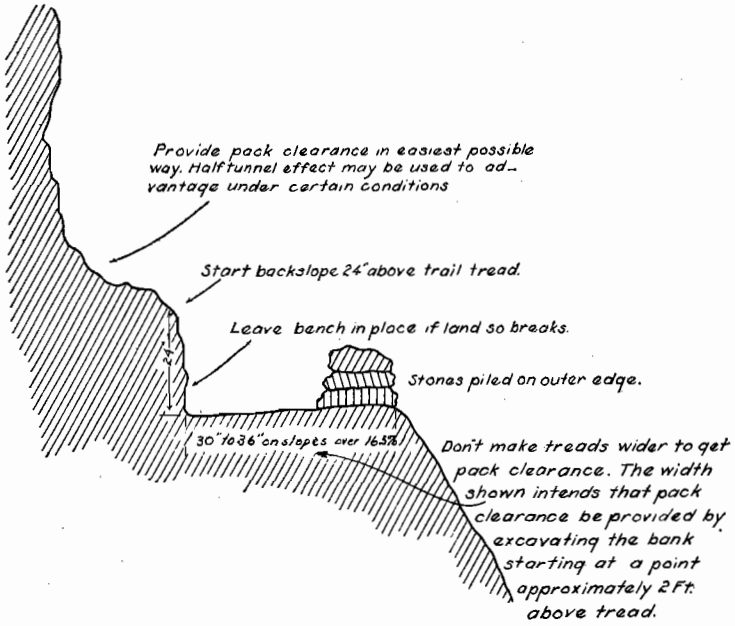


FIGURE 8.—Trail construction around bluffs.

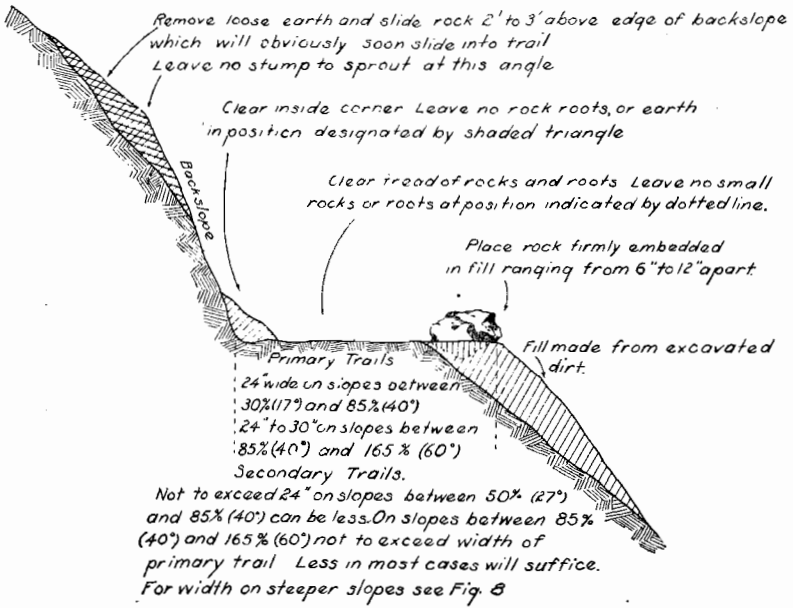


FIGURE 9.—Type of trail suited to regions of heavy rains.

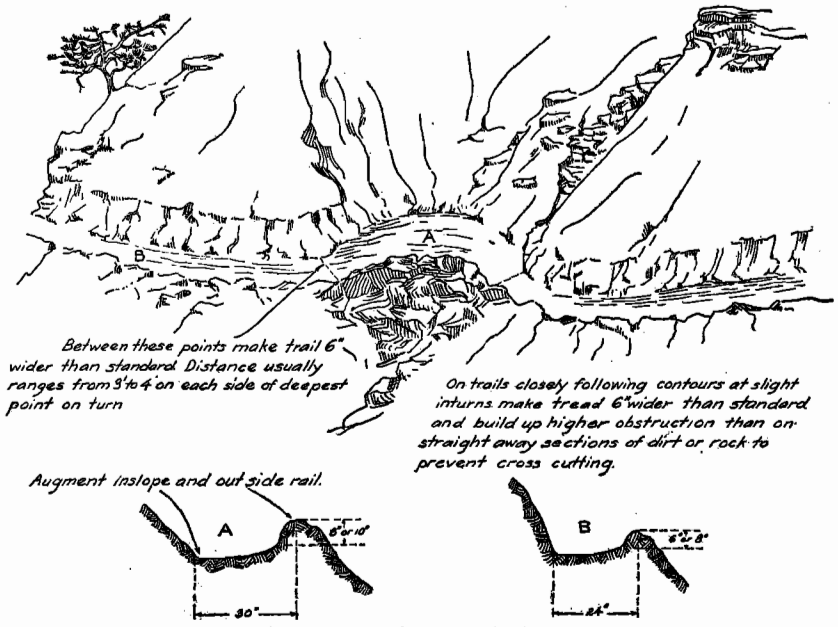


FIGURE 10.—Inapplicable construction in Southwest.

ards of width and finish of primary trails, but should seldom equal and never exceed them. Always confine work on secondary trails to that which is just necessary to furnish reasonably easy and safe passage and no more. Do not grade treads on ways except where impossible for loaded animals to pass. Confine work to clearing logs and brush and unescapable groups or reproduction.

26. ROCK SLIDES.

In building either class of trail across rubble slides remove only sufficient material to provide good footing for an animal. Do not attempt to make a nice-looking job. To do so may mean the making of a deep cut which, if the rock is small, seriously disturbs the equilibrium of the material. This disturbance frequently leads to never-ending obstruction and continuous maintenance (figs. 11–12).

27. TURNOUTS.

Along very steep slopes, under certain circumstances of use, it may be necessary to improve natural turnouts at intervals. Such places are most commonly found on points, or in gullies or ravines.

Short, rough treads above or below the regular one may be made to provide passing places for pack trains or other forms of heavy travel on long stretches of abrupt slopes lacking in natural turnouts. Confine work on passing trails to the minimum; merely make a passing place safe.

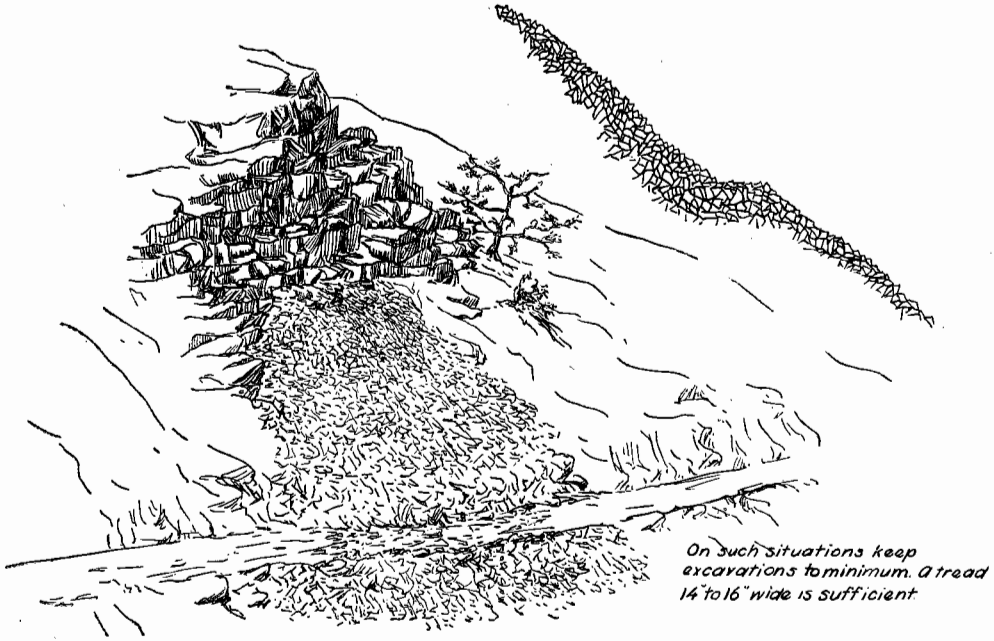


FIGURE 11.—Trail on rubble consisting of small rocks.

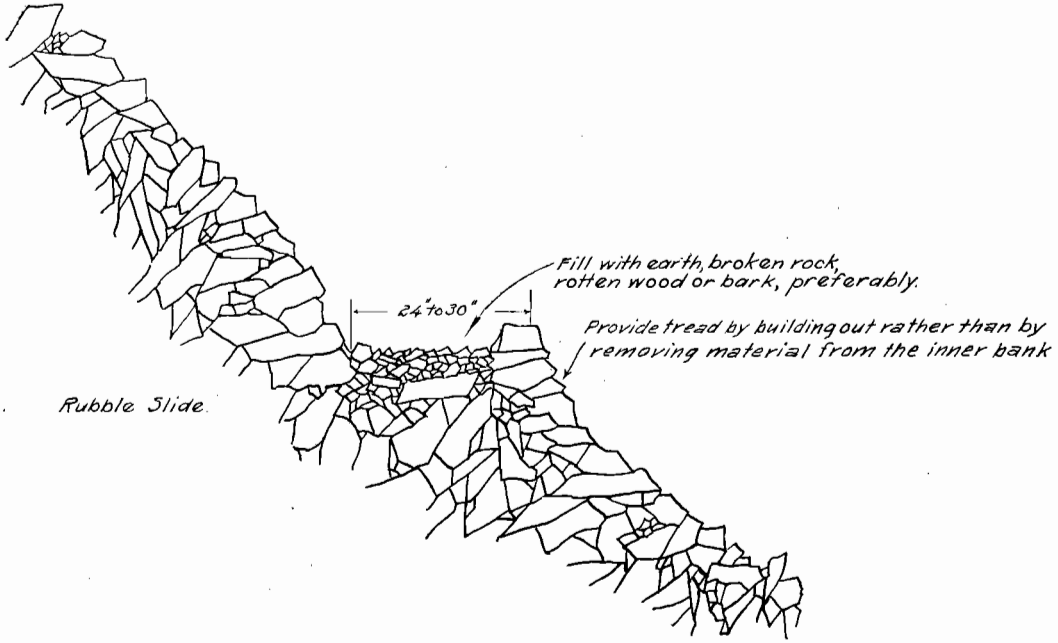


FIGURE 12.—Trail on rubble consisting of large rocks.

TABLE 3.—*Width of ways and trails*

Class of trail	Side slopes		Width over all (inches)	Notes
	Percentage	Corresponding degree of slope		
Ways				Do not grade where loaded pack animals can get footing. Where grading is actually necessary, make treads only wide enough to give footing. Twelve to fifteen inches is enough.
Secondary	0 to 50	0 to 26	None	Simply mark a narrow line to indicate the proposed line of travel. If stumps, rocks, and roots occur, remove them only to a width sufficient to provide free passage and never in excess of 24 inches.
Primary	0 to 30	0 to 18	None	
Secondary	50 to 85	27 to 40	24 maximum	Any width to a maximum of 24 inches, which will make passage reasonably easy and safe.
Primary	31 to 85	18 to 40	do	
Secondary	85 to 165	40 to 60	30 maximum	Any width up to a maximum of 30 inches which will make passage reasonably easy and safe.
Primary	85 to 165	40 to 60	24 to 30 maximum	
Secondary	Over 165	Over 60	36 maximum	Any width up to a maximum of 36 inches which will make passage reasonably easy and safe.
Primary	Over 165	Over 60	30 to 36 maximum	

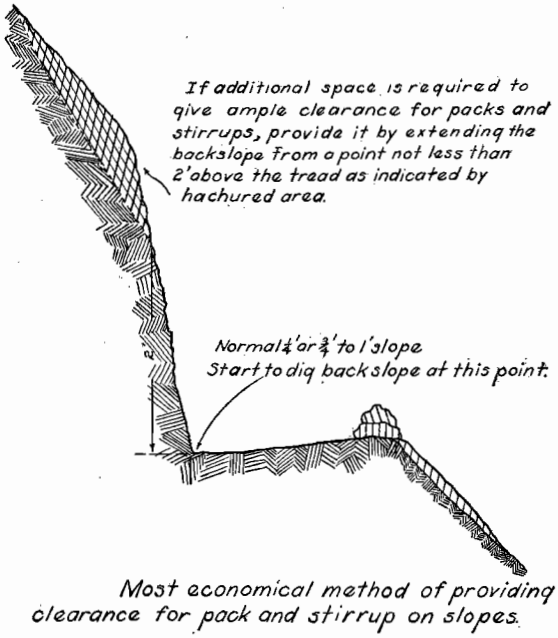


FIGURE 13.—Economical method of clearing for pack and stirrup.

28. BACK SLOPES.

In earth, start back slopes from inside edge of tread. Give sufficient pitch to the back slopes to bring the earth to angle of repose. If packs or stirrups will not then clear, provide ample room by removing more earth from the bank at the position designated in figure 13. These instructions apply to both primary and secondary trails.

In solid rock, start back slope 2 feet above trail tread. Additional clear space for packs or stirrups should be provided in the easiest possible way. (See fig. 8.)

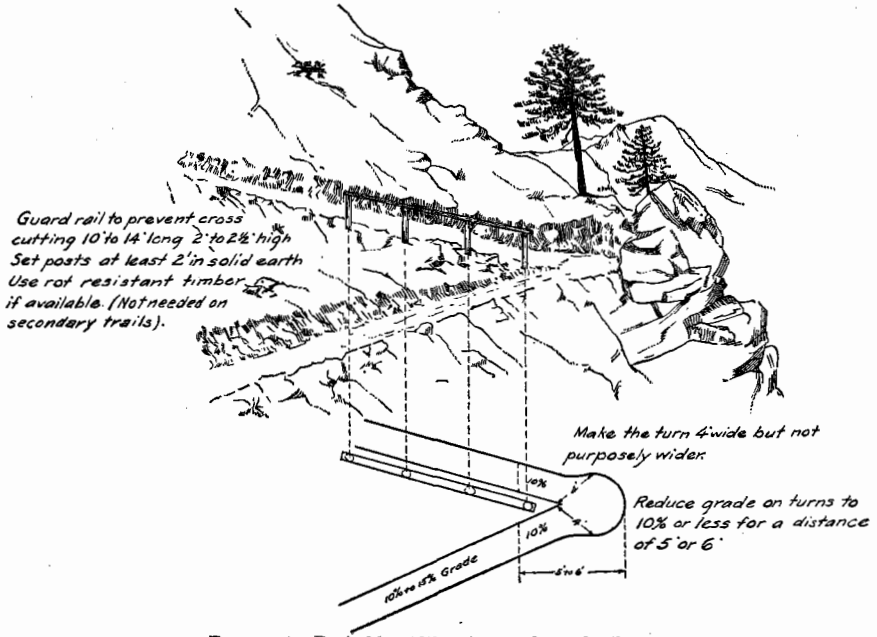
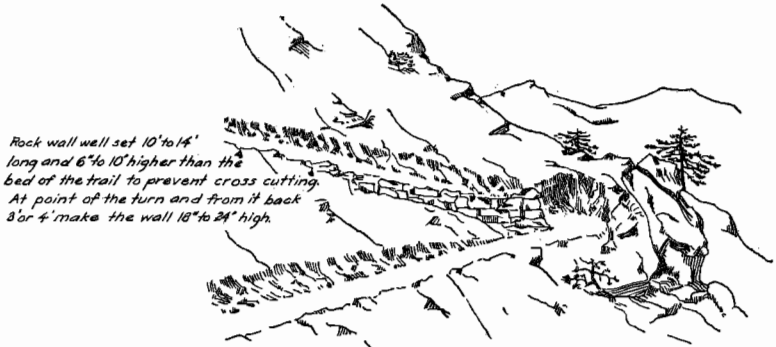


FIGURE 14.—Desirable width of turn and guard rail.

29. SWITCHBACKS.

Switchbacks are undesirable and involve the moving of large quantities of material. They are often necessary on primary and secondary trails where the physical characteristics limit the location rather definitely, and where the difference in elevation between two points is such that the maximum allowable grade is not sufficient to meet the required rise in the distance obtainable.

Some method of preventing crosscutting should be used on primary trails unless the turn is made in solid rock, or around a large tree. Two methods are shown in figures 14 and 15.



Showing use of rock wall to prevent cross cutting at turns of switch backs.
Use only where rock of substantial sizes are handy.

Cross section 10'ahead of turn showing use of dirt rail or cut 18"to 24" deep and rocks on outer embankment to prevent cross cutting on switch back

FIGURE 15.—Rock wall to prevent crosscutting on turns.

30. ROCK WALLS.

Rock walls should be used only where it is cheaper to construct a wall than to blast out a new trail tread. (See fig. 16.)

In wall construction, a foundation is first prepared on solid earth or rock. The minimum width of the foundation should be 2 feet, and the outer edge should then be 6 inches higher than the inside edge.

Use only sound, durable, and well-shaped rocks. Ordinarily, use no stone less than 3 inches thick nor less than three-quarters of a cubic foot in volume in the body of the wall. Use of smaller stones for chinking is permissible.

Be sure that:

(*a*) At least one-fourth of the front and rear face of the wall is composed of headers having a length of at least two and a half times the thickness.

(*b*) All projecting points are removed from top and bottom of main rocks, and that each is laid with good bearing on its broadest face.

(*c*) All headers are laid with their greatest dimension extending into the wall and never parallel to it, except at corners, in which case alternating headers should cross.

(*d*) The outer face of the wall has a batter or a slope inward of at least 3 inches to each foot of height.

(*e*) The wall has a front and rear face well tied together with good big header stones. Avoid, without exception, the practice of laying up a face course of any kind of rock and filling behind it with small rocks and dirt as the wall goes up. It will surely collapse sooner or later.

31. DRAINAGE.

Drainage structures will take three forms:

(*a*) Open ditches (fig. 17) for seepage.

(*b*) Water bars (figs. 18 and 19) to turn seepage and run-off of rains and snow from the trail.

(*c*) Culverts.

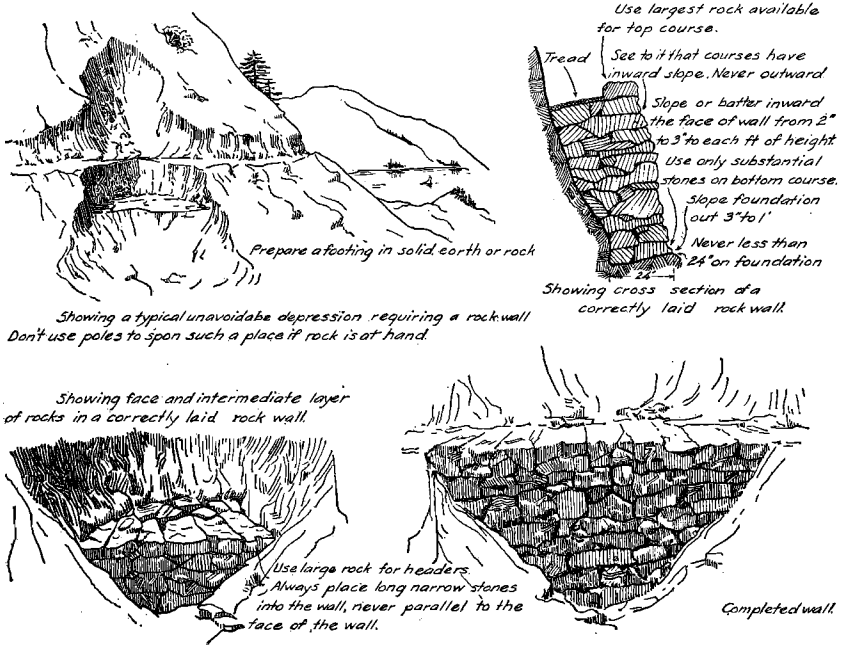


FIGURE 16.—Building a rock wall.

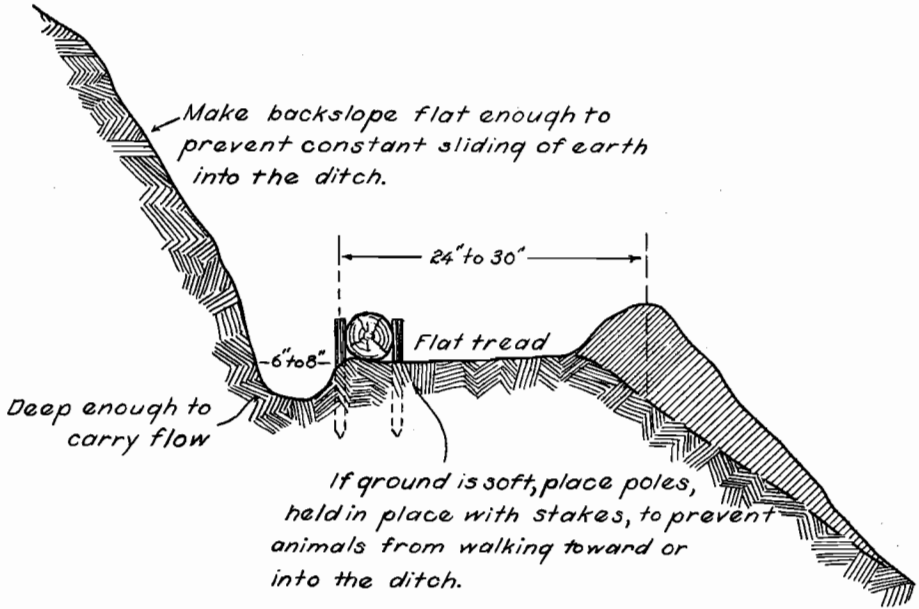


FIGURE 17.—Trail provided with drainage ditch.

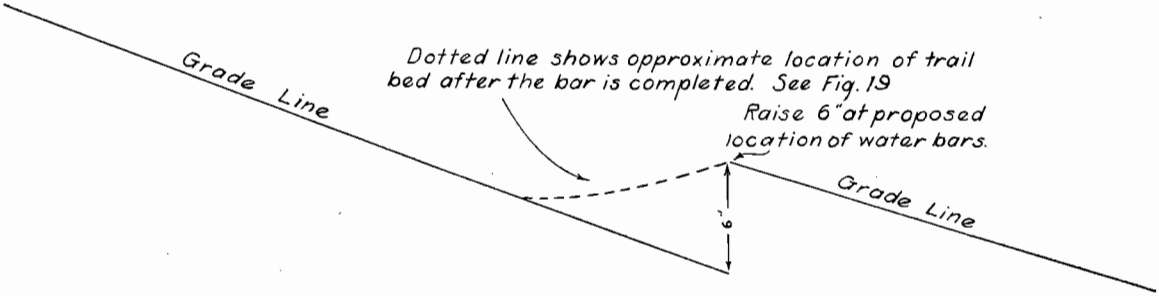


FIGURE 18.--Profile of grade line at water bars.

32. OPEN DITCHES.

Open ditches should be used to drain seepage or run-off from springs located above a trail. If the earth is solid, open ditches may be used to carry the water across the trail, but the use of water bars or culverts is considered better practice. Never use open ditches to drain the run-off from storms or melting snow. If the ground is soft, the ditch should be protected as shown in figure 17.

33. WATER BARS.

Install water bars at the time the grading work is done. The character of the soil and the volume of the run-off will determine the interval between water bars. This general statement must not be interpreted to mean that water bars may be entirely omitted. They must be placed at intervals of not more than 500 feet on long grades where other provision for cross drainage is not made. They should be installed at an angle of 30° to 45° to a straight line across the trail.

In selecting places for water bars and other forms of drainage, advantage must be taken of natural obstructions. Trees, stumps, roots, and rock aid materially in preventing erosion of the outer embankment. It is sometimes good practice to riprap the lower side of the trail when the soil is loose and natural obstructions are not available. Figures 18 and 19 illustrate the construction of water bars.

34. CULVERTS.

Culverts should be constructed when necessary. It is sometimes necessary to construct culverts to cross streams where soft bottoms and boggy land on each side make travel difficult. Culverts are sometimes constructed to drain seepage water across trails when the earth in the trail is soft and subject to erosion. Culverts should be constructed of large stones or durable timber.

35. CORDUROY.

Avoid boggy land to the fullest possible extent, even if to escape it the best topographical location of a trail must be sacrificed, the best grades abandoned, and the length of a trail materially increased.

If impracticable to avoid swamps and bogs, first consider the possibility of making a dry tread by draining as illustrated in figure 21. If that is not feasible; lay corduroy across such places.

Do not try to fill boggy places with large rocks. It is bad practice, and the result is simply a place in which a horse may injure or break his leg.

Principles to be observed in all corduroy constructions are:

(*a*) Extend the ends to solid ground.

(*b*) Use the most durable timber available of substantial size.

(*c*) Remove the bark from the logs.

(*d*) Wherever practicable, place the entire structure—sills, stringers, and flooring—below the mud line instead of placing it on sills which elevate the structure above the line of permanent moisture. This practice will help to prevent rot.

(*e*) Provide an adequate base of stringers and add sills to prevent sagging and tipping of any section of the structure.

(*f*) Fasten the flooring in place.

(*g*) Lay flooring crosswise. This prevents stock from slipping, especially where corduroy is necessary on a grade.

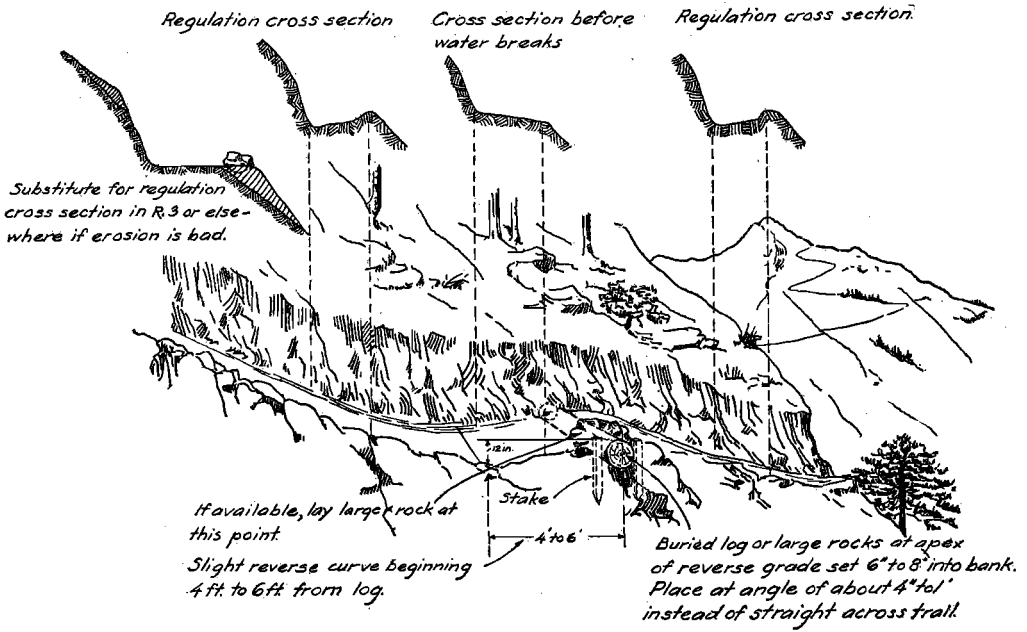


FIGURE 19.—Section of trail showing water-break log.

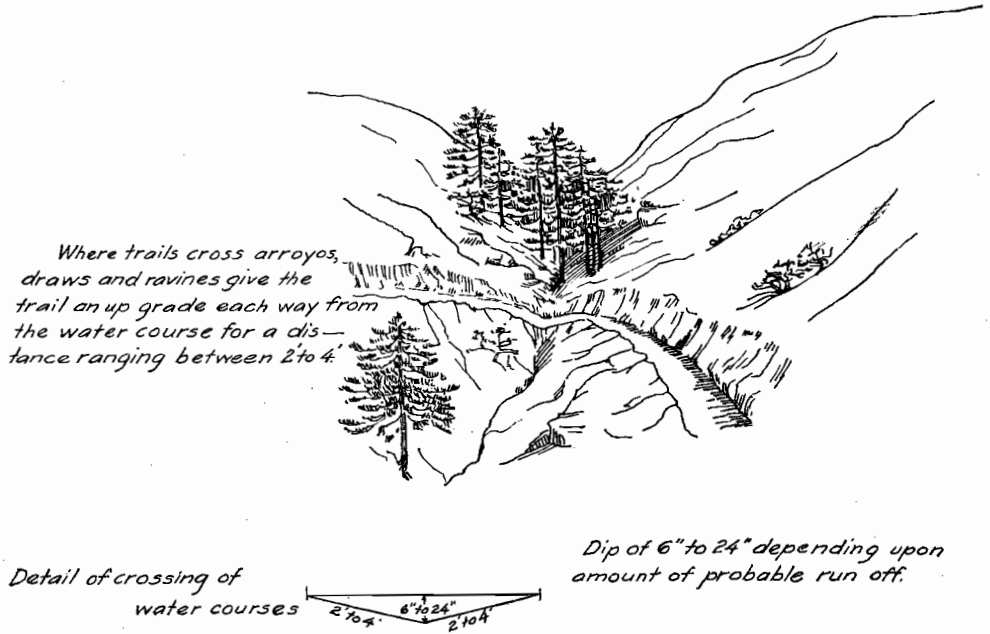


FIGURE 20.—Trails across arroyos, draws, and ravines.

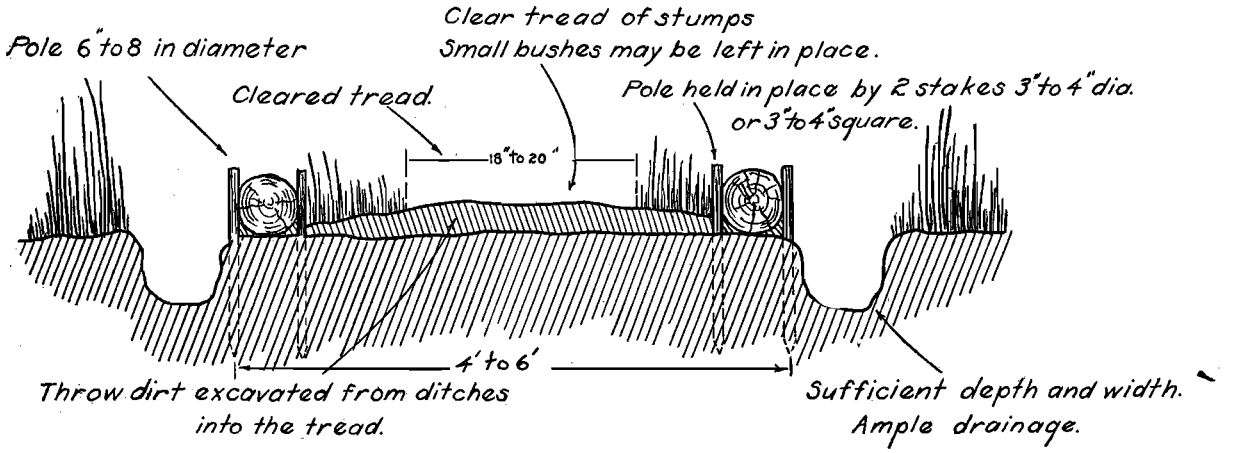


FIGURE 21.—Trail on flat soft wet ground.

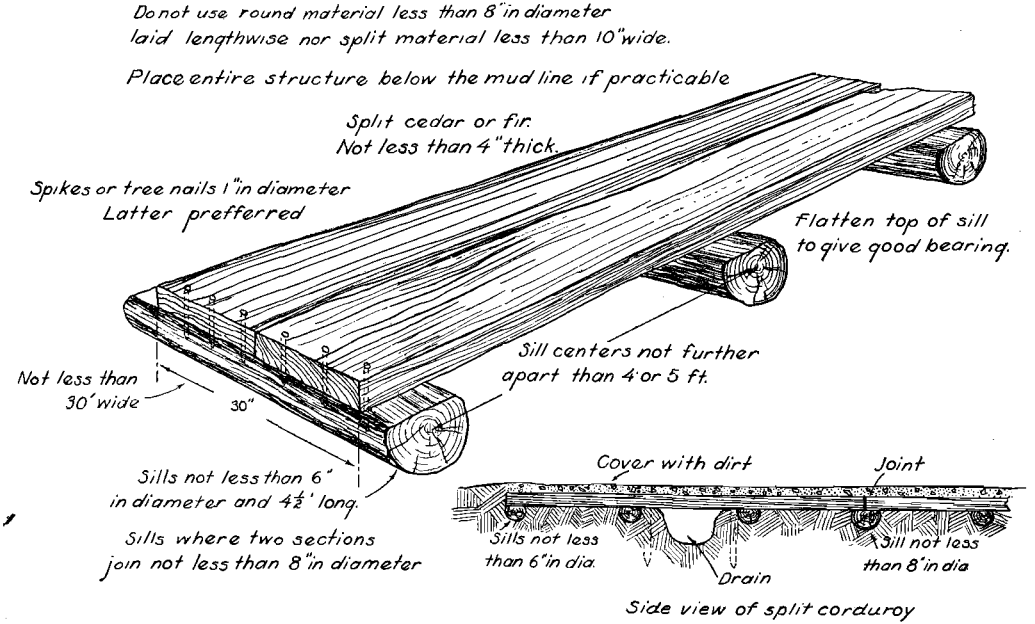


FIGURE 22.—Section of split corduroy.

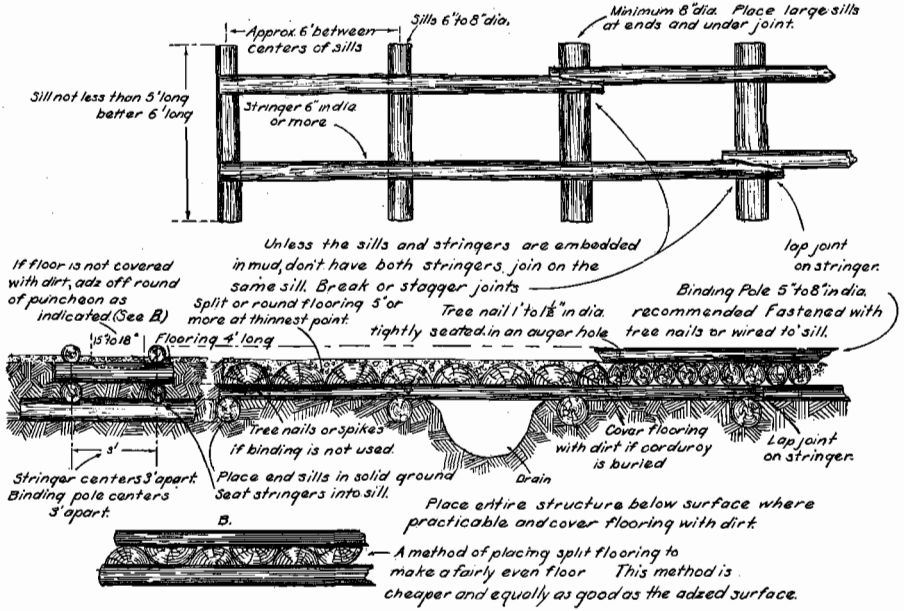


FIGURE 23.—Views of ordinary sill and stringer corduroy.

36. **FORDS.**

Fords, in place of bridges, are to be favored where suitable ones can be located. The ideal ford is at a point where the stream widens out, with a slackening in velocity and a gravelly bottom. Carry grading to the water's edge so an animal will not drop off on one side and have to scramble out on the other. Wherever practicable, rocky fords should, during low water, be improved by rolling out or blasting rocks from the tread and filling in with smaller rocks and gravel, or by rolling the loosened rock to the downstream side to restrain debris in the form of sand and small rocks which in time will accumulate and make a good bottom. A log firmly fixed across smaller streams may sometimes be effectively used to form a barrier to hold debris.

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SECTION VII.—MARKING

37. BLAZING.

Place Forest Service trail blazes so that they are visible to a traveler approaching in either direction. Graded sections, except in deep snow country, require little or no blazing. Ungraded sections should be carefully marked. Any more blazing than actually needed is a waste, and is often very unsightly.

Blazing should be done only as construction progresses. Trails into temporary camps should not be marked with standard blazes.

Table 4 specifies a system of marking Forest Service trails. It applies to all existing trails not adequately marked and to all new construction.

TABLE 4.—*Marking systems*

Location	Character of markers in order of preference
In timber	(1) Forest Service blazes on both sides of trees; optional on graded trails, except in deep snow country.
Across meadows and other openings over 600 feet wide	(1) Posts, or posts and markers or stone monuments 300 feet apart (approximately). Blaze trees on both sides of the opening.
Both sides of fords	(1) Blazes on trees on both sides of trail; (2) posts, or posts and markers or monuments on both sides of the trail.
Above timber line	(1) Small rocks placed on larger ones commonly known as "ducks"; (2) monuments, 300 feet apart (approximately); (3) posts, or posts and markers.
All other places where a traveler may be in doubt	(1) Blazes; (2) posts, or posts and markers or stone monuments.

FIGURE 24.—Trail blaze.

FIGURE 25.—Trail blaze.

38. SIGN POSTING.

Simple and inexpensive markers are desirable on a main trail. The location of markers should be indicated as the construction progress is measured. If permanent signs are not available, use temporary signs. The roughest sign, lettered with charcoal, pencil, or crayon is better than none at all. The ultimate objective is to have metal signs of standard design for the Forest Service at all trail forks, intersections, fords, etc. (See figs. 26 to 28.)

Use substantial posts of the most durable timber at hand, peeled, and well set, for signing all heavily used trails (fig. 29). Otherwise, put all the better types of signs on correctly located large trees wherever possible and never on a limber or crooked sapling or bush. Do not place signs on poorly located trees, such as trees out of line or ones bordering the trail, but 50 or more feet ahead of or back of an intersection of two trails. Never place signs lower than 5 feet, and, as a rule, not more than 6 feet above the ground. In regions of heavy snowfall, or in localities where damage by cattle is probable, heights up to 7 feet are approved. Metal signs should always be backed with boards and attached with screws, preferably blued screws, never with nails. The instructions on the mechanical features of sign posting may be summed up by saying: "Give sign posting the stamp of good workmanship."

AN AXIOM

At every intersection there should be at least TWO directional signs

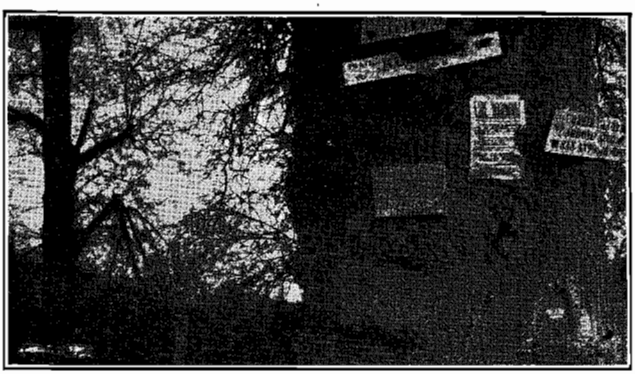


FIGURE 26.—Example of careless practice in placing signs.

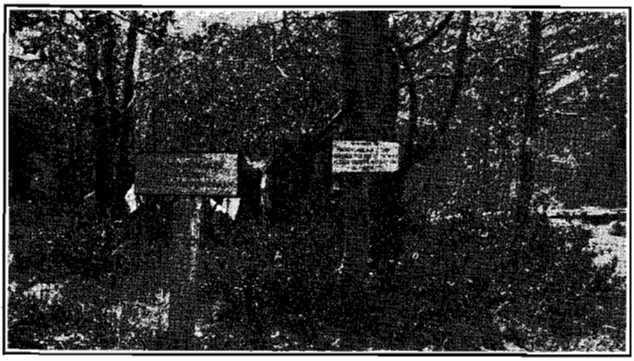


FIGURE 27.—Neatly placed signs.

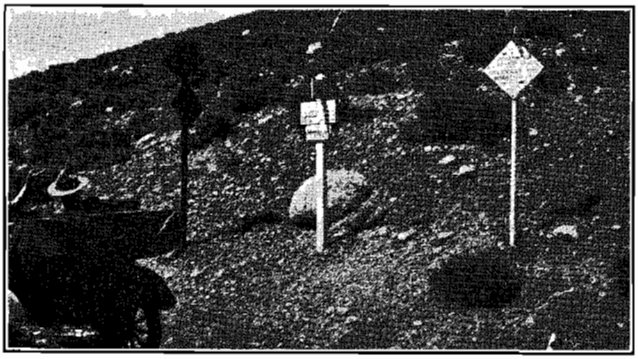


FIGURE 28.—Example of duplication in placing signs.

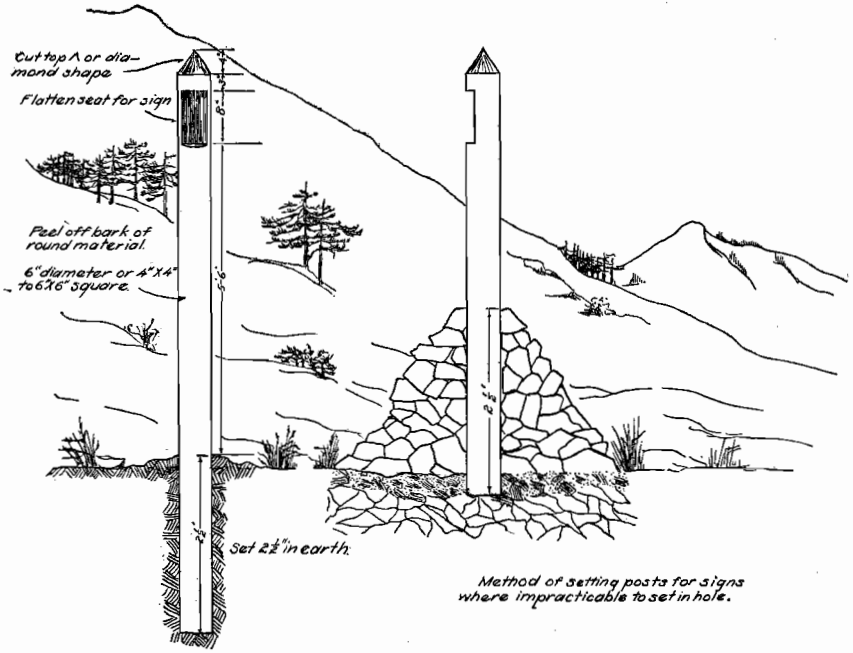


FIGURE 29.—Sign-board posts.

SECTION VIII.—MISCELLANEOUS PRACTICES

39. PRACTICE.

The following suggestions are worth the study of all users of this handbook:

Good practice—

1. To use bits of rags or paper, or any other mark easily obliterated, to mark preliminary location lines.
2. To start to dig tread from the grade line.
3. To use the undercut method of digging.
4. To have grader stand on the lower side of the grade line in order that he can draw the dirt outward and shape the dirt rail without the need for a shovel.
5. To use shovels sparingly on the average trail job.
6. To have the foreman designate sections 25 feet to 50 feet long for each man, to prevent bunching of men.
7. To have the foreman equipped with a measuring stick to check up width of tread.
8. To use "single jacks" on drills in soft rock.
9. To use 40 percent explosives for rock work.
10. To use 20 percent explosives for stumping.
11. To study the comparative cost in time and material in use of explosives as against labor for the doing of a given job.
12. To do all blasting just before noon or evening quitting time whenever practicable.
13. To have at least one wheelbarrow on every primary trail job.
14. To have plenty of tools and to have sharp ones in the hands of every man who uses an edged or pointed tool.

15. To make camps comfortable for men.
16. To serve good, substantial food, and to go light on fancy stuff.
17. To have cooks carry hot food to men on the job rather than serve cold lunches or to walk men long distances to dinner.
18. To treat men fairly and to expect and get a full day's work from everyone.
19. To discharge promptly those who do not give a full day's work.
20. To discharge promptly the chronic "kicker."
21. To measure carefully each week the amount of trail completed and to check cost of the output.
22. To mark mile points as construction work progresses.

Bad practice—

1. To blaze out preliminary location lines.
2. To start to dig tread from a point above the grade line.
3. To dig trails so wide that the use of a shovel becomes necessary.
4. To permit mattock men or swampers to select places to start work.
5. To make trails wider in good ground than on rough, steep places simply because it is easy and nice to do.
6. To follow recklessly the notion that use of explosives is cheaper than labor in the removal of small stumps and logs.
7. Blasting at any time the rock men or powder men might have holes ready to shoot.
8. To permit men to work with dull tools.
9. To use poles covered with dirt to span depressions unless very rot-resistant material is available.
10. To use nondurable poles under fill as a support.

SECTION IX.—MAINTENANCE

40. POLICY.

The maintenance policy is stated in paragraphs 2 and 9. Slighting of maintenance work allows the standard of the trail to decline until reconstruction becomes necessary. Overdoing maintenance limits the mileage that can be maintained with available funds. Well-balanced work is required. Construction should not proceed so rapidly that maintenance cannot be kept apace. Remember that anything worth constructing is worth maintaining properly.

41. CLASSIFICATION.

Maintenance is classified under three general headings:

(*a*) Emergency maintenance.
(*b*) Ordinary maintenance.
(*c*) Extraordinary maintenance.

EMERGENCY MAINTENANCE includes all work that must be done to make trails simply passable before the fire season opens or before the regular crews complete the repair of a given trail.

ORDINARY MAINTENANCE has first call upon available funds, following emergency maintenance. It will be done currently, and ordinarily includes:

(*a*) Routine work of clearing trails of all logs and interfering brush.
(*b*) Clearing tread of small slides and debris from the inside of the tread, and light repair of treads.
(*c*) Upkeep of drainage systems.
(*d*) Repairing wash-outs.
(*e*) Light repair of bridges, culverts, and corduroys.

(*f*) Removing rocks and roots from treads to make feasible the use of plows and scrapers in removal of the debris.

(*g*) Upkeep and replacement of trail markers and signs.

(*h*) Tearing down and burning or burying mutilated and faded "Fire" and "Reward" signs.

EXTRAORDINARY MAINTENANCE is given high priority, usually ahead of new projects in trail work plans. It comprises:

(*a*) Removal of dense growth of brush and trees.

(*b*) Removal of heavy downfalls of timber over considerable distances.

(*c*) Removal of heavy slides or reconstructing new sections of trails around slides.

(*d*) Replacement of cribbing, preferably by rock walls, and rebuilding of damaged rock walls.

(*e*) Regrading of tread at proper position where it has worn downhill.

(*f*) Making dangerous places safe.

(*g*) Relocating and constructing new sections where mistakes in original location materially reduce average rate of travel over the project as a whole or where the original trail is so badly damaged that reconstruction is necessary.

(*h*) Replacement of unsafe bridges, culverts, and corduroys.

(*i*) Providing drainage which entails a large amount of work.

(*j*) Replacement of trail markers in considerable numbers.

(*k*) Improving grades on steep, broad-faced ridges.

42. SPECIFICATIONS FOR CONSTRUCTION APPLY IN MAINTENANCE.

All specifications under the section "Construction", whether specifically mentioned under the "Maintenance" chapter or not, insofar as they cover the maintenance field, are to be followed in maintenance. For

example, in repairing treads, shape them according to proper design for the region (see figs. 6 to 10); or in the installation of water bars, follow design shown in figure 19.

43. MAINTENANCE SEASON.

Ordinary maintenance may continued throughout the field season. It should be the plan when moving crews, to place them where they will be of the greatest advantage in fire control.

44. ORGANIZATION FOR MAINTENANCE.

Use the type of organization which will do the most work for the least cost on all repair jobs.

45. ORDINARY.

To do ordinary maintenance, if dirt in small quantities only is to be removed, mobile crews composed of three men including a "worker boss" or foreman, equipped with suitable tools and cook outfits and two or three burros for moving camp as work proceeds, have proved to be a very effective and economical form of organization. In this handbook it will be referred to as the "burro system." Use of the system is strongly urged. Where the removal of loose or settled earth from the tread is a material factor, then, if feasible, use plows and scrapers drawn by horses or mules. Under these conditions the "burro system" may or may not be practicable.

For light maintenance, not involving much clearing of down timber or dirt work, use of a single man will often be the most economical arrangement.

46. EXTRAORDINARY.

The best organization for this class of work will approximate that outlined for the construction job. Here, too, use plows and scrapers to the fullest practicable limit.

47. DECREASE OF EXTRAORDINARY MAINTENANCE.

Need for extraordinary maintenance should gradually grow less if proper attention is given to current repair and reconditioning of the many miles of trails now in bad shape as a result of years of neglect. With extraordinary maintenance of the trail system completed, then, generally speaking, upkeep of trails will fall into the class of ordinary maintenance.

48. MAINTENANCE UNITS.

After needed extraordinary maintenance has been completed the trail systems of a forest might be divided into "maintenance units", each unit to receive a thorough going over at scheduled intervals, as circumstances may require, by crews using the "burro system", or by a single man. Fallen trees will have to be removed and other emergency work done as a matter of course each spring, in addition to ordinary maintenance.

Grouping trails in maintenance units may not be practicable for many years in some of the badly burned forests of the Northwest because each spring the emergency maintenance due to the enormous amount of windfall is such a huge job.

49. DANGEROUS PLACES.

Confine work under (*f*), extraordinary maintenance, to the elimination of actually dangerous sections, such as places with beds of slick rock on steep slopes, very rough trail beds bordering precipices, trails in boggy ground and where insufficient side clearance makes travel unsafe. Remember that conditions classed as dangerous in one locality may be merely relatively and not actually so; the same conditions might be accepted elsewhere as satisfactory without thought of need for improvement.

50. RELOCATING.

Confine work on graded sections as described under (*g*) extraordinary maintenance, to those where rate of travel has proved to be actually and materially slower than the average of the project.

Do not cut out pitches merely for the sake of making a section of trail look better, as, for example, the elimination of the reverse grade indicated in figure 30, by the construction of a 10-percent grade (shown by dotted line) simply because the 10-percent grade should have been built in the first instance. However, if the section of a trail, as, for example, the section shown between (*a*) and (*b*) in figure 31, is badly overgrown, its tread worn out, and the cost of reconditioning it would equal the expense of constructing a new section along the 10-percent gradient, follow the latter plan.

51. IMPROVING GRADES ON BROAD RIDGES.

In brushing out old ungraded trails which follow ridges or points, having broad faces, abandon the old route and cut a new clearing through on lower percentage of grades if the old trail is unreasonably steep and there is room to switch back. In the relocation, follow the principles outlined in paragraph 10. (See fig. 32.)

52. REMOVAL OF OBSTACLES FROM THE TREAD.

In maintenance work on secondary and primary trails, always remove all roots, stumps, and projecting rock in the bed of the trail which, if not dug out, would interfere with efficient use of plow and scraper. Give particular attention to the making of a clear-cut angle at the meeting of the back slope and the tread (figs. 6–10)

53. FREQUENCY OF MAINTENANCE.

All classes of trails should be maintained annually, and the maintenance plan should make it clear that low-duty trails are to get the same attention as other classes; that is, they must be opened up annually to be sure they are open, passable, and usable. Of course, the class and amount of maintenance work to be done on these low-duty trails should be in keeping with the requirements of this class of trail.

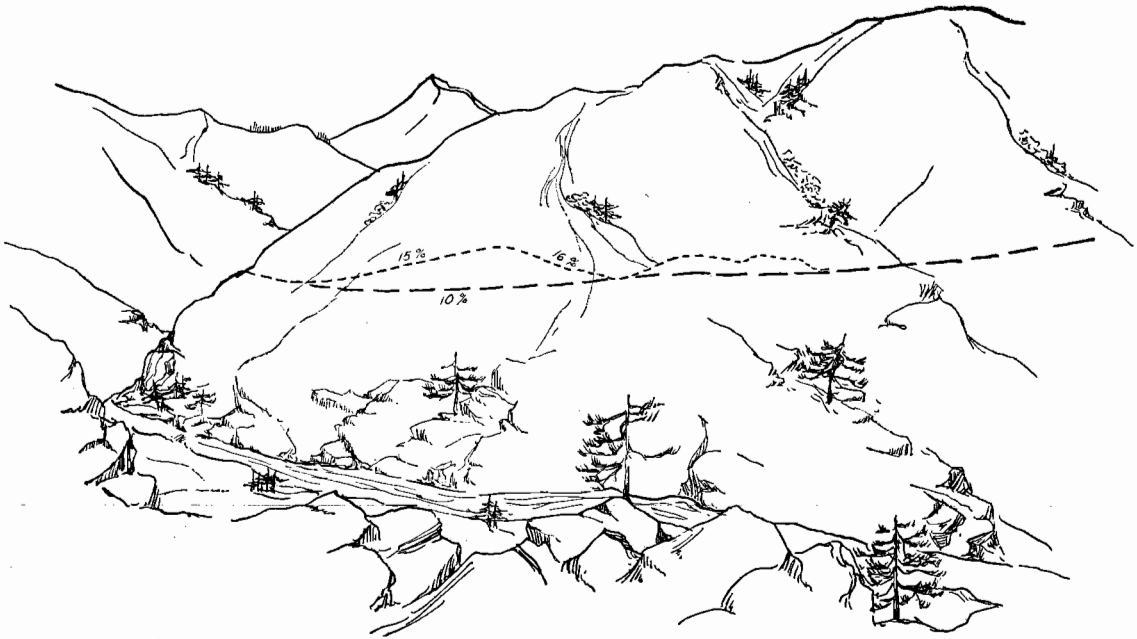


FIGURE 30.—Abandonment of existing trails on side hills.

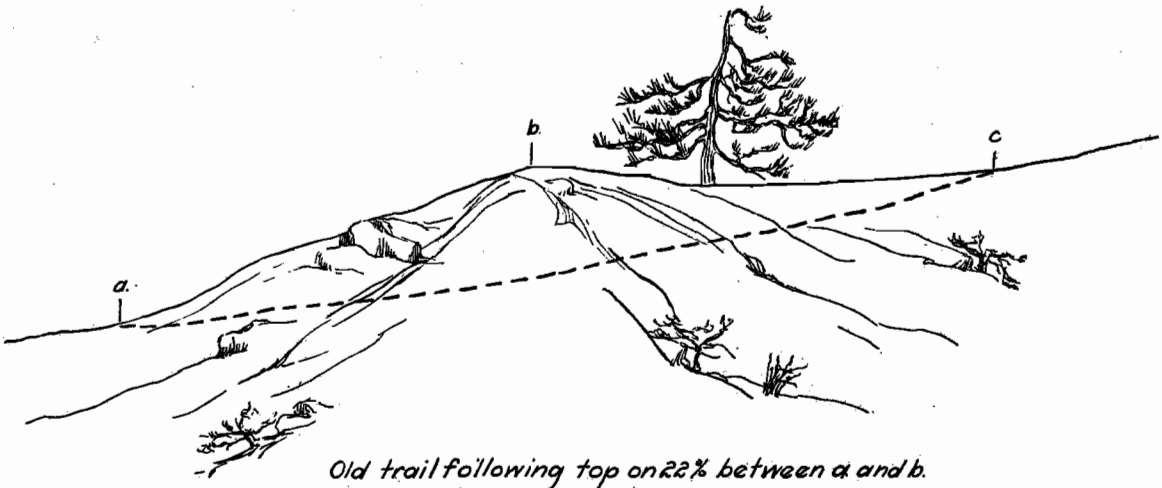


FIGURE 31.—Abandonment of existing trails on ridges.

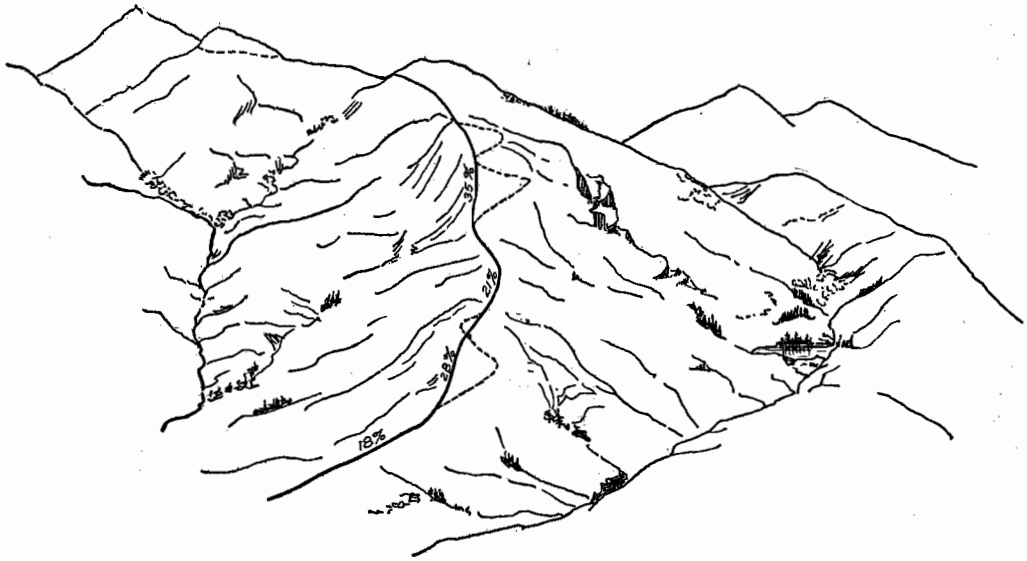


FIGURE 32.—Improving grade on flat ridge.

On account of the urgency and need a few years ago for a large mileage of low-duty trails, a large portion of this class of trail was built to a very low standard originally; this permitted leaving some logs and other obstructions that a horse could get over, but probably with some difficulty. Where this condition still exists, or whenever the way-trail system has slipped back so that the trail or trails do not measure up to the requirements and specifications, as set forth in this manual for low-duty trails, maintenance plans should make provision to bring this system up to these requirements as soon as practicable.

To insure systematic and efficient maintenance, the work in each Ranger District should be done according to a plan worked out by the Ranger. This plan being with a master map of all trails, shown by classes in color; each trail foreman to be given a rough sketch map on which is indicated only the trail system on which he is to work; the foreman to turn this map in to the Ranger when he completes maintenance work on a system of trails. He should indicate on the map his accomplishments. The Ranger will transfer this information to his master map to be used as a check on his inspection trips.

A work schedule should be made and given to the foreman of each crew. This schedule should have, as an example, the following information: The name, number, and mileage of trails to be worked; approximate time that each job should be completed; special instructions about contacts with packstrings, with supplies, etc.; where and when to split crews; instructions about posting signs, etc. All working tools and equipment necessary should be listed, and checked to be sure they are taken along. Foreman should be supplied with a carrying case containing all necessary instructions and time-keeping supplies, such as Trail Manual, maps, diary, time books, special instructions on use of explosives, and written instructions from the Ranger covering all necessary details as applied to local conditions.

SECTION X.—BRIDGES

54. LOCATION.

Construct bridges only where to avoid construction is impracticable. Never build bridges—

(*a*) To span streams where reasonably safe fords are available during the field season or where they can be provided.

(*b*) To span gullies and arroyos if physically practicable to cross them by constructing a trail. Balance cost of trail against cost of bridge.

(*c*) To improve the alinement of a trail by a relatively small amount.

The Regional Forester should approve the construction of all truss bridges and all stringer bridges. The design of all bridges should be checked and approved by the Regional Engineer. Officers selecting sites and designing bridges need to feel a keen sense of responsibility for the permanency or failure of their work. Failure due to controllable errors calls for the application of the principle of personal accountability.

The chief points that locators and designers of bridges must keep in mind are:

(*a*) Minimum length of span providing at the same time for:

(1) Stable footing for abutments.

(2) Ample clearance above the water line to provide for free passage of drift logs and uprooted trees.

(3) Advantage of location where the stream is straight and unobstructed.

(4) Minimum cost of new trail for approaches.

(*b*) Stringers and other members of no less dimensions and in no less numbers than provided in table 5.

(*c*) Suitable foundations.

(*d*) Treatment of joints with heavy asphalt paint or some other kind of preservative.

(*e*) Careful study of all instructions of this chapter before going ahead with the job.

When requesting approval and plans for structures from the Regional Engineer, a topographic survey and vicinity map with profile should be prepared, giving the following data:

Vicinity map: Scale 10 feet equals 1 inch. Indicate for 100 feet on each side of center line and 200 feet at each end of approach for proposed crossing. Contours, 5-foot intervals.

Profile: Scale 10 feet horizontal=1 inch; 10 feet vertical=1 inch.

Depth to bedrock for piers or abutments.

Character of material at approaches.

Location of nearest sand and gravel deposits.

Location of nearest suitable timber.

Estimated cost.

Where special designs are requested and field personnel is not qualified to make the proper surveys, the Regional Engineer should be requested to make the survey and selection of bridge for the crossing proposed.

Construction details as to material used, sizes of members, etc., as outlined on the plans should be followed closely, or where materials for span are not available, and other materials used, approval of the Regional Engineer should be obtained before substitution is made.

55. STRINGER BRIDGES.

Stringer bridges will be used in the great majority of cases where construction is done by the regular trail crew. Figures show the approved types to serve as a guide. Six feet is standard width for the floor. This will be exceeded only where use of large stringers make it necessary. Observe the following in every case:

(*a*) Use rock for abutments and foundations in preference to logs, where possible.

(*b*) Where abutments and sills are of wood, they should be of the most rot-resistant species available.

(*c*) Fills around logs should be of rock and not earth. This permits drainage and reduces rate of decay.

(*d*) Always peel the bark off the logs.

(*e*) Wood pins or tree nails may be used in place of iron driftpins.

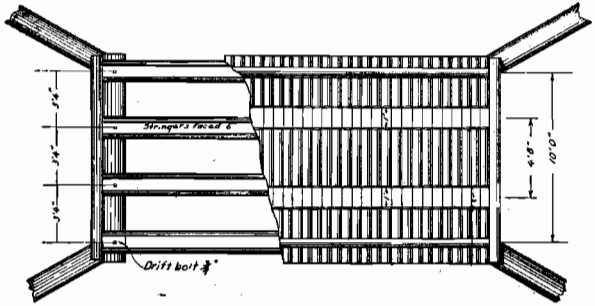
(*f*) If round material is used for flooring, hew tread along center line. Figure 33 shows a satisfactory floor. Do not put a dirt covering over the floor.

(*g*) Flooring on three-stringer bridges must be at least equal in strength to that of 2- by 12-inch planks.

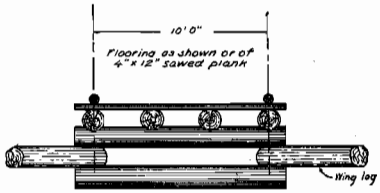
(*h*) Use four stringers in heavy snow country and where timber is small: also, where span is over 20 feet. (See figures 33, 35, 36, 37, and 38.)

TABLE 5.—*Minimum number and dimensions of stringers for spans up to 36 feet*

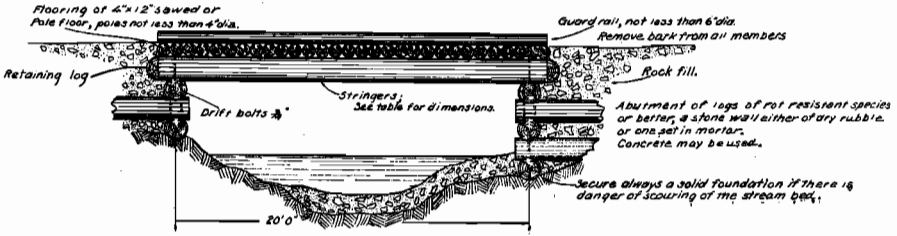
Span in feet	3-stringer bridge, 6 feet wide			4-stringer bridge 6 to 7 feet wide		
	Sawed timber		Round timber, diameter	Sawed timber		Round timber, diameter
	Width	Depth		Width	Depth	
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
8	3	6	6	3	6	6
10	3	6	6	3	6	6
12	3	8	7	3	8	7
14	3	10	8	3	8	7
16	3	10	8	4	8	8
18	4	10	9	4	8	8
20	4	12	10	4	10	9
22	----------	----------	----------	4	12	9
24	----------	----------	----------	4	12	10
26	----------	----------	----------	6	12	10
28	----------	----------	----------	6	12	10
30	----------	----------	----------	6	12	12
32	----------	----------	----------	8	12	12
34	----------	----------	----------	8	12	12
36	----------	----------	----------	8	12	12



Plan



End View



Elevation.

FIGURE 33.

The calculations in table 5 were based on a uniform load of 400 pounds per linear foot of span. A maximum bending stress of 1,200 pounds per square inch was used.

The round-timber diameters are to be measured at the small end after deducting one-half of the diameter of the sapwood.

56. TRUSS BRIDGES.

Truss bridges should be used only when strangers of adequate dimensions cannot be obtained. The cost is much higher than for a stringer bridge, and unless accurately framed, only a small portion of the theoretical strength is developed.

Where the snow is exceptionally heavy and portions of the floor cannot be removed conveniently in the fall, a truss bridge may be necessary to avoid permanent sag in a simple stringer type.

Figures 34, 39, and 40 show approved plans of this kind of bridge. The same general rules are to be observed here as with stringer bridges.

57. BRIDGE INSPECTION.

Inspection of trail bridges should be made each year. This inspection should cover:

(*a*) Scour or washouts around piers or abutments.

(*b*) Timber inspection—breaks, splitting, rot, paint.

(*c*) Suspension bridges:

- (1) Cable curves uniform.
- (2) Evidence of sagging.
- (3) Broken wires and surface rust.

(4) Anchorage and towers.

Signs of slipping or failure in masonry or dead-man locations.

Rot, breaks, paint.

(5) Bolts tight on all rods and bearings.

Where inspection indicates repair or replacement is necessary, such maintenance and repair should be made as quickly as possible.

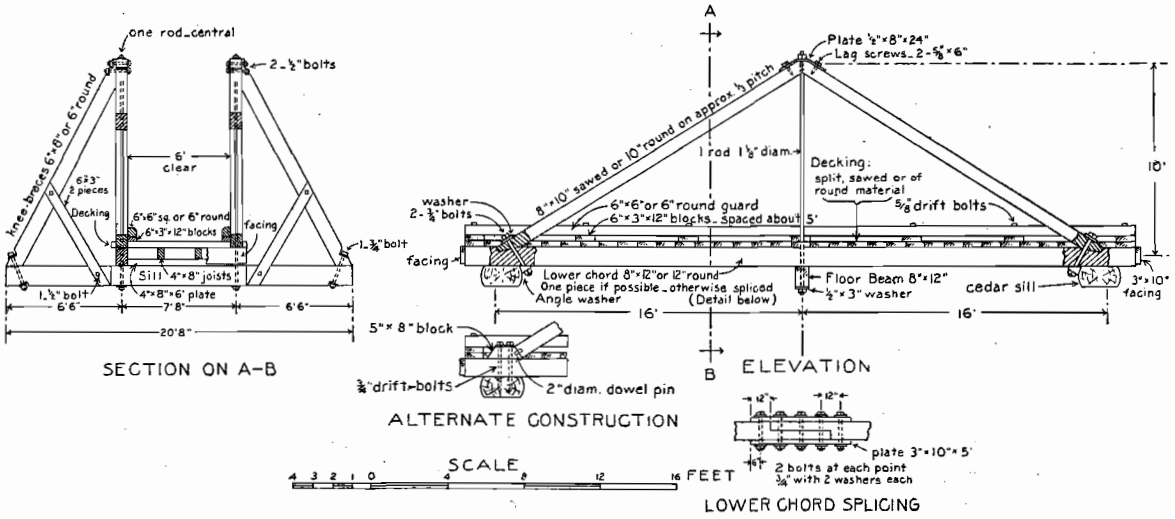
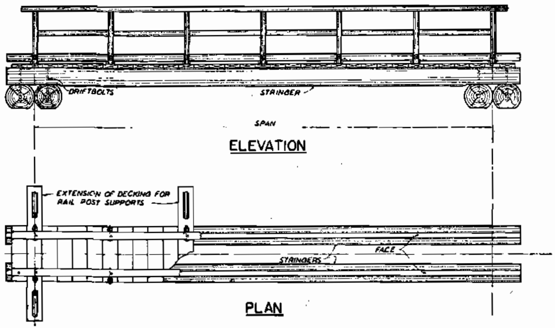
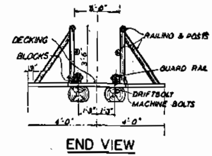

one rod_central
2_½"bolts
knee_braces 6"×8" or 6"round
6"×3" 2 pieces
Decking
6"×6"sq. or 6"round
6"×3"×12"blocks
facing
6'
clear
1_¾"bolt
Sill 4"×8"joists
1_¾"bolt
4"×8"×6' plate
6'6"
7'8"
6'6"
20'8"
SECTION ON A-B
A
Plate ½"×8"×24"
Lag screws_2-⅝"×6"
1 rod 1⅛"diam.
8"×10" sawed or 10"round on approx. ⅓ pitch
Decking:
split, sawed or of
round material
10'
washer
2-⅞"bolts
6"×6"or 6"round guard
6"×3"×12"blocks_spaced about 5'
⅝"drift bolts
facing
Lower chord 8"×12"or 12"round
One piece if possible_otherwise spliced
(Detail below)
Floor Beam 8"×12"
½"×3" washer
cedar sill
3"×10"
facing
Angle washer
16'
16'
B
ELEVATION
5"×8"block
¾"drift-bolts
2"diam. dowel pin
ALTERNATE CONSTRUCTION
12"
12"
plate 3"×10"×5'
2 bolts at each point
¾" with 2 washers each
SCALE
4 3 2 1 0
4
8
12
16 FEET
LOWER CHORD SPLICING

FIGURE 34.





NOTES
NAIL DECK WITH 4 SPIKES PER PER PLANK. PLACE ASPHALT ROOFING FELT 12" WIDE OVER STRINGERS. BORE DRIFTBOLT HOLES 1/16 UNDER SIZE. BORE BOLT HOLES 1/16" OVER SIZE. FOR SHEEP TRAVEL USE 4" ROUND POLE RAILS AT 6" C. TO C.

DESIGNED FOR 5 FT OF SNOW + 200# PER LINEAL FT. OF BRIDGE - LIVE LOAD
FOR NO SNOW - 50# PER LINEAL FT OF BRIDGE - LIVE LOAD

BILL OF MATERIAL

		10' SPAN			20' SPAN			30' SPAN			35' SPAN			40' SPAN			45' SPAN			50' SPAN			55' SPAN			60' SPAN		
	MATERIAL	NO.	SIZE	LGTH	NO.	SIZE	LGTH	NO.	SIZE	LGTH	NO.	SIZE	LGTH	NO.	SIZE	LGTH	NO.	SIZE	LGTH	NO.	SIZE	LGTH	NO.	SIZE	LGTH	NO.	SIZE	LGTH
		LIVE LOAD - SNOW - 200 LB. PER LINEAL FT. OF BRIDGE																										
STRINGERS	FIR	2	10"	14'	2	12"	24'	2	15"	34'	2	18"	39'	2	18"	44'	2	21"	49'	2	21"	54'	2	23"	59'	2	23"	64'
MIDDLE DIAM.	PINE	2	10"	14'	2	14"	24'	2	17"	34'	2	20"	39'	2	20"	44'	2	23"	49'	2	23"	54'	2	26"	59'	2	26"	64'
		LIGHT LOAD - NO SNOW																										
STRINGERS	FIR	2	10"	14'	2	11"	24'	2	13"	34'	2	16"	39'	2	16"	44'	2	18"	49'	2	18"	54'	2	20"	59'	2	20"	64'
MIDDLE DIAM	PINE	2	10"	14'	2	12"	24'	2	15"	34'	2	18"	39'	2	18"	44'	2	21"	49'	2	21"	54'	2	23"	59'	2	23"	64'
GUARD RAIL	FIR or PINE		6"	28'		6"	48'		6"	68'		6"	78'		6"	88'		6"	98'		6"	108'		6"	118'		6"	128'
RAILING & POSTS	"		4"	140'		4"	210'		4"	280'		4"	320'		4"	350'		4"	390'		4"	420'		4"	460'		4"	490'
DECKING 2"X12"	"	5		12'	9		12'	12		12'	14		12'	16		12'	17		12'	19		12'	21		12'	23		12'
DRIFT BOLTS	5/8"X18"	6			10			16			18			20			22			24			26			28		
DRIFT BOLTS	3/4	8		17"	8		20"	8		23"	8		26"	8		26"	8		29"	8		29"	8		31"	8		31"
MACHINE BOLTS	5/8"X18"	6			10			14			16			16			18			20			22			24		
NAILS - GALV	40D	25#			25#			25#			30#			35#			40#			45#			50#			55#		
ROOFING FELT		1 SQUARE									2 SQUARES																	

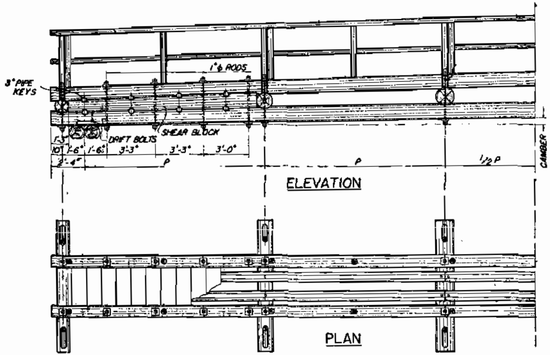
FIG. 35

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
REGION 6

LOG STRINGER BRIDGE
10 TO 60 FT. SPAN.
3 FT. ROADWAY
FOOT TRAIL

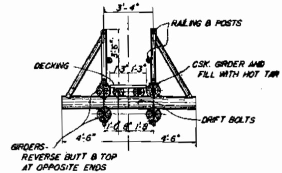
5-M-26.

FIGURE 35.



ELEVATION

PLAN



END VIEW

NOTES

TREAT HOLES WITH HOT CREOSOTE AFTER RODS IN PLACE, POUR IN HOT TAR.

FASTEN DECKING WITH 4 SPIKES PER PLANK.

PLACE ASPHALT ROOFING FELT OVER STRINGERS 10" WIDE & OVER FLOORBEAMS 12" WIDE

BORE ROD HOLES 1/16" OVERSIZE & DRIFT HOLES 1/16" UNDERSIZE

FOR SHEEP TRAVEL, PARALLEL RAILING WITH 4" ROUND POLES 8" C TO C FROM DECK

STRINGERS MAY BE LAPPED AT FLOORBEAMS.

DESIGNED FOR 5 FT OF SNOW
LIVE LOAD-SNOW- + 200# PER LINEAL FT. OF BRIDGE

BILL OF MATERIAL

		50' SPAN			55' SPAN			60' SPAN			65' SPAN			70' SPAN			75' SPAN			80' SPAN			85' SPAN			90' SPAN		
NUMBER PANELS		4			4			5			5			5			6			6			7			7		
PANEL LENGTH-P		12'-6"			13'-9"			12'-0"			13'-0"			14'-0"			12'-6"			13'-4"			12'-2"			12'-10"		
INITIAL CAMBER		9"			9"			10"			10"			10"			11"			11"			12"			12"		
	MATERIAL	NO	SIZE	LGTH	NO	SIZE	LGTH	NO	SIZE	LGTH	NO	SIZE	LGTH	NO	SIZE	LGTH	NO	SIZE	LGTH	NO	SIZE	LGTH	NO	SIZE	LGTH	NO	SIZE	LGTH
GIRDERS-MIN DIA.	FIR	4	10"	55'	4	10"	60'	4	10"	65'	4	10"	70'	4	10"	75'	4	10"	80'	4	10"	85'	4	10"	90'	4	10"	95'
STRINGERS- " "	"	8	8"	14'	8	8"	15'	10	8"	13'	10	8"	14'	10	8"	15'	12	8"	14'	12	8"	15'	14	8"	14'	14	8"	14'
FLOORBEAM-AV DIA	"	2	10"	9'	2	10"	9'	2	10"	9'	2	10"	9'	2	10"	9'	2	10"	9'	2	10"	9'	2	10"	9'	2	10"	9'
" " "	"	2	12"	9'	2	12"	9'	2	12"	9'	2	12"	9'	2	12"	9'	2	12"	9'	2	12"	9'	2	12"	9'	2	12"	9'
" " "	"	1	14"	9'	1	14"	9'	2	14"	9'	2	14"	9'	2	14"	9'	2	14"	9'	2	14"	9'	2	14"	9'	2	14"	9'
" " "	"																1	16"	9'	1	16"	9'	2	16"	9'	2	16"	9'
SHEAR BLOCK- "	"	4	12"	13'	4	12"	13'	4	12"	13'	4	12"	13'	4	12"	13'	4	12"	13'	4	12"	13'	4	12"	13'	4	12"	13'
RAILING & POSTS	"		4"	355'		4"	365'		4"	400'		4"	410'		4"	420'		4"	455'		4"	465'		4"	500'		4"	510'
DECKING 2"X12"	"	13		10'	15		10'	16		10'	17		10'	18		10'	20		10'	21		10'	22		10'	23		10'
TAR		25 POUNDS																										
KEYS		EXTRA HEAVY GALVANIZED IRON PIPE - 3" DIA. - 9" LONG 32 REQUIRED																										
RODS - AV LENGTH	1"X4'-6"	26			26			28			28			28			30			30			32			32		
HEX NUTS	1"	104			104			112			112			112			120			120			128			128		
WASHERS	6"X6"X1/2	52			52			56			56			56			60			60			64			64		
DRIFT BOLTS	3/4"X18"	18			18			20			20			20			22			22			24			24		
NAILS-GAL.	40 D	40#			40#			30#			50#			50#			60#			60#			70#			70#		
ROOFING FELT		2 SQUARES																		3 SQUARES								

FIG. 36

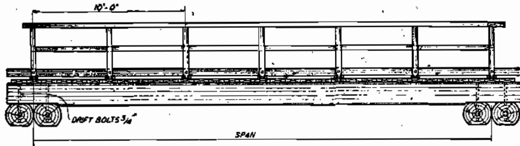
U S DEPARTMENT OF AGRICULTURE
FOREST SERVICE
REGION 6

DOUBLE LOG GIRDER BRIDGE

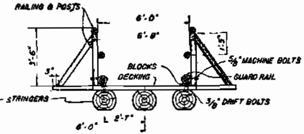
50 TO 90 FT SPAN
3 FT. ROADWAY
FOOT TRAIL

5-M-28

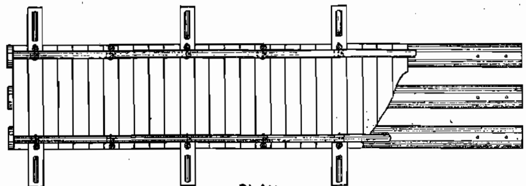
FIGURE 36.



ELEVATION



END VIEW



PLAN

NOTES
FASTEN DECKING WITH 3 SPIKES PER PLANK
PLACE ASPHALT ROOFING FELT 12" WIDE OVER STRINGERS
BORE DRIFT HOLES 1/16" UNDER SIZE
FOR SHEEP TRAVEL, PARALLEL RAILING WITH 4" ROUND POLES 8" C TO C FROM DECK

BILL OF MATERIAL

		10' SPAN			15' SPAN			20' SPAN			25' SPAN		
	MATERIAL	NO.	SIZE	LGTH.	NO.	SIZE	LGTH.	NO.	SIZE	LGTH.	NO.	SIZE	LGTH.
STRINGERS	FIR	2	10"	14'	2	12"	19'	2	12"	24'	2	15"	29'
MIDDLE DIAM.	PINE	2	10"	14'	2	13"	19'	2	13"	24'	2	17"	29'
GUARD RAIL	FIR or PINE		6"	28'		6"	38'		6"	48'		6"	58'
RAILING & POSTS	"		4"	140'		4"	180'		4"	210'		4"	230'
DECKING 3"X12"	"	8		12'	11		12'	14		12'	17		12'
DRIFT BOLTS	5/8"X18"	6			10			12			14		
DRIFT BOLTS	3/4"	12		17"	12		19"	12		19"	12		23"
MACHINE BOLTS	5/8"X12"	8			8			10			12		
NAILS-GALV.	40D	15 #			20 #			25 #			30 #		
ROOFING FELT		1 SQUARE									2 SQUARES		

	30' SPAN			35' SPAN			40' SPAN			45' SPAN			50' SPAN		
	NO.	SIZE	LGTH.	NO.	SIZE	LGTH.	NO.	SIZE	LGTH.	NO.	SIZE	LGTH.	NO.	SIZE	LGTH.
STRINGERS	2	13"	34'	2	18"	39'	2	18"	44'	2	20"	49'	2	20"	54'
MIDDLE DIAM.	2	17"	34'	2	20"	39'	2	20"	44'	2	23"	49'	2	23"	54'
GUARD RAIL		6"	68'		6"	78'		6"	88'		6"	98'		6"	108'
RAILING & POSTS		4"	280'		4"	320'		4"	330'		4"	390'		4"	420'
DECKING 3"X12"	20		12'	23		12'	26		12'	29		12'	32		12'
DRIFT BOLTS	18			20			22			24			26		
DRIFT BOLTS	12		23"	12		26"	12		26"	12		28"	12		28"
MACHINE BOLTS	14			16			16			18			20		
NAILS-GALV.	30 #			40 #			40 #			45 #			50 #		
ROOFING FELT							3 SQUARES								

DESIGNED FOR 5 FT. OF SNOW
SNOW LIVE LOAD = 330# PER LINEAL FOOT OF BRIDGE.

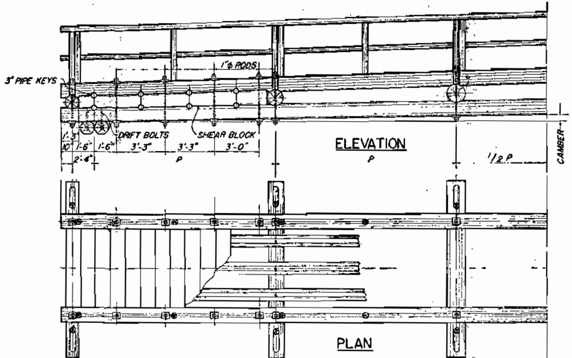
FIG 37

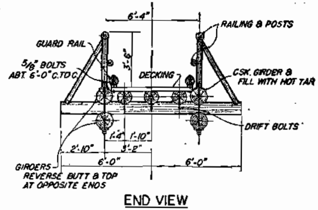
U S DEPARTMENT OF AGRICULTURE
FOREST SERVICE
REGION 6

LOG STRINGER BRIDGE
10 TO 50 FT SPAN
6 FT. ROADWAY
HORSE TRAIL

5-M-27

FIGURE 37.





NOTES

TREAT HOLES WITH HOT CREOSOTE.
AFTER RODS IN PLACE, POUR IN HOT TAR.

FASTEN DECKING WITH 5 SPIKES PER PLANK

PLACE ASPHALT ROOFING FELT OVER STRINGERS 10" WIDE & OVER FLOORBEAMS 12" WIDE

BORE ROD HOLES 1/16" OVERSIZE & DRIFT HOLES 1/16" UNDERSIZE

FOR SHEEP TRAVEL, PARALLEL RAILING WITH 4" ROUND POLES 8" C TO C. FROM DECK

STRINGERS MAY BE LAPPED AT FLOOR-BEAMS

DESIGNED FOR 5 FT. OF SNOW.
LIVE LOAD-SNOW-- 350 LBS. PER LINEAL FT OF BRIDGE

		50' SPAN			55' SPAN			60' SPAN			65' SPAN			70' SPAN			75' SPAN			80' SPAN			85' SPAN			90' SPAN		
NUMBER PANELS		4			4			5			5			5			6			6			7			7		
PANEL LENGTH-P		12'-6"			13'-9"			12'-0"			13'-0"			14'-0"			12'-6"			13'-4"			12'-2"			12'-10"		
INITIAL CAMBER		9"			9"			10"			10"			10"			11"			11"			12"			12"		
	MATERIAL	NO.	SIZE	LGTH.	NO.	SIZE	LGTH.	NO.	SIZE	LGTH.	NO.	SIZE	LGTH.	NO.	SIZE	LGTH.	NO.	SIZE	LGTH.	NO.	SIZE	LGTH.	NO.	SIZE	LGTH.	NO.	SIZE	LGTH.
GIRDERS-MIN DIA.	FIR	4	10"	55'	4	10"	60'	4	11"	65'	4	11"	70'	4	11"	75'	4	11"	80'	4	11"	85'	4	11"	90'	4	11"	95'
STRINGERS " "	"	12	8"	14'	12	8"	15'	15	8"	13'	16	8"	14'	15	8"	15'	18	8"	14'	18	8"	15'	21	8"	14'	21	8"	14'
FLOORBEAM-AV. DIA.	"	2	10"	12'	2	10"	12'	2	10"	12'	2	10"	12'	2	10"	12'	2	10"	12'	2	10"	12'	2	10"	12'	2	10"	12'
" " "	"	2	12"	12'	2	12"	12'	2	12"	12'	2	12"	12'	2	12"	12'	2	12"	12'	2	12"	12'	2	12"	12'	2	12"	12'
" " "	"	1	14"	12'	1	14"	12'	2	14"	12'	2	14"	12'	2	14"	12'	2	14"	12'	2	14"	12'	2	14"	12'	2	14"	12'
" " "	"																1	16"	12'	1	16"	12'	2	16"	12'	2	16"	12'
SHEARBLOCK " "	"	•	12"	13'	4	12"	13'	4	12"	13'	4	12"	13'	4	12"	13'	4	12"	13'	4	12"	13'	4	12"	13'	4	12"	13'
GUARD RAIL	"		6"	110'		6"	120'		6"	130'		6"	140'		6"	150'		6"	160'		6"	170'		6"	180'		6"	190'
RAILING & POSTS	"		4"	400'		4"	430'		4"	470'		4"	490'		4"	510'		4"	530'		4"	580'		4"	610'		4"	640'
DECKING-3"X12"	"	18		18'	19		18'	21		18'	23		18'	24		18'	26		18'	28		18'	29		18'	31		18'
TAR		25 POUNDS																										
KEYS		EXTRA HEAVY GALVANIZED IRON PIPE - 3" DIA 9" LONG 32 REQUIRED																										
RODS-AV. LENGTH		26	1"	4'-6"	26	1"	4'-6"	28	1"	4'-6"	28	1"	4'-6"		1"	4'-6"	30	1"	4'-6"	30	1"	4'-6"	32	1"	4'-6"	32	1"	4'-6"
HEX. NUTS		104	1"		104	1"		112	1"		112	1"		112	1"		120	1"		120	1"		128	1"		128	1"	
WASHERS	6"X6"X1/2"	52			52			56			56			56			60			60			64			64		
DRIFT BOLTS	3/4"X18"	23			23			26			26			26			29			29			32			32		
MACHINE BOLTS	5/8"X14"	20			22			24			24			26			28			30			32			34		
SPIKES	60D-6"	325			350			375			425			450			475			500			525			550		
NAILS	40D	20#			20#			25#			25#			25#			30#			30#			35#			33#		
ROOFING FELT		3 SQUARES																		4 SQUARES								

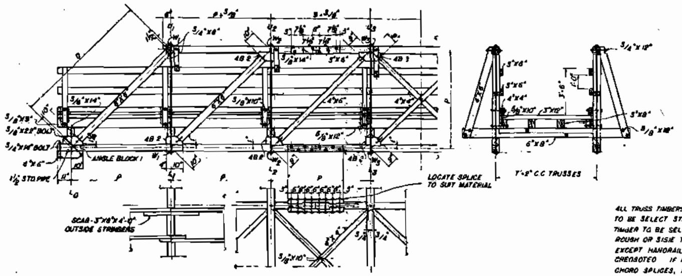
FIG. 38

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
REGION 6

DOUBLE LOG GIRDER BRIDGE
50 TO 90 FT. SPAN
6 FT ROADWAY
HORSE TRAIL

5-M-29

FIGURE 38.



BILL OF MATERIAL

MARK	DESCRIPTION	SIZE	50'-2" SPAN NO. REQ.	50'-2" SPAN LENGTH	60'-1" SPAN NO. REQ.	60'-1" SPAN LENGTH	70'-0" SPAN NO. REQ.	70'-0" SPAN LENGTH
P	PANEL LENGTH & HEIGHT			7'-2"		8'-7"		10'-0"
D	DIAGONAL LENGTH			10'-1⅜"		12'-1⅝"		14'-1¾"
L_1U_3	TOP CHORDS	6"x6"	4	18'-3"	4	21-11½"	4	26'-4"
	TOP CHORD SPLICES	3"x6"	4	3'-6"	4	3'-6"	4	3'-6"
L_0L_2	BOTTOM CHORDS	6"x6"	4	26'-0"	4	22'-0"	4	26'-0"
L_2L_3	" "	6"x6"			2	17'-11"	2	19'-10"
	BOTTOM CHORD SPLICES	3"x6"	4	4'-0"	8	4'-0"	8	4'-0"
L_0U_1	END POST	6"x6"	4	9'-2⅛"	4	11'-2⅛"	4	13'-2¼"
L_1U_2	DIAGONALS	6"x6"	4	8'-5⅝"	4	10'-3⅝"	4	12'-9⅝"
L_2U_3	"	4"x6"	4	8'-7⅝"	4	10'-7⅝"	4	12'-7¼"
L_3U_3	"	4"x4"	4	8'-7⅝"	4	10'-7⅝"	4	12'-7⅝"
AB	ANGLE BLOCKS - MATERIAL	4"x8"	4	8'-0"	4	8'-0"	4	8'-0"
L_0	BOLSTERS	4"x6"	1	8'-0"	1	8'-0"	1	8'-0"
	FLOOR BEAMS	6"x8"	2	8'-0"	2	8'-0"	2	8'-0"
	" "	6"x8"	6	12'-0"	6	12'-0"	6	12'-0"
	STRINGERS	3"x8"	14	16'-0"	6	20'-0"	4	12'-0"
	"	3"x8"			8	18'-0"	12	22'-0"
	SCABS	3"x8"	12	4'-0"	12	4'-0"	12	4'-0"
	DECK	3"x12"	28	14'-0"	31	14'-0"	36	14'-0"
	GUARD RAIL	4"x4"	7	16'-0"	7	18'-0"	7	22'-0"
	HAND RAIL	3"x6"	14	16'-0"	14	18'-0"	14	22'-0"
	HAND RAIL POSTS	4"x4"	3	18'-0"	3	18'-0"	3	18'-0"
	BOTTOM LATERALS	4"x4"	14	10'-0"	14	12'-0"	14	12'-0"
	KNEE BRACES	4"x6"	6	14'-0"	6	14'-0"	6	14'-0"
L_1U_1	VERTICAL RODS - ROUNDS		4	1"x8'-5"	4	1⅛"x9'-7"	4	1¼"x11'-1"
L_2U_2	" " "		4	1⅛"x8'-8"	4	1"x9'-7"	4	1"x11'-1"
L_3U_3	" " "		4	¾"x8'-8"	4	⅞"x9'-7"	4	⅞"x11'-1"
	TOTAL LUMBER - F.B.M.			3800		4348		4974
	TOTAL HARDWARE - LBS			830		940		1020

DESCRIPTION	NO. REQ.	SIZE
MACHINE BOLTS - SQ. HD. & NUTS	6	5/8"x9"
	18	5/8"x10"
	88	5/8"x12"
	12	5/8"x14"
	13	3/4"x12"
	4	3/4"x14"
	30	3/4"x18"
	4	3/4"x22"
DRIFT BOLTS	34	3/4"x8"
	4	3/4"x14"
	22	5/8"x10"
1½" STD PIPE	4	0'-6"
PL. WASHERS - W_1	8	6"x5/8"x0'-6"
" " - W_2	8	5"x1/2"x0'-5"
" " - W_3	16	4"x3/8"x0'-4"
60D SPIKES	125 #	
MALL. WASHERS	210	3/4"
"	110	5/8"

BILL OF TRUSS RODS

NOTES

ALL TRUSS TIMBERS, JOISTS AND FLOOR BEAMS TO BE SELECT STRUCTURAL AND ALL OTHER TIMBER TO BE SELECT MERCHANTABLE, EITHER ROUGH OR S1S1E TO FULL SIZE. ALL LUMBER EXCEPT HANDRAILS PREFERABLY PRESSURE CREOSOTED. IF NOT SO TREATED, PROTECT CHORD SPLICES, FLOOR BEAMS AND STRINGERS WITH ASPHALT ROOFING WEIGHING 35 LB OR MORE PER 100 SQ FT AND DAUB JOINTS AND DIP ANGLE BLOCKS IN BOILING CREOSOTE. ANGLE BLOCKS TO BE SELECT LUMBER SEASONED BEFORE FRAMING.

LAY DECK WITH ½" SPACING. USE 2-60D SPIKES AT EACH END AND ONE IN EACH INTERMEDIATE STRINGER.

INCREASE THE NUMBER OF SPLICES IF SHORTER CHORD MEMBERS ARE DESIRED.

BORE HOLES 1/16" OVERSIZE FOR BOLTS, 1/8" OVERSIZE FOR TRUSS RODS, AND 1/16" UNDERSIZE FOR DRIFT BOLTS.

DESIGNED FOR 3 FT OF SNOW
SNOW LIVE LOAD = 330# PER LINEAL FT OF BRIDGE

FIG 39

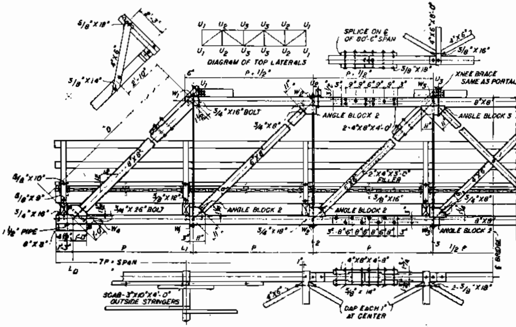
US DEPARTMENT OF AGRICULTURE
FOREST SERVICE
REGION 6

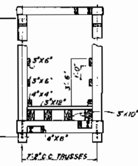
TIMBER HOWE TRUSS

50-60 & 70 FT SPANS
6 FT ROADWAY
HORSE TRAIL

DESIGNED BY O.W.L. FEB 1935
5-M-44

FIGURE 39.





TYPICAL SECTION

MARK	DESCRIPTION	SIZE	80'-6" SPAN NO. REQ.	80'-6" SPAN LENGTH	89'-10" SPAN NO. REQ.	89'-10" SPAN LENGTH	100'-4" SPAN NO. REQ.	100'-4" SPAN LENGTH
P	PANEL LENGTH & HEIGHT			11'-6"		12'-10"		14'-4"
D	DIAGONAL LENGTH			16'-5"		18'-1 3/4		20'-3 1/4
U1U2	TOP CHORDS	8"X8"	4	29'-3 3/4	6	21'-9 1/2	4	24'-0"
	" "						2	24'-8"
	TOP SPLICES	4"X8"	4	4'-0"	8	4'-0"	8	4'-0"
L0L2	BOTTOM CHORDS	8"X8"	4	28'-0"	4	32'-0"	4	34'-0"
L2L3	" "	8"X8"	2	27'-0"	2	28'-4"	2	34'-10"
	BOTTOM SPLICES	4"X8"	8	4'-8"	8	4'-8"	8	4'-8"
L0U1	END POST	8"X8"	4	15'-1 1/2"	4	17'-0 1/4	4	19'-1 3/4
L1U2	DIAGONALS	6"X8"	4	14'-5"	4	16'-3 3/4	4	18'-5 1/4
L2U3	"	6"X6"	4	14'-5"	4	16'-3 3/4	4	18'-5 1/4
L3U3	"	4"X6"	4	14'-5"	4	16'-3 3/4	4	18'-5 1/4
AB	ANGLE BLOCKS - MATERIAL	8"X12"	2	16'-0"	2	16'-0"	2	16'-0"
L0	BOLSTERS	6"X8"	1	12'-0"	1	12'-0"	1	12'-0"
	FLOOR BEAMS	6"X10"	8	8'-0"	8	8'-0"	8	8'-0"
	STRINGERS	3"X10"	12	14'-0"	28	14'-0"	28	16'-0"
	"	3"X10"	16	12'-0"				
	SCABS	3"X10"	12	4'-0"	12	4'-0"	12	4'-0"
	DECK	3"X12"	42	14'-0"	46	14'-0"	52	14'-0"
	GUARD RAIL	4"X4"	14	12'-0"	14	14'-0"	14	16'-0"
	HAND RAIL	3"X6"	12	14'-0"	28	14'-0"	28	16'-0"
	" "	3"X6"	16	12'-0"				
	HAND RAIL POSTS	4"X4"	8	10'-0"	8	10'-0"	8	10'-0"
	TOP STRUTS	4"X6"	6	8'-0"	6	8'-0"	6	8'-0"
	TOP & BOTT. LATERALS	4"X6"	19	14'-0"	6	16'-0"	2	18'-0"
	" " "	4"X6"			13	14'-0"	17	16'-0"
	KNEE BRACES	4"X6"	4	12'-0"	4	12'-0"	4	12'-0"
L1U1	VERTICAL RODS - ROUNDS		4	1 1/4"X12'-9	4	1 1/4"X14'-1	4	1 3/8"X15'-7
L2U2	" " "		4	1 1/8"X12'-9	4	1 1/8"X14'-1	4	1 1/4"X15'-7
L3U3	" " "		4	7/8"X12'-8	4	7/8"X14'-0	4	1"X15'-6
	TOTAL LUMBER - F.B.M.			7409		8065		8953
	TOTAL HARDWARE - LBS			1430#		1560#		1700#

BILL OF TRUSS RODS

DESCRIPTION	NO. REQ.	SIZE
MACHINE BOLTS - SQ.HD. & NUTS	4	5/8"X9"
	18	X10"
	30	X12"
	64	X14"
	10	X16"
	76	5/8"X18"
	16	3/4"X16"
	4	3/4"X26"
DOWELS	56	3/4"X8"
	16	3/4"X18"
	44	5/8"X18"
1 1/2" STD PIPE	4	0'-8" LONG
PL. WASHERS - W1	8	6"X3/4"X0'-8"
" " - W2	8	6"X5/8"X0'-6"
" " - W3	16	5"X1/2"X0'-6"
" " - W4	8	4"X3/8"X0'-4"
60D SPIKES	180#	
MALL WASHERS	420	5/8"
" "	40	3/4"

NOTES

INCREASE THE NUMBER OF SPLICES IF SHORTER CHORD MEMBERS ARE DESIRED.
BORE HOLES 1/16" OVERSIZE FOR BOLTS, 1/8" OVERSIZE FOR TRUSS RODS, AND 1/16" UNDERSIZE FOR DRIFT PINS.

NOTES:

ALL TRUSS TIMBERS, JOISTS AND FLOOR BEAMS TO BE SELECT STRUCTURAL AND ALL OTHER TIMBER TO BE SELECT MERCHANTABLE, EITHER ROUGH OR S1S1E TO FULL SIZE. ALL LUMBER EXCEPT HANDRAILS PREFERABLY PRESSURE CREOSOTED. IF NOT SO TREATED, PROTECT CHORD SPLICES, FLOOR BEAMS AND STRINGERS WITH ASPHALT ROOFING WEIGHING 55 LB OR MORE PER 100 SQ. FT AND DAUB JOINTS AND DIP ANGLE BLOCKS IN BOILING CREOSOTE. ANGLE BLOCKS TO BE SELECT LUMBER SEASONED BEFORE FRAMING.

LAY DECK WITH 1/2" SPACING. USE 2-60D SPIKES AT EACH END AND ONE IN EACH INTERMEDIATE STRINGER.

DESIGNED FOR 5 FT OF SNOW
SNOW LOAD = 350# PER LINEAL FT OF BRIDGE

FIG 40
U.S DEPARTMENT OF AGRICULTURE
FOREST SERVICE
REGION 6
TIMBER HOWE TRUSS
80-90 & 100 FT SPANS
6 FT. ROADWAY
HORSE TRAIL

DESIGNED BY R.W.L. FEB. [illegible]

5-M-48

FIGURE 40.

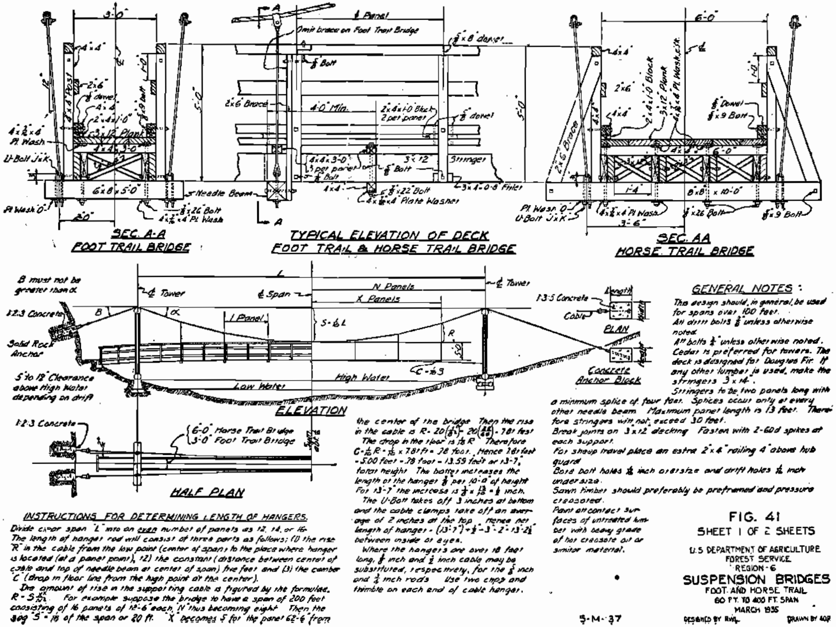
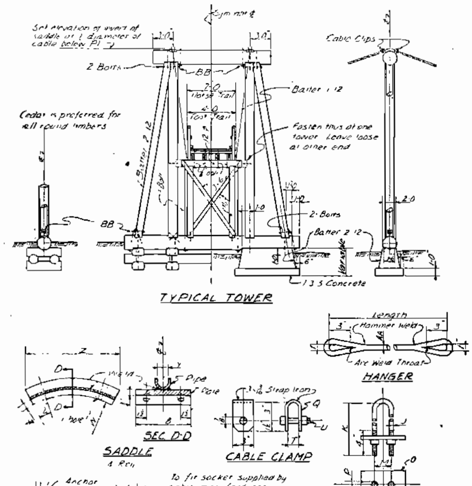
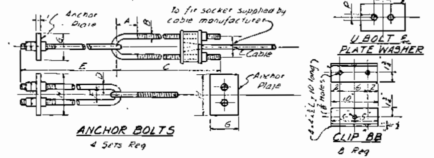

SEC. A-A
FOOT TRAIL BRIDGE
TYPICAL ELEVATION OF DECK
FOOT TRAIL & HORSE TRAIL BRIDGE
SEC. AA
HORSE TRAIL BRIDGE
ELEVATION
HALF PLAN
6'-0" Horse Trail Bridge
3'-0" Foot Trail Bridge
Concrete Anchor Block
INSTRUCTIONS FOR DETERMINING LENGTH OF HANGERS.
Divide clear span "L" into an even number of panels as 12, 14, or 16.
The length of hanger rod will consist of three parts as follows; (1) the rise "R" in the cable from the low point (center of span) to the place where hanger is located (at a panel point), (2) the constant (distance between center of cable and top of needle beam at center of span) five feet and (3) the camber "C" (drop in floor line from the high point at the center).
The amount of rise in the supporting cable is figured by the formulae. R = S X²/N². For example suppose the bridge to have a span of 200 feet consisting of 16 panels of 12'-6" each, "N" thus becoming eight. Then the sag "S" = 1/10 of the span or 20 ft. "X" becomes 5 for the panel 62'-6" from the center of the bridge. Then the rise in the cable is R = 20(5²/8²) = 20(25/64) = 7.81 feet.
The drop in the floor is 1/10 R. Therefore C = 1/10 R = 1/10 x 7.81 ft = .78 foot. Hence 7.81 feet + 5.00 feet − .78 foot = 13.59 feet or 13'-7" total height. The batter increases the length of the hanger 1/8" per 10'-0" of height. For 13'-7" the increase is 1/8 x 13/10 = 1/8 inch.
The U-Bolt takes off 3 inches at bottom and the cable clamps take off an average of 2 inches at the top. Hence net length of hanger = (13'-7") + 1/8" − 3" − 2" = 13'-2 1/8" between inside of eyes.
Where the hangers are over 18 feet long, 5/8 inch and 3/4 inch cable may be substituted, respectively, for the 5/8 inch and 3/4 inch rods. Use two clips and thimble on each end of cable hanger.
GENERAL NOTES:
This design should, in general, be used for spans over 100 feet.
All drift bolts 5/8" unless otherwise noted.
All bolts 3/4" unless otherwise noted.
Cedar is preferred for towers. The deck is designed for Douglas Fir. If any other lumber is used, make the stringers 3"x14".
Stringers to be two panels long with a minimum splice of four feet. Splices occur only at every other needle beam. Maximum panel length is 13 feet. Therefore stringers will not exceed 30 feet.
Break joints on 3"x12" decking. Fasten with 2-60d spikes at each support.
For sheep travel place an extra 2"x4" railing 4" above hub guard.
Bore bolt holes 1/16 inch oversize and drift holes 1/16 inch undersize.
Sawn timber should preferably be preframed and pressure creosoted.
Paint all contact surfaces of untreated lumber with heavy grade of hot creosote oil or similar material.
FIG. 41
SHEET 1 OF 2 SHEETS
U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
REGION-6
SUSPENSION BRIDGES
FOOT AND HORSE TRAIL
60 FT. TO 400 FT. SPAN
MARCH 1935
5-M-37

FIGURE 41.





ITEM		MARK									
Kind of Cable			Siemens-Martin		7x7 Bridge Cable						
Diameter of Cable			3/4"	7/8"	3/4"	7/8"	1"	1 1/8"	1 1/4"	1 3/8"	1 1/2"
Foot Trail	A Loading	L	60-80	81-110	112-150	151-180	181-260	261-340	341-400		
	B "	"		60-69	60-90	91-108	109-160	161-200	201-240	241-286	287-340
	C "	"			50-60	61-69	70-100	101-129	130-150	151-179	180-210
Horse Trail	A "	"				55-75	76-110	111-144	145-164	165-200	201-240
	B	"					60-80	81-100	101-116	119-143	144-170
	C	"						55-65	66-74	75-90	91-106
Tower		Cap	22"φ	24"φ	24"φ	24"φ	24"φ	26"φ	26"φ	26"φ	26"φ
"		Leg	14" top	16" top	16" top	16" top	16" top	18" top	18" top	18" top	18" top
"		Brace	12" top	12" top	12" top	12" top	12" top	14" top	16" top	14" top	14" top
U Bolt for Bridge Socket		A	4"	4 1/2	4"	4 1/2	5	6"	6 1/2"	7"	7 1/2"
		B × C	7/8φ×2-0	1φ×2-0	1 1/8φ×2-6	1 1/4φ×2-6	1 3/8φ×2-6	1 1/2φ×2-6	1 3/4φ×2-6	2φ×2-8	2 1/4φ×3-0
U Bolt in Anchor Block		D × E	7/8φ×6-0	1φ×7-0	1 1/8φ×7-0	1 1/4φ×7-6	1 3/8φ×9-0	1 1/2φ×9-6	1 3/4φ×10-0	2φ×12-0	2 1/4φ×12-6
		F	2 1/4"	3"	3 1/2	3 3/4"	4"	5"	5 1/2"	6"	6 1/2"
		G × H × I	6×6×1/2	6×8×3/4	6×8×7/8	8×8×1	8×10×1 1/8	8×1-0×1 1/4	8×1-2×1 1/2	10×1-2×1 3/4	10×1-4×2
U-Bolt in Needle Beams	Foot Trail A & B Loading Horse Trail	J × K	5/8×1-2	5/8×1-2	5/8×1-2	5/8×1-2	5/8×1-2	5/8×1-2	5/8×1-2	5/8×1-2	5/8×1-2
		M	2	2"	2	2"	2	2	2"	2	2"
		O	3×6×1/2	3×6×1/2	3×6×1/2	3×6×1/2	3×6×1/2	3×6×1/2	3×6×1/2	3×6×1/2	3×6×1/2
		P	1/2	1/4"	1/4	1/4	1/4"	1/4"	1/4	1/4"	1/4"
	C Loading Horse Trail	J × K						3/4×1-2"	3/4×1-2	3/4×1-2"	3/4×1-2
		M						2 1/4"	2 1/4"	2 1/4	2 1/4"
		O						3 1/4×7×3/8	3 1/4×7×3/8	3 1/4×7×3/8	3 1/4×7×3/8
		P						3/8"	3/8"	3/8	3/8"
Cable Clamp		Q	3×10×1/2	3×10×1/2	3×10×1/2	3×10×1/2	3×10×1/2	3×10 1/4×1/2	3×10 1/4×1/2	3×10 1/2×1/2	3×10 1/4×1/2
		T	3/4"	7/8	3/4"	7/8"	1"	1 1/8	1 1/4"	1 3/8	1 1/2"
		U	1/2"×2 1/2	1/2×2 1/2	1/2×2 1/2	1/2×2 1/2	1/2×2 1/2	1/2×3	3/4×3	3/4×3"	3/4×3"
Saddle	Plate	V	8×1/2×1-0	8×1/2×1-1	8×1/2×1-0	8×1/2×1-0	8×1/2×1-1	8×1/2×1-2	8×1/2×1-2	8×1/2×1-3	8×1/2×1-4
	Radius	W	1-0	1-0	1-0	1-0	1-2	1-4	1-5	1-6	1-8
	Pipe	Y × Z	1φ×1-1	1 1/4φ×1-1	1φ×1-1	1φ×1-1	1 1/4φ×1-2	2φ×1-3	2φ×1-3	2 1/2φ×1-4	2 1/2φ×1-5
		Weight	Std	Std	Std	Std	Std	Dbl X Str	Dbl X Str	Dbl X Str	Dbl X Str
Hanger	Foot Tr, A & B Ldg., Horse Tr	AA	5/8φ	5/8φ	5/8φ	5/8φ	5/8φ	5/8φ	5/8φ	5/8φ	5/8φ
	C Loading Horse Trail	AA						3/4φ	3/4φ	3/4φ	3/4φ
Anchor Block		Height	3-0"	3-0	4-0	4-0	5-0"	5-0	5-0"	5-0	5-0"
		Width	4-0"	4-6	4-6"	5-0	5-0	6-0"	6-0	6-0	7-0
		Length	5-0"	6-0	5-0	6-0	6-0"	7-0	8-0	9-0	9-6"
Clip		BB	4×4×1/2 L ×10" long	4×4×1/2 L ×10" long	4×4×1/2 L ×10" long	4×4×1/2 L ×10" long	4×4×1/2 L ×10" long	4×4×5/8 L ×10" long	4×4×5/8 L ×10" long	4×4×3/4 L ×10" long	4×4×3/4 L ×10" long

LIVE LOADS			
Bridge	Load	Feet of Span	Lbs. per ft. of Bridge
Foot Tr	A	1	50#
	B	5	150#
	C	10	300#
Horse Tr	A	1	160#
	B	5	300#
	C	10	660

FIG 42

SHEET 2 OF 2 SHEETS

U S DEPARTMENT OF AGRICULTURE
FOREST SERVICE
REGION - 6

SUSPENSION BRIDGES
FOOT AND HORSE TRAIL
60 FT TO 400 FT SPAN
MARCH 1935

5 - M - 37

DESIGNED BY HWL DRAWN BY ADP

FIGURE 42.

148303—37——6

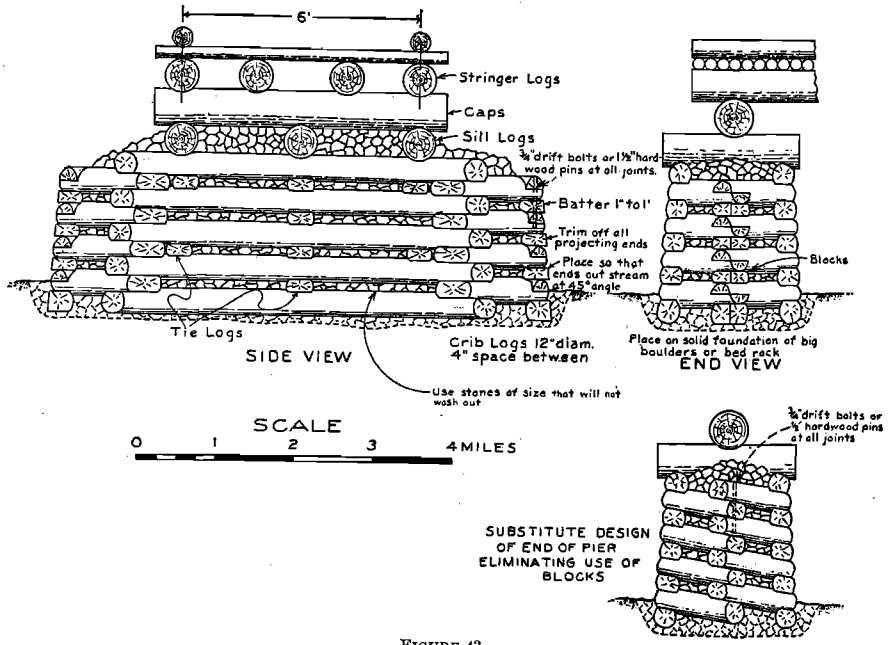
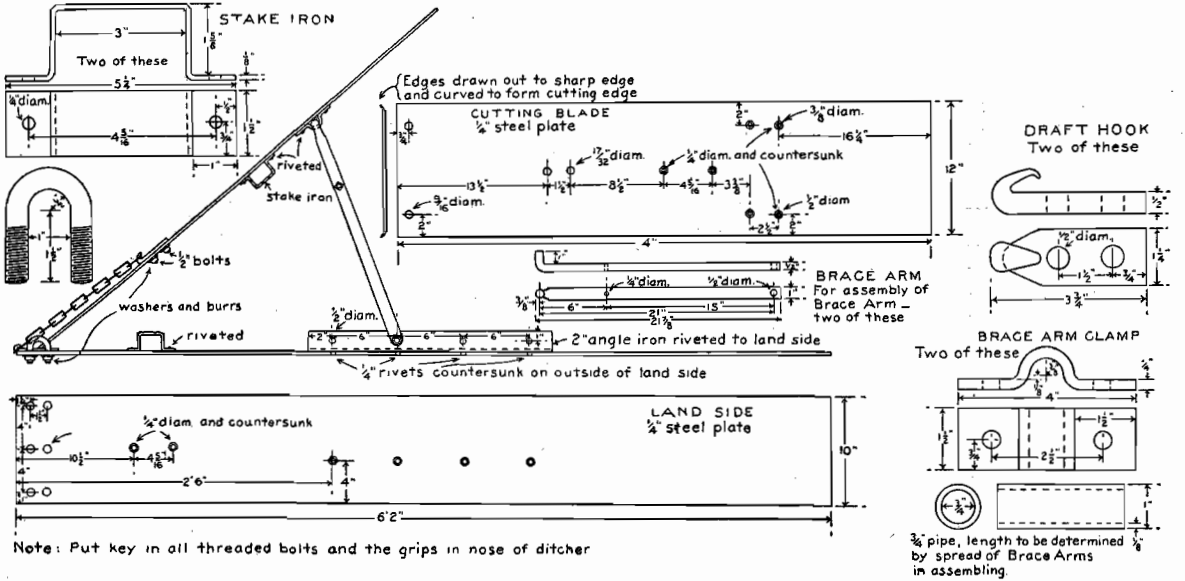

6'
Stringer Logs
Caps
Sill Logs
¾"drift bolts or 1½"hard wood pins at all joints.
Batter 1"to1'
Trim off all projecting ends
Place so that ends out stream at 45°angle
Tie Logs
SIDE VIEW
Crib Logs 12"diam. 4" space between
Use stones of size that will not wash out
Blocks
Place on solid foundation of big boulders or bed rock
END VIEW
SCALE
0 1 2 3 4 MILES
¾"drift bolts or ¾ hardwood pins at all joints
SUBSTITUTE DESIGN OF END OF PIER ELIMINATING USE OF BLOCKS

FIGURE 43.



Note: Put key in all threaded bolts and the grips in nose of ditcher

FIGURE 44.

APPENDIX

TOOLS

Provide trail and bridge crews with all the tools likely to be needed on any part of the job. Some of the tools may not be used, but it is better to have them on hand when and if required than to lose valuable time securing them or trying to improvise substitutes.

TOOL EQUIPMENT LIST

Suggested Standard List For Trail Crews

	2-man	5-man	8-man		2-man	5-man	8-man
Axes, D. B., 3½-pound	3	4	5	Hooks, brush	1	1	1
Bags:				Kits, timekeeper's	1	1	1
Man-pack, 5-gallon (only where needed)	1	1	1	Level, Abney			1
Water, 2½-gallon	2	2	3	Mattocks		1	2
Bars, crow (where needed)				Outfits:			
Chains, log, 12-foot (where needed)				Cobbler		1	1
Chest, medicine, crew	1	1	1	Saw-filing	1	1	1
Crimpers, cap (where needed)				Smokechaser's, complete	2	2	2
Files:				Peavy	1	1	1
8-inch	3	4	6	Picks, mattock	1	2	3
10-inch	2	4	6	Picks, railroad	1	2	3
Flags, United States	1	1	1	Plow, trail (where needed)			
Grader, Beatty trail (where needed)				Rasp, wood	1	1	1
Grinder, carborundum	1	1	1	Sacks, pack, Duluth no. 2, or pack frames	1	1	2
Grindstone and frame, Army	1	1	1	Saw, C. C., 5½-foot	1	1	2
Hammers:				Shovel, L. H. R. P	1	2	2
Claw	1	1	1	Stone, carborundum, pocket	2	3	4
Falling, 4-pound	1	1	1	Wedges, falling	2	2	4
Handles:							
Ax	1	2	3				
Mattock	1	2	4				
Saw	2	2	4				

MESS EQUIPMENT

Basin, wash	1	2	3
Beater, egg			1
Board, wash	1	1	1
Boiler, 2-gallon		1	
Boiler, 3-gallon			1
Bowls, mixing, 6-quart			1
Bowls, soup, granite	4	4	10
Buckets, water, 10-quart, canvas	1	1	1
Can opener	1	1	2
Clocks, alarm	1	1	1
Collander			1
Cups, nested	4	7	10
Canvas, table top (feet)	1–5	1–8	1–8
Do			1–5
Forks:			
Meat			1
Table	4	8	10
Griddle, pancake		1	1
Kettles:			
2-quart	2	2	1
4-quart	2	2	3
6-quart		1	1
Knives:			
Butcher	1	1	1
Paring	1	1	1
Table	4	8	10
Nails, assorted, pounds	5	6	10
Oilcloth, white, 46 inches wide, yards	2	3	5
Pans:			
Bread:			
Medium	1	2	2
Large			1
Dish	1	1	2
Dish-up:			
1-quart	2	3	2
2-quart	2	3	4
3-quart			1
Fry:			
Medium	2	1	1
Large		2	2
Plates, enamel	4	8	10
Platter, meat			1
Pots, coffee	1	1	1
Sacks, cloth, lunch	6	12	15
Saw, meat		1	1
Screen, cheesecloth, yards	4	4	5
Shaker, salt		1	1
Sifter, flour, flat, 16-inch bottom			1
Spoons:			
Desert	4	6	8
Mixing		1	1
Table	4	8	10
Telephone, complete	1	1	1
Tins, pie	2	3	4
Toweling, dish, 50-pound flour sacks	6	8	10
Tubs, wash	1	1	1
Turner, cake	1	1	1

TENTAGE

Flies, 10 by 12 feet	1	1	1	Tents, 10 by 12 feet	1	2	3

BEDDING

	2-man	5-man	8-man		2-man	5-man	8-man
Blankets, wool (6 thicknesses per bed)	12	30	48	Tarps	2	5	8
Extra bed each crew for Forest Officer	1	1	1				

STOVES

Stoves, cook, Lang or sheep	1	1	1	Stovepipe, joints	5	5	5

BLACKSMITH OUTFIT

[To be furnished only on jobs where need is fairly constant]

Anvil	1
Chisel, hot	1
Coal, sack	1
Drill, spoon	1
Drill steel, set or detachable bit set	1
Forge, portable	1
Hammer:	
Blacksmith, ball pein	1
Double jack	1
Flatter	1
Rock, 12-pound	1
Single jack	1
Tool-sharpening	1
Hardie	1
Tongs:	
Bolt	1
Pick	1
Plain	1
Vise	1
Welding compound, 5-pound box	1

Nested mess outfits for the above units are the most desirable and should be used wherever possible.

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