New Trail Construction

Basic Construction Standards
Once the trail is marked and approved, construction can begin. This section addresses basic construction standards, beginning with the clearing of trees, brush, and rocks, then establishing the trail foundation and basic trail tread, and continuing into standard methods for surface water control, wet area crossings, and water crossings. Special structures such as switchbacks, cribwalls and steps are included, as well as support structures such as overlooks and kiosks. Specific types of trail construction techniques relevant to specific trails, such as mountain bike trails or equestrian trails, are presented in the following section, titled Specific Trail Types.

Creating the Trail Corridor
The trail corridor is a zone that includes the trail tread and the area above and to the sides of it. For the purpose of this manual, the edges of the corridor are considered the “clearing limits.” Vegetation and other obstacles, such as boulders, are trimmed back or removed from this area to make it possible to ride or walk the tread. (Note that common references to the Appalachian Trail “corridor” typically extends beyond the cleared limits.)

The dimensions of the corridor are determined by the needs of the target user and the desired trail difficulty level. For example, trail corridors for a recreational biking trail are cleared 8-12 feet wide (4 feet for single lane tread or 8 feet for double lane tread, and 2 feet beyond the tread each side) and 8 feet high. Hiking trails are cleared 6-9 feet wide (2 feet for single lane tread or 5 feet for double lane tread, and 2 feet beyond the tread each side) and 8 feet high. Check the specific trail type dimensions in the following section titled Specific Trail Types.

Clearing and Brushing—No sooner is a trail corridor cleared of plants than they begin to rush toward this new avenue of sunlight. A significant threat to trail integrity comes from plants growing into trail corridors, or falling across them. Brush is a major culprit. Other encroaching plants such as thistles or dense ferns may make travel unpleasant or even completely hide the trail. If people have trouble traveling your tread, they’ll move over, usually along the lower edge, or make their own “volunteer” trail.

In level terrain the corridor is cleared an equal distance on either side of the tread centerline. Using the hiking trail example, this means that the corridor is cleared for a distance of 2-1/2 feet of the center. Within 1 foot of the edge of the tread, plant material and debris should be cleared all the way to the ground. Farther than 1-1/2 feet from the trail edge, plants do not need to be cleared unless they are taller than 1-1/2 feet or so. Fallen logs usually are removed to the clearing limit.

On moderate to steep slopes, a different strategy is often useful. Travel along the lower (outer) edge of the tread is a significant cause of tread failure. Trail side material can

![Figure 4-1: Trail Structure Terminology](image)

[Trail Construction & Maintenance Notebook, USFS, p 17]
be used to help hold traffic to the center of the tread. A
downed log cut nearly flush with the downhill edge of the
trail will encourage travelers to move up to avoid it. Rocks,
limbed trees, and the like can all be left near the lower
edge of the tread to guide traffic back to the center.
However, be sure that material along the lower edge of
the tread does not cause water to run along the trail instead
draining off.

On the uphill side of the trail, cut and remove material for
a greater distance from the centerline. For instance, on
slopes steeper than 50 percent you may want to cut
downed logs or protruding branches 6-1/2 feet horizontal
distance or more from the centerline. This is particularly
true for equestrian trails as horses tend to shy away from
objects at the level of their heads.

Remember that the “scorched earth” look created by a
corridor with straight edges is not very pleasing to the eye.
Work with natural vegetation patterns to “feather” or
meander the edges of the clearing work so they don’t have
such a severe appearance. Cut intruding brush back at
the base of the plant rather than in midair at the clearing
limit boundary. Cut all plant stems close to the ground.
Scatter the resulting debris as far as practical on the downhill
side. Toss stems and branches so the end lies away from
the trail (they’ll sail farther through the brush as well). This
minimizes the obvious visual impact of trail clearing efforts.
Don’t windrow the debris unless burning or other removal
can occur. Rubbing the cut ends of logs or stumps with
the soil will reduce the brightness of a fresh saw cut.

**Removing Trees**—Trees growing within the corridor should
usually be removed. Remember that those cute little
seedlings will eventually grow into pack-snagging
adolescent trees. They are a lot easier to pull up by the
roots when they are small than they are to lop when they
grow up.

Prune limbs close to the tree trunk. For a clean cut, make
a shallow undercut first, then follow with the top cut. This
prevents the limb from peeling bark off the tree as it falls.
Do not use an ax for pruning.

If over half of the tree needs pruning, it is usually better to
cut it down instead. Cut trees off at ground level and do
not leave pointed stobs. Felling standing trees (including
snags) is statistically one of the most dangerous activities a
trail worker can engage in. Simply put, do not even
consider felling trees unless you have been formally trained
and certified by the Site Safety Officer. Be sure to fill and
tightly pack the soil in holes left from stumps.

When removing down logs from the trail, cut the log
out as wide as your normal clearing limits on the uphill
side, and out of the “clearing zone” but close to the trail
on the downhill side. Roll the log pieces off the trail
and outside of the clearing limits, on the downhill side.
Be sure to keep ditches or waterbar outflows free.

**Removing Roots and Stumps**—Removing roots and
stumps is hard work. Stump grinders are good alternatives
for removing stumps, but chances are you will have to do
the work by hand. A sharpened pick mattock or pulaski
is most often used to chop away at the roots. If you are
relying on some type of winch system to help you pull out
the stump, be sure to leave the stumps high enough (2 - 3
feet above ground level) to give you something to latch
onto for leverage.

Not all roots and stumps are problems. You should not
have to remove many large stumps from an existing trail.
Before you do so, consider whether a stump was left the
last time around to help keep the trail from creeping
downhill. Rule of thumb for roots - if perpendicular to the
tread, fairly flush, and not a tripping hazard, leave them.
Remove roots that are parallel with the tread. They cause
erosion and create slipping hazards. Look for the problem that exposed the root and fix that problem.

Removing Rocks—Rock work ranges from shoveling cobble to blasting solid rock. Both ends of the spectrum are often speciality work. Blasting can save a crew an astounding amount of work, but can only be conducted by a trained, certified blaster. The key to any decent rock work is good planning and finely honed skills. Other solutions to large rocks include ramping the trail over them, or rerouting the trail around them.

The secret to moving large rocks is to think first. Plan out where the rock should go, and anticipate how it might roll. Be patient—moving rock in a hurry almost always results in the rock ending up in the wrong location. Communicate with the crew about how the task is progressing and what move should occur next. Be careful to avoid opportunities for loosened rocks to careen down a slope, out of control. Damage to people, as well as the trail, can occur. If there is a possibility of people below, close the trail or area until the rock removal is complete.

Two of the most common injuries in rock work are pinched fingers and strained backs. When dealing with rocks, work smarter, not harder. Skidding rocks is easiest. Rolling them is sometimes necessary. Lifting rocks is the last resort. When you need to lift rocks, be sure to keep your back straight and to lift with the strong muscles of your legs. Sharing the burden with another person is sometimes a good idea.

Rocks should be removed to a depth of at least 4 inches below the tread surface. Simply knocking off the top flush with the existing tread may mean a future obstacle as erosion removes soil from around the rock.

Small stones are often needed for fill material behind crib walls, in turnpikes and cribbed staircases, and in voids in talus sections of trail. Buckets, canvas carrying bags, and wheelbarrows are handy for transporting this fill material. If you are part of a large crew, handing rocks person-to-person often works well. In some areas, much of the tread will be made up of rocks that are shifted from their original position and laid in place to develop the desired slope.

For additional details on moving and using rocks, see Lightly on the Land by Robert Birkby.

Trail Foundation

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

Hillside Trails—Construction of hillside trails usually requires grading a shelf for the trail, but if the existing surface is flat and provides a suitable tread, it should be left undisturbed. Hillside excavation may not be necessary on slopes less than 10 percent. On hillside trails, the trail bed is excavated into the side of the hill to provide a slightly outsloped travel path. Depending on the slope of the hill, the amount of excavation and the use of the excavated material will vary.
On steep slopes, **full-bench construction** is usually needed. Soil excavated from the hill is cast as far as possible from the trail and not used at all in the fillslope. Especially on steep slopes, relying on fill for part of the trailbed is a bad idea. This soft material is likely to erode away quickly, creating dangerous soft spots on the downhill edge of the trail. If fill is used, it often needs to be reinforced with expensive crib or retaining walls. As the slope of the hillside decreases, it becomes more feasible to use fill material as part of the trailbed. However, even though it requires more hillside excavation, full-bench trailbeds will generally be more durable and require less maintenance than partial bench construction. There is a tradeoff, though. Full-bench construction is often more costly because more excavation is needed, and it also results in a larger backslope. Most trail professionals will usually prefer full-bench construction.

The **backslope** is the excavated, exposed area of the trailway above the tread surface. Backslopes range from near vertical (in rock) to 1:2 in soils having little cohesion. Backslopes cannot be steeper than the exposed material’s ability to stay put during typical climatic conditions. If backslopes exceed this limit, usually after a period of wet weather, the slope usually fails, blocking the tread.

A second option is to construct a crib wall and use the fill to support the entire tread surface. This can be less obtrusive than huge backslope excavations and more stable, if the wall is well constructed. Much less backslope, if any, may be needed.

The **fillslope** is that area of the trail below (downslope from) the tread surface. A full-bench tread, of course, will not have any fill associated with this side of the trail. Fillslopes are critical. If you take care of the downhill side of the trailway, you will avoid the vast majority of problems associated with trail maintenance. See figure 4-2.

The **slope**, or the percent of grade, is the relationship between the horizontal distance and the vertical gain. It is a way to describe and determine the steepness of hillsides, trail tread, backslope and downslope. Slopes are often described as percents, but may be described as a ratio of vertical to horizontal, or “rise” to “run” (rise:run). For slopes flatter than 1:1, express the slope as a ratio of one unit vertical to the number of horizontal units. For slopes steeper than 1:1, express the slope as the ratio of the number of vertical units to one unit horizontal.
Percent of grade may be expressed as the following equation:

\[ \text{Percent of grade} = \frac{\text{rise}}{\text{run}} \]

Rise is equal to the vertical gain, and run equals the horizontal distance over which the rise occurs.

The grade of a trail rising at a rate of 4 feet for each 100 feet of horizontal distance would have a prevailing grade of 4 percent. It would be calculated as follows:

\[ \frac{4 \text{ feet} \text{ (rise)}}{100 \text{ feet} \text{ (run)}} \]

See Appendix XVIII for additional information on calculating and laying out grade.

Often you will need fill material. The hole you dig is called a borrow pit. It should be screened from view. The material in the pit also needs to be suitable for the desired use. Good choices are soils with a balanced mixture of different size particles. Sand and gravel work well. So do small, well-graded angular rocks.

Compare existing trail tread materials with borrow sources. Consider the proportions of gravel, sand, and fines. Individual “fine” particles are not visible to the naked eye and are classified as silt or clay. If the proportions of gravel, sand, and fines are similar, you can expect the borrow materials to perform as well as the existing trail tread materials. If the borrow source has a smaller proportion of fines, you can expect better performance under wet conditions.

Soils from bogs are not suitable for tread fill because they lose strength when they become wet. These dark organic soils are identified by musty odor when damp. Creek bottoms that are replenished by storms and seasonal water flow, and the base of cliffs where heavy runoff or gravity deposit sand and gravel, are good places to look. Don’t destroy aquatic or riparian habitat with your pit.

Save all your squares of vegetation removed from the top of the pit. You’ll need them for restoration. Place them in the shade and keep them moist by covering them with wet burlap. To rehabilitate, grade the pit out to natural contours with topsoil and debris, then revegetate. Camouflage the area and access trails with boulders and dead wood.

The following steps describes how to build a sidehill trail, once the vegetation has been cleared:

1) Mark the centerline of the trail with wire flags no more than 10 feet apart. These wire flags are the key to explaining how to dig the tread, and they keep the diggers on course.

2) Remove leaf litter, duff, and humus down to mineral soil. To mark the area to be cleared, straddle the flag facing the uphill slope. Swing your Pulaski or other tool. Where the tool strikes the ground is approximately the upper edge of the cut bank. The steeper the slope, the higher the cut bank. Do this at each centerline flag, then scratch a line between them. This defines the area to be raked to mineral soil. Clear about the same distance below the flag. Remove the duff. Don’t clear more trail than can be dug in a single day unless you know it is not going to rain before you can complete the segment.

3) For a balanced bench trail, the point where the wire flag enters the ground is finished grade. Scratch a line between flags to keep you on course. Facing the uphill slope, begin digging about 6 inches from the flag cutting
back into the slope. Imagine a level line drawn from the base of the flag into the bank. Dig into the bank down to this line, but not below. Pull the excavated material to the outer edge. Tamper this fill material as you go. On a full-bench trail, the wire flag essentially ends up at the outside edge of the trail. For less than a full-bench trail, the flag ends up somewhere between the centerline and the outside edge. Keep this in mind when you place the wire flags.

4) There is a tendency to want to stay facing uphill. To properly shape the tread, you need to stand on the trail and work the tread parallel to the trail direction to level out the toe of the cut slope and to get the right outslope.

5) There is a tendency to make the trail too narrow. If the width of rough tread equals the length of a Pulaski handle, the narrower finished tread will be about right for a good hiking trail.

6) Make sure grade dips and other drainage structures are flagged and constructed as you go.

7) If you try to slope the cut bank close to the original surface, you will usually get somewhere close to what is needed. Slope ratios are hard to understand. Instead, look at the natural slope and try to match it.

8) Round off the top of the cut slope. The easiest way to do this is to rake parallel to the cut edge with a fire rake.

9) The best way to check the outslope is to walk the tread. If you can feel your ankles rolling downhill, there is too much outslope. The outslope should be barely detectable to the eye. If you can see a lot of outslope, it’s probably too much. A partially filled water bottle makes a good level. Keep in mind that compaction from use will make the outslope greater.

**Trail Tread**

![Excess Outsloping](image)

Flat land trails-A flat land trail is a trail where the cross slope is less than 10 percent.

A crowned tread detail is used on flat areas where cross slopes are less than 10 percent, and occasionally up to 20 percent. The crown shall be 3 inches high, minimum. The objective is to construct a trail and provide for proper drainage when the slope does not take care of the drainage on its own. Crowning the trail creates a trench on the
uphill and downhill side of the tread. Only one trench may be required in some cases. The uphill trench may need to cross the trail with a structure such as a cobble drain. Locate the crowned trail so that remaining vegetation keeps people on the trail. The trail surface must be well compacted.

The **tread cut with ditch** is used in flat areas and other areas of less than 20 percent slope where drainage is impeded on the downhill side (puddling). The trail tread is cut through sod or the litter layer and an appropriate size trench on the downhill side is cut. Dispose properly of all material removed (downhill). Cross drains may still be required, even with a ditch. Remember to outslope trail and smoothly grade the ditch to expedite revegetation. While this technique is an option to solve a “puddling” problem, it has greater impact on the trail environment and requires more maintenance than a trail avoiding such an area altogether.

A **through tread cut** is used where topography does not allow typical tread cut construction. Typical tread cut can only be built on cross slopes between 20 and 70 percent. A through tread cut might be necessary when encountering a small mound, or where the grade needs to be lowered to attain proper profile and shape. The trail should be built to both ends of the problem area. Figure how far the trail needs to be lowered over the distance connecting the high point and low point. Cut to the desired depth, and proceed with outslope for tread, ditches on the downhill side and uphill and downhill backslopes.
**Trail Tread**

*Tread*- Tread is the actual travel surface of the trail. This is where the foot, rubber or hoof meets the trail. Tread is constructed and maintained to support the intended use of the trail.

Most trail construction revolves around making sure that solid, obstacle-free tread is established and enough protection is provided to keep it in place. If the tread is not located, constructed and/or maintained correctly, the users will find their own pathways instead.

Tread also includes the travel surface on structures like turnpike and puncheon. Tread, whenever elevated, should be slightly crowned to drain better.

**Surfacing**- Surfacing refers to any material which is laid down on a trail which lessens compaction of soil, provides a dry surface for users and prevents potential erosion and abrasion. Surfacing is necessary when the natural surface has been damaged or destroyed, when the existing material is unstable and needs protecting and strengthening, or when environmentally sensitive areas need protection and the trail cannot be rerouted.

The type of surface material used will depend on the kind and amount of use the trail receives. Ideally, natural materials should be used as the surfacing material. When natural materials cannot be acquired, materials which blend with and preserve the natural environment should be used.

In some cases a single layer of surfacing will be sufficient. In other cases, a sub-base may be required such as in areas of wet ground and peat or on trails which flood easily. In these cases, the base is the load-bearing part of the trail and will comprise the bulk of the material to be used and should have adequate drainage to keep the surface dry.

Each situation which requires surfacing will be unique. How the trail will harden will depend on the soil type, slope, depth of water saturation, the sensitivity of the environment, the trail’s expected use, and the availability of natural materials.

**Surface Water Control**

One of the main concerns in any trail construction is that of effectively diverting surface water off the trail. Running water can erode the tread and support structures, creating unsafe conditions as well as sedimentation problems. Standing water can result in boggy tread or even the failure of the tread and support structures.

Well planned trails include the installation of appropriate and effective drainage structures at the time of original construction. Keep in mind that good drainage is self-maintaining with minimal maintenance demands.

**Outsloping**- Outsloping is the first line of defense against tread erosion. An outsloped tread is one that is lower on the outside or downhill side of the trail than it is on the inside or bank side. Outsloping lets water run naturally off the trail. Outsloping should continue the entire length of the trail, and is used quite successfully in conjunction with grade dips. The amount of outsloping is small, usually only a few percent. Outsloping is most effective when used in combination with grade dips.

Tread maintenance includes the removal of debris, the filling of ruts and holes and the restoration of the outsloped tread by removing any berm and slough.
**Grade Dips**—The best grade dips are designed and built during the original construction. These are also called terrain dips, Coweeta dips, and swales. Other versions, often called rolling grade dips, or drain dips, can be built on most sidehill trails or constructed to replace waterbars (dug into existing tread). The basic idea is to use a reversal in grade to force water off the trail without the need for any other structure. The use of grade dips is preferred over structures such as waterbars.

If the grade is steep, the tread carries a lot of water, traffic is high, or the soils are erosive, a grade dip may need some additional strengthening. Sometimes a shallow water channel can be constructed in the last several feet of the tread leading into the dip. Water follows the channel off the tread without slowing down and depositing soil and debris. A spillway may be needed if there is a potential for headcut erosion in the fillslope. The secret is to keep the water moving at a constant velocity until it is all the way off the tread.

Grade dips should be placed frequently enough to prevent water from building enough volume and velocity to carry off your tread surface. Grade dips are pointless at the very top of grades unless they intercept significant amounts of slope drainage. Usually mid-slope is the best location. Grade dips also should not introduce sediment-laden water into streams.

Grade dips are permanent and usually maintenance-free. The construction of grade dips can effectively take advantage of natural features by descending into and then climbing out of slight folds in the terrain. Grade dips provide barrier-free drainage.

**Terrain dips** use grade reversal to take advantage of natural dips in the trail. These need to be planned into the trail when it is first laid out. The grade of the trail is reversed for about 10 to 15 feet, then rolled back over to resume the descent. A trail that lies lightly on the land will take advantage of each local drainageway swale to remove water from the tread as the trail winds around trees and rocks. The terrain dip, which uses existing terrain as the control point for the grade reversal, is a natural part of the landscape.

The beauty of terrain dips is that water collected from the hillside is not intercepted and carried by the tread. These grade dips are the most unobtrusive of all drainage structures if constructed with smooth grade transitions, and they require very little maintenance. Be sure to protect the drain outlet by placing guide structures along the lower edge of the tread above or below the outlet.

Another kind of grade dip is the **rolling grade dip**, which consists of a short reversal of grade in the tread. These can be designed into most sidehill trails. If a trail is descending at a 7 percent grade, a short climb of 10...
to 20 feet at 3 percent, followed by a return to the descent, constitutes a rolling grade dip. Water running down the trail cannot climb over the short rise and will run off the outsloped tread at the bottom of the dip. The beauty of this structure is that there is nothing to rot or be dislodged. Maintenance is simple.

Another grade dip is the **reinforced or armored grade dip**. In this dip, a curved water channel is constructed and an angled (like a water bar) reinforcing bar of rock or wood is placed at the top of the grade reversal. The bar is placed in an excavated trench, with its top edge flush with the existing tread surface so it is not an obstacle to traffic. Essentially, this is a buried waterbar.

This short reinforced grade dip can be built to replace waterbars on existing trails, especially trails used by wheeled vehicles. Well-located waterbars can be converted by constructing a curved water channel and recontouring the outslope from the top of the bar. For longevity it is best if the bar is reseated so that the top edge is flush with the existing tread surface and the channel is constructed with the correctly angled bar as the reference point.

The outlet is critical; it should be at least 1 2 feet wide, and outsloped. In shallow dips the task is to prevent berms, soil buildup, and puddling. Reinforced spillways may also be needed.

**Waterbars**—The waterbar is another commonly used drainage structure. Water moving down the trail is turned by contact with the waterbar and, in theory, is directed off the lower edge of the trail.

Waterbars can be used to solve a wide range of drainage problems when drain dips are inappropriate. They are usually placed in switchbacks and climbing turns to prevent water flowing down the upper leg of a trail from continuing onto the lower leg.

Improperly constructed waterbars can be the most ineffective tread structure in all of the trail world. When constructed and maintained correctly, however, they can be effective. By incorporating grade dips into the initial construction of the trail, the need for additional drainage structures will hopefully be avoided.

On grades less than 5 percent, waterbars are less susceptible to clogging (unless they serve a long reach of tread or are in very erodible tread material), and should be set at angles of 20- to 30- degrees. On steeper grades (15 to 20 percent) waterbars are very prone to clogging or even wash out if the bar is less than a 45 degree angle to the trail. Waterbars can be quite dysfunctional at grades steeper than 20%. At these grades a very fine line exists between clogging the drain and eroding it (and the bar) away. However, by utilizing more bars spaced closer together, they can be effective. Drainage ditches installed along the side of the trail may help keep the waterbar clean.

Most waterbars are ineffective because they are not installed at the right angle and are too short. The waterbar needs to be anchored 12 inches into the cutslope and still extend 12 inches into the fillslope. If your tread is 24 inches wide, the bar must be 5 feet, 6 inches long to be correctly installed at a 45 degree angle. A bar fitted to 60 degrees must be 7 feet, 7 inches long. Wider tread requires a longer bar. When the bar is cut too short, the usual response is to install it at a lesser angle. Then it clogs.

Poorly constructed and maintained waterbars also become obstacles. Most waterbars are installed with one-third to one-half of the bar material above the existing tread surface.
On grades steeper than 7% (particularly in erodible soils), the soil placed on the tread below the waterbar is rapidly lost to traffic and water erosion. The structure becomes a “low hurdle” for travelers. Waterbars should be set so that it rises no more than 2 to 4 inches above the level of the tread (uphill side).

Bars less than 6 inches in diameter wear or clog quickly into uselessness. Often they rot away in just a few years. Another problem with wooden waterbars is that horses kick them out. They also can present a safety hazard for cyclists.

Wood or rock waterbars are useful on foot and stock trail where a tripping hazard is acceptable, especially at grades less than 5%. Also consider reinforced waterbars where you do not have much soil to work with and in areas that experience occasional torrential downpours.

The bar helps keep traffic from wearing a water carrying groove through the drain. Install the bar at an angle of at least 45 degree and increase the angle as the grade approaches 5 percent or if the soils are very erodible.

Remember that high-faced bars are barriers to wheeled traffic. On trails that serve wheeled traffic, use either reinforced grade dips or rubber waterbars instead of traditional waterbars.

An important consideration is the number and spacing of waterbars on a section of trail. Variables to consider in determining the spacing of waterbars include the grade of the trail, the type of soil, the amount of runoff, the amount of use and the movement of the water off of the trail. Spacing appropriate to each unique site should be developed based on soils, precipitation and use.

When installing waterbars keep the following in mind:

- The waterbar should fit the characteristics of the site, and be located as near as possible to the top of the pitch grade or as close to the source of the water as possible.
- Avoid locating waterbars where a long outlet ditch is needed.
- Don’t install a waterbar if the discharge is onto a steep slope or part of the trail.
- The discharge should be into a filter area (vegetation present).
- Waterbars are useful when located near switchbacks and turns such that the flow of discharge water can continue without disturbing the trail.

[Figure 4-9: Backed Waterbar with Riprap Tray]

*Figure 4-9: Backed Waterbar with Riprap Tray*

*Trail Construction & Maintenance Notebook, USFS, p. 45*
Traditional waterbars should not be used on biking or equestrian trails due to the associated hazards. There are some designs for modified waterbars promoted for use on biking trails, but in general, there is dissatisfaction with their longterm use.

**Check Dams**—Check dams are steps that create a terraced section of trail, using rocks or logs. Treated lumber or peeled logs should be used, rather than unpeeled logs. The height of the installed logs is determined by what is required to restore the trail tread to its pre-erosion state. If a series of dams are installed, it is best to use a string to measure placement, and keep them equal distance apart, for ease in walking this section of trail. Check dams are placed across the trail at a 90 degree angle, with a minimum of 5 inches into the undisturbed bank for anchoring. They should be staked or anchored securely with rebar or wooden stakes. They are effectively used on old trails which are being abandoned to help with the reclamation process. Check dams can be major obstacles to users if not backfilled.

**Wet Area Crossing Structures and Techniques**

**Drainage**—Although an area may appear perfectly flat, often it will have a slight gradient and flow of water. Drainage ditches and culverts can ensure that water drains off the trail.

Generally, ditches are at least 12 inches deep, have flat bottoms, and side slopes of 1:1. In many cases, the ditch can be extended beyond the wet area to capture water that might flow into the trail.

A **French drain** is an open drain can be filled with crushed stone, stone or aggregate. This is called a French drain. Start with larger pieces of rock and gravel at the bottom, topping off with smaller aggregate. French drains are often used to drain a spring or seep from under a trail bed. The use of geotextiles are common with these drains. The geotextiles reduce the infiltration of fines and increase the effectiveness of the drain.
Culverts are probably the best way to move small volumes of water across a trail. The tread extends over the culvert without interruption. A disadvantage to culverts is that they require regular maintenance. Metal or plastic culverts can be installed easily, or the culverts can be constructed out of rock. Dig a ditch across the trail as wide as the culvert and somewhat deeper. Bed the culvert in native soil shaped to fit the culvert. There also needs to be sufficient drop, about 3 percent, from one side to the other so water will flow through the culvert without dropping sediment. The culvert needs to be covered with 6 inches or more of fill. Cut the culvert a little longer than the trail width, and build a rock facing (headwall) around each end to shield it from view and prevent it from washing loose. Often a rock-reinforced spillway will reduce headcutting and washouts.

Use a culvert with a diameter large enough to handle maximum storm runoff and to be accessible for cleaning with a shovel or combination tool. Usually this means at least a 9-inch diameter culvert.

Rock culverts offer a chance to display some real trail skills. Begin by laying large flat stones in a deep trench to form the bottom of the culvert. In some installations, these bottom rocks may not be necessary. Then install large, well-matched stones along either side of the trench. Finally, span the side rocks with more large, flat rocks placed tightly together, enough to withstand the expected trail use. Cover the top rocks with tread material to hide and protect the culvert. These culverts, too, need to be large enough to clean out easily. The rocks should not wiggle.
Water flowing toward a culvert often carries a lot of silt. If the water slows as it goes under the trail, the silt may settle out and clog the culvert. A good way to help prevent this from happening is to construct a settling basin at the inlet to the culvert. This is a pit at least 1 foot deeper than the base of the culvert. It can be lined with rocks as desired. The idea is that sediment will settle out here, where it is much easier to shovel away, rather than inside the culvert.

**Figure 4-14: Settling Basin**

*Trail Construction & Maintenance Notebook, USFS, p. 60*

**Turnpike**—Turnpikes are used to elevate the trail above wet ground. The technique uses fill material from parallel side ditches and from offsite to build up the trail base higher than the surrounding water table. Turnpike construction is used to provide a stable trail base in areas of high water table and fair to well drained soils. Turnpikes are practical up to 10 percent trail grade.

Turnpikes should be used primarily in flat areas with 0 to 20 percent side slope where there is wet or boggy ground. The most important consideration is to lower the water level below the trail base and carry the water under and away from the trail at frequent intervals. Turnpikes require some degree of drainage. When the ground is so wet that grading work can not be accomplished and drainage is not possible, use puncheon surfacing instead. However, a turnpike is easier and cheaper to build and may last longer than a puncheon. A causeway is another alternative where ground water saturation is not a problem but a hardened tread is needed.

**Figure 4-15: Turnpike**

*Trail Construction & Maintenance Notebook, USFS, p. 67*
any retainer rocks or logs. Lay the geotextile over the top with no excavation, then fill over with high quality fill.

Firm mineral soil, coarse-grained soils or granular material, or small, well-graded angular rock are needed for fill. Often it is necessary to haul in gravel or other well-drained material to surface the trail tread. If good soil is excavated from the ditch, it can be used as fill. Fill the trail until the crown of the trail tread is 2 inches above the retainers. It doesn’t hurt to overfill to begin with, as the fill will settle. Use rocks as the base layer of fill and decrease their size as you fill closer to the tread surface.

Construct a dip, waterbar, or a drainage structure at each end of the turnpike where necessary to keep water from flowing onto the structure. Keep the approaches as straight as possible when coming onto a turnpike.

Puncheon—Puncheon is a wooden walkway used to cross bogs, small streams, or fragile terrain. It can be used where uneven terrain or lack of tread material makes turnpike construction impractical. It can be supported on muddy surfaces better than turnpike, which requires effective drainage.

Puncheon consists of a deck or flooring made of treated timber or native logs placed on stringers to elevate the trail across wet areas that are not easy to drain. Puncheon that are slightly elevated are termed surface puncheon. Puncheon placed flush with the wetland surface is known as subsurface puncheon.

The simplest type of puncheon is a topped-log puncheon, made with two stringers that form the treadway and set on top of two base logs, that serve as the sills. Hew the timbers to make a flat walking surface and score the surface with an axe. Level each sill and cut notches where the stringers will be attached. Sills should be set 2 inches into the soil surface to provide for added stability. For stringer spans over 10 feet, a center sill should be used. Use natural rot resistant wood,
Figure 4-18: Topped-Log Puncheon  

such as cedar or locust, or treated timber to reduce the potential for decay.

When constructing puncheon, it is important that the entire structure extends to solid mineral soil so that soft spots do not develop at either end. The approaches to the puncheon should be straight for at least 10 feet. The first step is to install mud sills. These support the stringers. Mud sills can be native logs, treated posts or short treated planks, and are laid in trenches at both ends of the area to be bridged at intervals of 6 to 10 feet. They should be buried about two-thirds in firm ground. Rock and fill may be used to solidify the bottom long as practical up to 8 feet.

Stringers are set on top of the mud sills. They should be at least 10 feet long and matched by length and diameter. They need to be level with each other so the surface of the puncheon will be level when the decking is added. Two stringers are sufficient for hiking trails, but more should be used for equestrian trails. Stringers can be peeled logs or treated timbers. To hold the stringers in place, toenail spikes through the stringers to the mud sills or drive 1/2-inch rebar through holes in the stringers.

Installation of the decking is the next step. If using a center stringer, do not spike decking to it, as the center spikes may work themselves up with time and become obstacles.

Leave at least a 3/4 inch gap between decking to allow water to run off. The thickness and lengths of the decking depend on the loads the structure will need to support.

Figure 4-19: Mud sill and stringer layout  
[Trail Construction & Maintenance Notebook, USFS, p. 73]

Figure 4-20: Puncheon  
[Trail Construction & Maintenance Notebook, USFS, p. 71]
Running planks can be added down the center for horses to walk on. Do not leave gaps between running planks because they can trap wheeled vehicles (service vehicles). Curb logs should be placed along each side of the puncheon for the full length of the structure to keep traffic in the center. To provide for drainage, nail spacers between the curb logs and the decking.

The final step is to place a bulkhead or backing plate at each end of the structure to keep the strings from contacting the soil. Do not spike it to the ends of the stringers, as spiking causes the stringers to rot faster.

If puncheon is constructed on grades steeper than 5 percent, treat the surface to reduce slipping.

**Geosynthetics**—Geosynthetics are synthetic materials that are used with soil or rock in many types of construction. They can increase the effectiveness of construction methods and offer some additional alternatives to traditional trail construction practices.

Geosynthetics perform three functions: separation, reinforcement, and drainage. Geosynthetic materials include geotextiles, geonets, sheet drains, geogrids and geocells. All these materials become a permanent part of the trail, but must be covered with soil or rock to prevent deterioration by ultraviolet light or damage by trail users.

**Geotextiles** are the most widely used geosynthetic material and are sometimes called construction fabric or filtercloth. They are made from long-lasting synthetic fibers bonded to form a fabric. They are used primarily for separation and reinforcement over wet, unstable soils. They support loads and allow water, but not soil, to seep through. Geotextiles are often used in trail turnpike construction. They serve as a barrier between the silty, mucky soil beneath the fabric and the mineral coarse-grained or granular soil placed as tread material on top of the fabric. This insures that the tread surface does not become mud. The openings should be .3 mm or less to prevent silt from passing through. Since geotextiles can decompose when exposed to sunlight, store unused material in its original wrapper.
Geonets have a thin polyethylene drainage core that is covered on both sides with geotextile. They are used for separation, reinforcement and drainage. Geonets have a core plus two layers of geotextile, and thus provide more reinforcement than a single layer of geotextile.

Sheet drains are another form of a composite made with a drainage core and one or two layers of geotextile. The core provides an impermeable barrier unless perforated. When used under the trail tread material, sheet drains provide separation, reinforcement and drainage. They have greater bending strength than geotextiles or geonets, and thus require less tread fill. Sheet drains can be used as drainage cutoff walls. If the trail section is on a side slope where subsurface water saturates the uphill side of the trail, a cutoff wall can be constructed to intercept surface and subsurface moisture, helping to drain and stabilize the trail section.

Geocells are usually made from polyethylene strips bonded to form a honeycomb structure. Each of the cells is filled with backfill and compacted. Geocells are good for reinforcement, and reduce the amount of fill material required, and help hold it in place. Geocell usually has geotextile under it to provide separation from saturated soils. The grids need to be covered with soil so they will not be exposed.

Water Crossing Structures

Shallow Stream Ford- A ford is a shallow stream crossing that utilizes the stream bed. It is a consciously constructed crossing that will last for decades with a minimum of maintenance (barring major flood or debris torrent) and will provide a relatively low challenge to users.

The idea behind a shallow stream ford is to provide solid footing, at a consistent depth from one bank to the other. Most fords are not designed to be used during high runoff, but are intended to be used when flows are moderate to low. A ford for hikers should not be more than 16 to 24 inches deep (about knee high) during most of the use season. A horse ford shouldn’t be deeper than 39 inches. Equestrians favor fords over other types of stream crossings.

Fords should be located in wider, shallower portions of the stream. The approaches should climb a short distance above the typical high water line so that water isn’t channeled down the tread. Avoid locations where the stream turns, because the water will undercut approaches on the outside of the turn.
The tread in the ford is level, ideally made of medium-sized gravel, which provides solid footing. The plan is to even out the flow through the ford so the gravel-sized material isn’t washed away, leaving only cobble or boulders.

This can be done by arranging a level riprap of big rocks (like a miniature dam) or anchoring a log about 3 to 7 feet downstream from the trail centerline. The idea is to evenly slow the water as it goes across the ford. This slowing effect can be enhanced by placing several rows of stepping stones or rocks upstream from the tread. These slow the water entering the ford and begin to even out the flow. Be sure these upper rocks are not too close to the trail to avoid a scouring effect.

Well-constructed shallow stream fords are almost maintenance free. Watch for deep spots developing in the crossing. Floods or seasonal runoff can wash away the approaches or parts of the dam. Debris can catch in the dam or stepping stone line and alter flow characteristics. Approaches can erode into jumpoffs or turn into boggy traps. Maintenance consists of retaining or restoring the design criteria of an even shallow flow with solid footing.

Concerns that can arise from the use of fords include the generation of bank erosion, disturbance of aquatic life, the generation of water quality problems due to disturbing the natural stability of the stream bed, as well as posing some danger to the user.

**Stepping Stones**—Stepping stones are large flat topped rocks set into a stream that allows for dry passage. They are a standard solution for low wet and boggy areas, and work well when well placed.

Stepping stones are the option of least environmental impact that accomplish the objective of protecting the environment and providing dry passage. The ideal location for placing stepping stones is in shallow streams with light to moderate water flows. Avoid their use where dangerous stream flooding may occur.

When placing stepping stones, set stones approximately 1-1/2 feet apart with the flat surface facing up. The placement of stepping stones at the edge of the stream must not create stream bank erosion or cause water to undercut the bank. If the stepping stones are unsteady, they may not be set correctly or be large enough.

Stepping stones are generally appropriate for hiking and walking trails, but are not universally accessible. Stagger stones to reduce potential damming of debris between stones. The distance of stepping stones can be adjusted to accommodate the majority of users. The stone surface area should be a minimum of one square foot in size. Wet areas or streams with soft mucky bottoms may not adequately support stepping stones.
Boardwalks-Boardwalks are fixed planked structures, usually built on pilings, erected in areas of wet soils or water to provide for dry crossing. Boardwalks are especially useful when other forms of wet soil crossings are inappropriate due to the restriction of surface water flow, in areas of fragile habitat such as bogs or marshes, and in areas susceptible to flooding.

Boardwalks also provide for universal accessibility. Boardwalks should be designed to enhance the visitor’s experience of the environment, and are often used to provide an interesting means of access to shorelines and wetlands. In our coastal parks, boardwalks are a means of providing visitors access to marsh, wetlands and shoreline with minimal and controlled impact on the fragile environment.

All wood used in construction should be either pressure treated or naturally rot resistant species. The planks should be placed perpendicular to the direction of travel. The width of the boardwalk will depend on the expected use and whether the trail will be designed for one- or two-way travel. Boardwalks constructed on equestrian trails must be designed and constructed to support the intended load. Handrails and wheelguards may be added as a safety or accessibility feature, depending on the expected use of the trail.

The simplest boardwalk design is that of a light duty structure used in crossing occasionally damp or wet areas. It is sometimes referred to as a bog bridge, or puncheon. See the section on puncheon in “Wet Area Crossing Structures”.

A more substantial boardwalk structure is one supported on piers or pilings and is used in wet areas and over small streams or marsh environments. The intended user group must be taken into consideration in the design and selection of size of pilings, stringers and decking. Designing the boardwalk with a curving shape, adding spurs, adding widened observation decks and varying the width of the deck at intersections enhances its appeal to users.
Lumber used should be rot resistant. All connecting hardware should be galvanized. Consider using decking screws instead of nails to fasten the decking to facilitate replacement or resetting. The supporting piers or pilings are typically pressure treated timbers driven into the wetland soil, or a concrete structure placed on the stream bottom with timbers imbedded. Galvanized helical screw piers can alternatively be used, minimizing the impact to the wetland, and offering easier installation. However, the expense of the helical screw piers is often a deterrent.

**Bridges**

Bridges are structures designed to cross open water, wetlands or ravines. A variety of designs are employed but all generally involve fixing both ends of the structure to dry land. Bridges range from a simple foot log with handrails to multiple span, suspended, and truss structures. Bridges that span roads, rivers, or require specialized design to support design loads and withstand expected flood events should be engineered by DCR’s Design and Construction section.

On hiking trails, foot logs can be used to cross streams where safe fords cannot be located or to provide access during periods of high runoff. Constructed foot logs consist of a log, sills, and bulkheads. The foot log should be level and well anchored. Notch the sill, not the log. The top surface should be hewn to provide a walking surface at least 10 inches wide. Don’t let the log or rails touch the ground. Remove all the bark from the logs and poles.

If the foot log is associated with a shallow stream ford, be sure to position the log upstream or well downstream of the ford. Logs immediately below the crossing can trap travelers who lose their footing in the ford. If you have handrails, construct them according to plan.

Choosing the appropriate material for a bridge is not a simple process. The use of pressure treated lumber, metal, concrete, wood laminates and other composites requires the transportation of these materials to the site. However, the cost is likely to be well worth the longevity and durability of the finished product, compared to using native materials and their typically frequent replacement requirements, as well as meeting load bearing requirements.

The construction of bridges is a last resort after other options in trail location have been considered. In addition to the challenge of getting materials to the site, bridge construction usually requires significant erosion control measures due to the proximity to wetlands, or water. Considerations for bringing the trail surface up to the level of the bridge deck, providing for adequate drainage on the approach and bridge itself, and insuring that the approach is stable and not subject to erosion and thus threatening the bridge anchoring design all need to be made. Additionally, if the bridge is located on equestrian trails, the bridge should be of sufficient width and with solid approaches to provide horses solid, sure footing.

**Special Structures**

Special structures such as climbing turns, switchbacks and cribwalls are common in trail construction. They can be expensive and difficult to design and construct correctly. However, a well-designed, well-built trail structure can last for decades and be quite unobtrusive. Retaining structures are designed to keep soil and rock in place. The crib wall keeps fill from following the call of gravity and taking the tread with it.

Planning carefully to avoid difficult terrain reduces the need for climbing turns and switchbacks.
Improperly constructed handrails are a big liability, because they are not strong enough.

User psychology is more important to the success of these structures than any other trail structure. The turns must be easier, more obvious, and more convenient than the alternatives. They work best when terrain or vegetation screens the view of travelers coming down the upper approach toward the turn. Long legs between turns help reduce the temptation to shortcut. The designer’s goal is to make the trail more attractive than the shortcut.

**Climbing Turn**—A climbing turn is a reversal in direction that maintains the existing grade going through the turn without a constructed landing.

Next to waterbars, climbing turns are the trail structure most often constructed inappropriately. The usual problem is that a climbing turn is built (or attempted) on steep terrain where a switchback is needed. A climbing turn is built on the slope surface, and where it turns, it climbs at the same rate as the slope itself. It is almost impossible to keep a climbing turn from eroding and becoming increasingly difficult to travel if the slope is steeper than 20 percent.

The advantages of climbing turns in appropriate terrain is that a larger radius turn (13 to 20 feet) is relatively easy to construct. They are usually less expensive than switchbacks because much less excavation is required, and fill is not used.

The tread at each end will be full bench construction, matching that of the approaches. As the turn reaches the fall line, the amount of material excavated will decrease. In the turn, the tread will not require excavation other than that needed to reach mineral soil. Guide structures should be placed along the inside edge of the turn.

A climbing turn should be located so that it curves around an obstacle such as dense brush, a thicket of trees or other natural features. Be sure to design grade dips into the approaches.

**Switchbacks**—A switchback is a reversal in direction, but has a relatively level constructed landing (figure). Switchbacks usually involve special treatment of the approaches, barriers, and drainages. They are used on steeper terrain, usually steeper than 15 percent to 20 percent.

Switchback turns are harder to build correctly, but retain stable tread on steeper terrain. The key to successful switchback construction is making an adequate excavation, using appropriate structures to hold the fill in place, and building psychologically sound approaches.

![Switchbacks and Climbing Turns](image)

**Figure 4-27: Switchbacks and Climbing Turns**

* [Trail Construction & Maintenance Notebook, USFS, p. 85]
Look for “natural” platforms when you are scouting for possible switchback locations. Use these for control points when locating the connecting tread. These will save a lot of time later by reducing the amount of excavation and fill needed.

A switchback consists of two approaches, a landing or turning platform, a drain for the upper approach and platform, and guide structures. The upper approach and the upper half of the turn platform are excavated from the slope. Part of the lower approach and the lower half of the turn are constructed on fill.

The approaches are the place where most of the trouble with the switchback turns start. In general, the last 65 feet to the turn should be as steep as the desired challenge level will allow.

The turn can be a smooth radius ranging from 5 to 10 feet or a simple Y-shaped platform. The turn platform is nearly flat, reaching no more than a 5 percent grade. The upper side is excavated from the side slope and the borrow used to construct the fill on the lower side. The greater the turn radius, the wider the platform, or the flatter the turn, the greater the excavation required. A point may be reached where a crib wall is needed to keep the backslope to a reasonable size.

The tread in the upper portion should be insloped, leading to a drain along the toe of the backslope. You may need guide structures - rock walls or logs are common - on the inside of the turn to keep traffic on the trail.

Construct the approach on the lower side of the turn on tamped fill. The crib wall should extend for most of this length. The tread on the lower portion of this turn should be outsloped. The fill section transitions into the full bench part of the approach; the approach changes grade to match the general tread grade.

Cribwall-The crib wall is used primarily to keep compacted fill in place. It is useful where vegetation will not provide sufficient protection for soil erosion and sedimentation problems or where the slope is too steep to establish and maintain vegetation.

Construct wood crib by interlocking logs or beams, pinned or notched (if logs) at joints. Lay sill logs at right angles to the direction of travel and alternate tiers of face logs and header logs. Each successive tier is set to provide enough batter to resist creep pressure from the slope and to reduce pressure on the face of the logs from the hill. The ends of the header logs are seated against the backslope of the excavation for stability. As fill is tamped in place, filler logs are placed inside the structure to plug the spaces between the face logs, and are held in place by the fill. Outslope
structures to keep traffic off the edge. Wood crib is easier to build than rock cribbing, but is less durable.

**Rock Walls**- Rock or crib retaining walls are used when a sturdy wall is needed to contain compacted fill or to hold an excavated wall in place. Rock, when available on site, is preferred over logs.

To build a rock wall, excavate a footing in soil or to solid rock. The footing should be insloped to match the desired batter angle and deep enough to support the foundation tier of stones (these are usually the largest stones in the wall) for the full width of the tread. Ideally, the footing is dug so that the foundation tier is embedded for the full thickness of the stones.

Ideally, the stones should weigh at least 45 pounds. At least half of the stones should weigh more than 130 pounds. The ideal stone is a rectangular with flat surfaces on all sides. The worst stone to use is rounded like a river rock.

The batter should range from 2:1 to 4:1 (figure). Factors determining this angle include the size and regularity of the rock, the depth of the header stones, and the steepness and stability of the slope. At batter angles steeper than 4:1 or so, cement, or internal anchors (or both) may be needed for stability.

On short walls, it may be possible to construct the entire structure starting upon a single keystone. The keystone is laid into the footing and successive tiers are laid. Each
tier’s face stones overlap the gaps between stones in the next lower tier. Each face tier includes tie or header stones that overlap the gaps between face stones and those deeper in the wall. The foundation tier (or the keystone) should be insloped slightly and rest on the excavated surface, not on fill. Each successive face tier should be staggered slightly into the hill to create the desired amount of batter. Header stones should also be used to tie deeper stones to those closer to the face. This is particularly important if the wall widens in cross section as it gains height.

Stones in each successive tier should be set so they have at least three points of good contact with the stones below. Good contact is defined as no wobble or shifting under a load without relying on shims (or chinking) to eliminate rocking. Backfill and tamp as you build.

**Steps**—Steps are sometimes used in an existing trail to fix a problem caused by poor trail location or design. The result often is out of character with the desired experience and aesthetics of the trail. Before you construct steps, make sure they are consistent with the expectations of those the trail is designed to serve.

The goal is to design the height (rise) and depth (run) of the steps to match the level of challenge desired. Steps are harder to negotiate as the rise increases.

The components of a step are: the rise, the run, a landing on easier grades, and often retainer logs.

The rise is the vertical distance gained at the face of each step. The run is the distance from the edge of one step to the base of the next step’s face. The landing is the extension of the run above the step. In structures where the landing is composed of tamped fill material, retainer logs or stone cribbing are used to retain the fill.

Hikers, especially backpackers, generally don’t like steps and will walk beside them if there is any opportunity. The steps need to be comfortable to climb or they won’t be used. This means keeping the rise a reasonable 6 to 8 inches and the run long enough to hold a hiker’s entire foot rather than just their toe. A general rule of thumb to keep in mind during step construction is that Atwice the riser plus the tread (run) should equal 25 to 27 inches.

If the stairway climbs straight up the hill, each step should be slightly crowned to drain water to the edges or slightly sloped to one side. When the trail traverses a slope, each step and landing should be slightly outsloped. Water should not be allowed to descend long lengths of a set of steps or to collect on or behind a step on the landing. A drain dip where the trail approaches the top step is a good idea.
Build stairways from the bottom up, at a break in the grade. The most common mistake is to start part way up a grade.

In all steps, the key is to use the largest material possible and to seat it as deeply as possible. Rocks should be massive and rectangular. On steps that traverse a slope, it helps to seat the upper end of the step material in footings excavated into the slope. Rocks placed alongside steps help keep users on the trail.

**Support Structures**

**Wildlife Observation Structures**—Viewing platforms or wildlife observation structures are being used increasingly with various trail systems.

Platforms can be used for watching wildlife and enjoying scenic vistas. These structures can provide a safe vantage point for trail users to enjoy vistas with minimal impact to the land.

Such platforms can have interpretive signs and viewing devices such as “pay per view” spotting scopes built in. Decks or platforms should have more complex shapes than simple rectangles. Deck shapes should bow outward from the running boardwalk in order to create an outward focus. To keep carpentry simpler, angles can optionally be kept to 45 degrees. The site and user circulation patterns should dictate deck designs.

The direction of decking lumber relative to the running deck can also affect the perception and aesthetics of the deck shapes. Deck shapes can be varied from simple rectangles to more complex shapes. For example, deck shapes can be bow outward from the running boardwalk. The deck should be shaped in a way that complements the natural terrain and enhances the overall aesthetics of the observation deck. The following design guidelines should be considered when designing deck shapes:

- **Deck on both sides**—This deck has two viewing areas on both sides of the running boardwalk. Each area should be designed to create a visually pleasing and functional space. The deck should be designed to accommodate the natural terrain and enhance the overall aesthetics of the observation deck.

- **Deck on one side**—This deck has one viewing area on one side of the running boardwalk. The deck should be designed to create a visually pleasing and functional space. The deck should be designed to complement the natural terrain and enhance the overall aesthetics of the observation deck.

**Vistas and Overlooks**—Vistas and overlooks are natural or man-made openings providing a scenic view, and are often the purpose or destination of one’s hike on a trail. The addition of a vista enhances an existing trail. Vistas must be maintained by periodic clearing (unless naturally occurring), and should not be created/maintained at the expense of resource damage. A vegetative survey should be done prior to clearing to insure that no significant plant species would be removed or impacted, and any clearing must be within existing departmental guidelines or federal/state/local legislation (riparian buffers, CBPA, etc.).
observation deck. The following are examples which illustrate this.

An overlook is created usually by installing railings or a platform with railings at a place highlighting the site’s scenic beauty.

Safety of the visitor must be kept in mind in creating and maintaining vistas and overlooks. Barriers such as a fence or railing, or vegetation may need to be installed or planted. Unwanted trails sometimes are created from the vista, and vegetative or other barriers can be put in place to discourage such use.

**Benches**—Benches may be placed at strategic points along a trail to provide resting and viewing opportunities. While there is no standard design for trail benches, benches within one park shall be of consistent design and construction. This adds to the overall aesthetic appearance of trail structures, and aids in maintenance and future installation. The placement of benches should not interfere with use of the trail, and as such, are typically placed in areas where clearing beyond the required trail width occurs. A sample bench design is found in Appendix XIX.

**Kiosks**—Kiosks, or bulletin boards, shall be placed at a minimum, at the major access point(s) to the trail system. This serves as an information center for trail users, and should display the trail system map(s), any pertinent user information and rules, and desired park specific information. In parks with specific or dedicated trails, such as equestrian or mountain biking trails, a kiosk should be installed at the main trail access point for those users. Where multiple use trails exist, user etiquette guidelines should be displayed. While there is no standard design for kiosks, within one park kiosks shall be of consistent design and construction.

This adds to the overall aesthetic appearance of trail structures, and aids in maintenance and future installation. Construction should be adequate to withstand the elements and visitor use. A sample kiosk design is found in Appendix XX.

Information and postings should be kept up to date. Trail map dispenser boxes may be attached to or located near the kiosks.

Kiosks can be a valuable tool in promoting safety, resource protection, and enhancing the user’s overall experience on our trails.

**Gates**—Gates are critical to preventing unauthorized or undesirable to areas of the park and portions of trails that are off limits to the public. While there is no standard design for gates, within one park gates shall be of consistent design and construction. This adds to the overall aesthetic appearance of trail structures, and aids in maintenance and future installation. Construction should be adequate to withstand the elements and visitor use. A sample gate design is found in Appendix XXI.

**Specific Trail Types**

*References*


