Figures

Photos

Chapter 12. Topographical Turns, Switchbacks, and Climbing Turns

Topographical turns, switchbacks, and climbing turns are used to provide additional linear run to overcome limitations of the landform. They are designed control points. Use and placement of these structures should follow the guidelines established in Chapter 5, *Principles of Trail Layout and Design*. Unless these structures are properly placed, they have little chance of being maintainable, regardless of the quality of construction.

12.1. Applications

Topographic, switchback, and climbing turns are trail features used to add linear run (trail length) to reduce linear grades. If landbase, resources, aesthetics, or construction feasibility prohibits lengthening the trail in a curvilinear fashion, then these types of trail features are used to overcome elevation gains between control points.

12.2. Construction

12.2.1. Topographic Turns

Topographic turns require the least amount of construction effort. As discussed in Chapter 5, *Principles of Trail Layout and Design,* a topographical turn allows the trail to contour around a small hill or knoll while maintaining an outsloped trail bed. The hill conceals one leg of the trail from the other, so cutting across the turn by users is minimized. The only place where an outsloped trail bed cannot be accommodated is where the trail crosses over the saddle during circumnavigation of the hill. The short section of trail that crosses the saddle will usually be turnpiked to provide drainage and greater tread sustainability. (See Figure 12.1.) No other special construction is required for the rest of the topographic turn as hillside construction and an outsloped tread provide the necessary drainage.

12.2.2. Switchbacks

The switchback is perhaps one of the most misunderstood and poorly constructed trail structures. In addition to frequently being laid out poorly without regard to the appropriate location criteria, rarely are all the required elements of a functional switchback prescribed, and those design elements that are prescribed are often under-constructed. The construction of a switchback begins with proper layout on the landform, as described in Chapter 5, *Principles of Trail Layout and Design.* The layout must allow for drainage from the corner of the landing, provide a natural barrier between the upper and lower legs, and provide a break in slope between the two legs. A vista off the corner of the turn can also be incorporated into the switchback. (See Photo 12.1.) Rarely are all these design criteria present at any given switchback location. At a minimum, a switchback must be located where the water from the upper leg can drain freely off the corner of the landing. The other criteria are important and the trail designer should incorporate as many of them as possible.

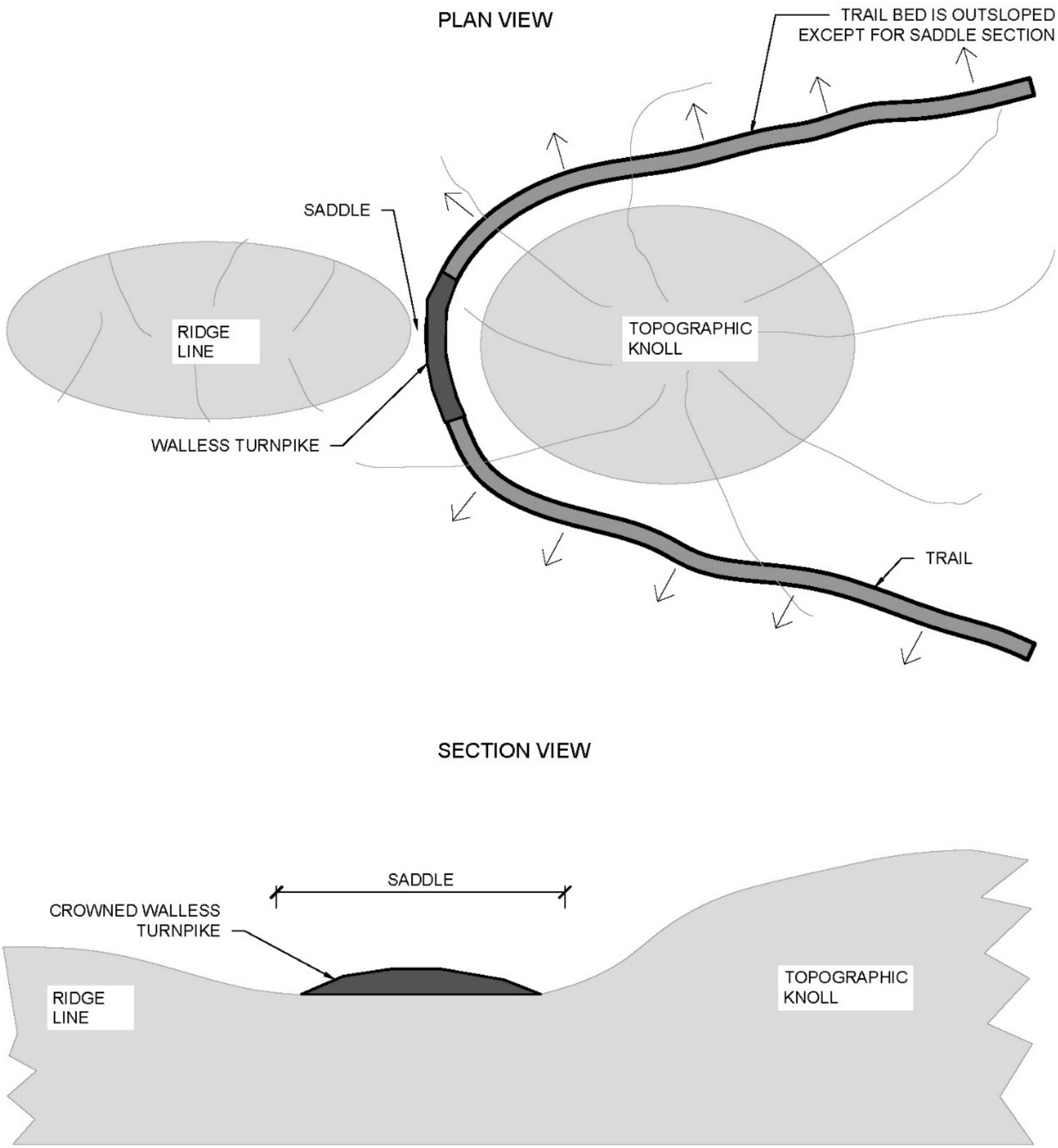

Figure 12.1 - Topographic Turn

TOPOGRAPHIC TURN

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Photo 12.1 - Switchback

Construction begins by locating the corner of the turn. During layout and flagging of the switchback, the corner is marked with two flags indicating the center of the outside edge of the turn and the finished grade of the center of the outside edge of the landing. These flags must not be disturbed during clearing and brushing. Vegetation, downed trees, and rocks needed for barriers or screening between the two legs must also be undisturbed.

Since a switchback is located on side slopes greater than 30%, constructing the switchback landing can require a retaining wall to support the lower corner of the landing. If the entire landing can be constructed into the hillslope on native ground, a retaining wall is not required. The switchback landing should have no fill material unless it is contained by a retaining structure. If a retaining wall is required, the location, size, design, finished elevation, and building materials must be identified. (See Chapter 13, *Retaining Structures.*) Usually the retaining wall is constructed first, since fill material for the wall is generated from excavation of the landing, especially the upper half of the landing, which is built into the hillslope.

If there is sufficient fill material from excavation of the landing, construction of the trail legs on either side of the switchback starts before the retaining wall is built. If not, construction of the legs must be coordinated with construction of the retaining wall. The upper leg of the switchback starts where drainage of the trail changes from outslope to inslope (“transition"). The exact location of this transition depends on how far back from the landing the upper leg can drain to the downhill side of the trail without impacting the lower leg. The amount of sheet runoff received, the distance between the two legs, and the amount of vegetation and organic material between the two legs are critical factors in deciding the exact location of the transition. If possible, the transition is located where a tree or rock outcropping adjacent to the trail can facilitate the transition. The transition from outslope to inslope is created by constructing a low berm at a 45 degree angle to the trail. (See Figure 12.2.) The berm should be a subtle feature and the trail graded from both directions to provide a nearly seamless transition.

Once the transition is completed, the upper leg of the switchback is constructed with an inslope into the hillside from the transition to the corner of the landing. If the soil is durable and the switchback properly located, the drainage for this insloped section of trail will not require a ditch. Water should flow along the inboard hinge of the trail and exit at the corner of the landing. If not, a ditch must be constructed with the trail bed wide enough to accommodate both the ditch and the designed tread width. The tread width should gradually widen as it approaches the landing. The landing is much wider than the approaching trail legs, and the widening legs help trail users negotiate the turn. (See Figure 12.2.) Given that the upper leg is constructed into a steep hillslope, insloped, and wide enough to accommodate both a ditch and the trail tread, the necessary excavation is substantial. This large volume of material is exported for use in the retaining wall that supports the landing or to another nearby location. Wherever possible, coordinate the construction of switchbacks with construction of other nearby trail structures that require fill material.

While work on the upper leg of the trail continues, the landing is constructed. If a retaining wall is necessary to support the landing, most of the excavation occurs into the hillslope above the center of the turn. Excavation often results in a high cut bank due to the steepness of the hillslope and the need to lay back the cut bank to the maximum angle at which it will retain its position without sliding down the slope, and even further if needed for stability and eventual revegetation. The area below the center of the turn will receive fill material, which is compacted into maximum 3-inch lifts. The size of the landing depends on the trail's classification and user type. For pedestrian trails, the radius of the landing is twice the width of the approaching trail bed or a minimum of 6 feet. For mountain bike trails, the landing radius is two and a half times the width of the approaching trail bed or a minimum of 8 feet. For equestrian trails, the landing radius is three times the width of the approaching trail bed or a minimum of 10 feet. Trails that allow pack stock have a minimum landing radius of 12 feet.

The shape of a switchback landing is designed to facilitate the transfer of the trail drainage from an inslope to an outslope. The upper portion of the landing is insloped into the hillside and the lower portion is outsloped to the downhill side. From the drainage point, the slope of the landing transitions to an outslope as it follows the curve of the landing. (See Figure 12.3.) Given the mechanical wear associated with turning maneuvers on a switchback, the cross-slope of the landing is constructed at a minimum of 1.5 times the outslope of the approaching legs. This cross-slope is applied uniformly through the landing. (See Figure 12.3.)

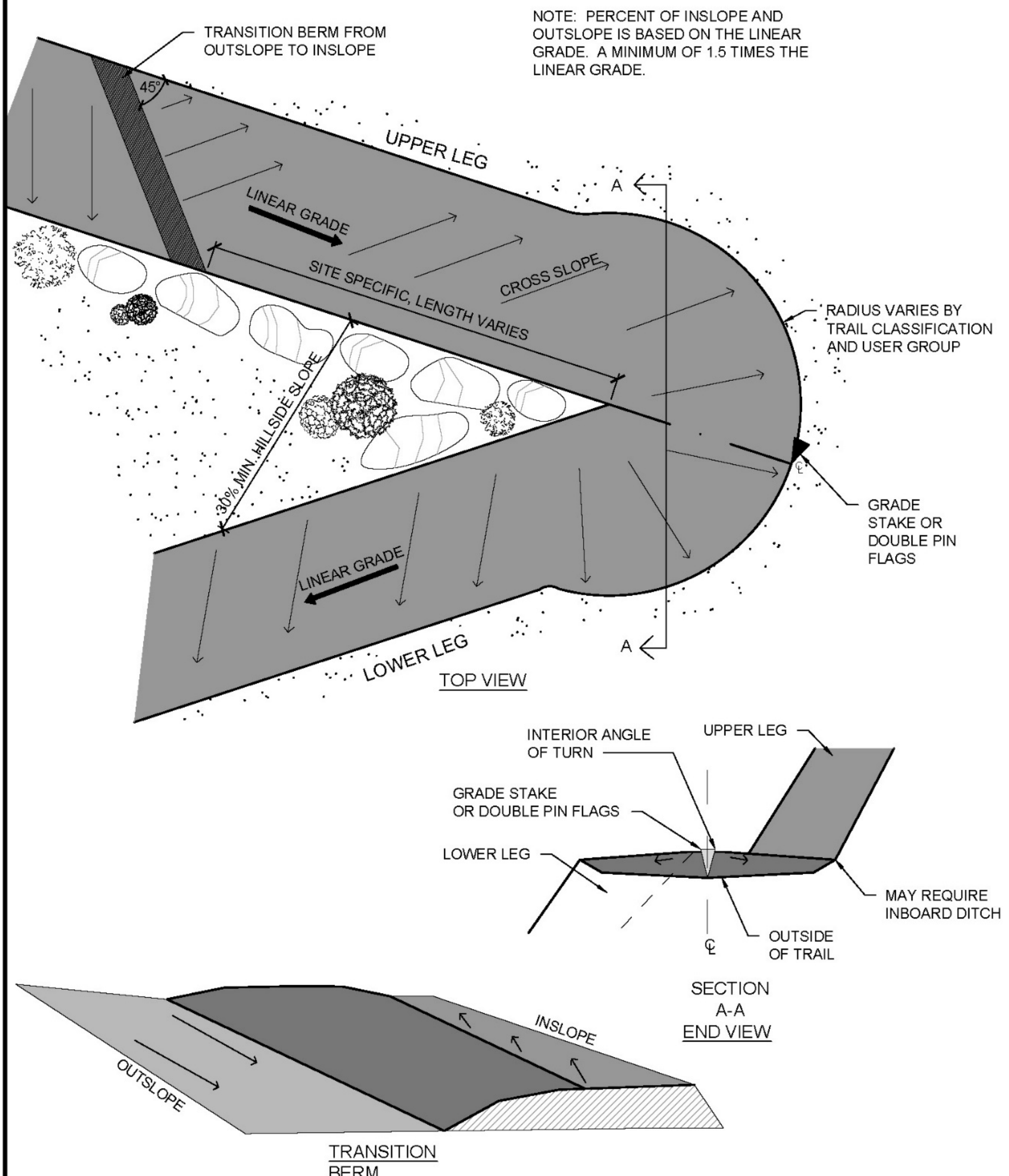

Figure 12.2 - Typical Switchback Details

TYPICAL SWITCHBACK DETAILS

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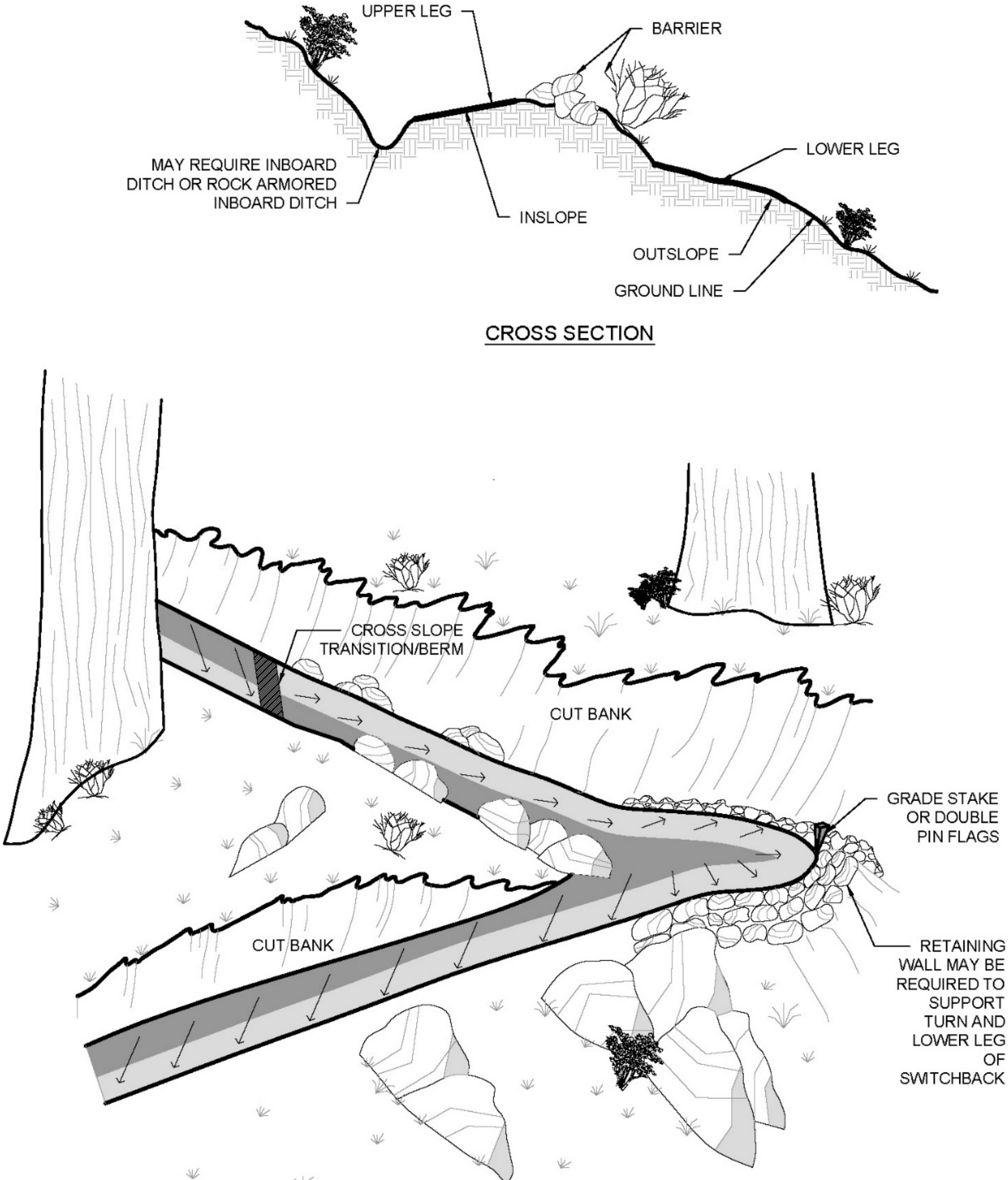

Figure 12.3 - Typical Switchback Details Continued

TYPICAL SWITCHBACK DETAILS CONTINUED

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Because the upper leg of the switchback is insloped, water drains along the inboard hinge or into a drainage ditch that leads to the upper corner of the landing. For water draining off the landing, a drain ditch outlet is constructed. The gradient of the inboard hinge or the drainage ditch is consistent from the upper leg of the turn to its exit off the landing. When this grade is reduced, water will lose its velocity and sediment will accumulate in the drainage ditch or at the outlet. The drainage ditch and outlet must be sufficiently armored to withstand erosion caused by concentrated flow and to prevent erosion of the landing. In some situations, installing an energy dissipater at the drain outlet is required to prevent erosion of the hillslope below the landing. (See Figure 12.3 and Chapter 14, *Drainage Structures.*)

The lower leg of the switchback may require a retaining wall to support the outside of the trail where it intersects the landing. The retaining wall supporting the lower leg is incorporated into the retaining wall supporting the landing. The lower leg of the switchback is constructed in a similar fashion to the rest of the trail. If the switchback is located near a watercourse, the excavated material is exported to another trail structure requiring fill or side-cast outside the influence of the watercourse.

When there are insufficient trees, brush, or rocks to serve as a physical or visual barrier between the two legs of the trail, or there is no break in slope to obscure the lower leg, additional trail structures are needed. Nearby logs or rocks can be placed between the two legs to serve as a visual and physical barrier. (See Photo 12.2.) These barriers are installed similarly to log and rock crib walls along the outside edge of the upper leg. Large rocks can also be used alone or in combination with logs. (See Chapter 13, *Retaining Structures.*) If suitable native material is not available, a railing or fence can be installed to discourage trail users from cutting between the legs.

Photo 12.2 - Use of Barriers Between Legs of a Switchback

Switchback construction cannot be approached in the same way as trail tread construction. A switchback is too small, and the construction tasks are too discrete for “hook line” construction as described in Chapter 11, *Principles of Trail Construction*. The crew must be split into small groups to work on different parts of the switchback simultaneously. For example, one group of workers constructs the retaining walls, while another group excavates the landing and provides fill material for the walls, and another constructs the upper leg. As these tasks are completed, the crew switches to constructing the drainage ditch and outlet, installing barriers between the two legs, and constructing the lower leg. The size of the crew should be adjusted as the tasks progress. Individual assignments should be changed to work different muscle groups and develop skills.

12.2.3. Climbing Turn

A climbing turn is a variation of a switchback. (See Photo 12.3.) The location, drainage, barriers, and separation of the legs of the structure are the same. Climbing turns are typically constructed on hillside slopes of less than 30% and usually require minimal excavation due to the limited hillside steepness. In a climbing turn, the legs approaching the turn form a wider angle than in a switchback. The lower corner of the landing does not require a multi-tier retaining wall, though it may require a small single tier wall to support the outside edge of the landing. The landing transitions from an inslope to an outslope gradually. (See Figures 12.4 and 12.5.) The approach to constructing this structure is the same as a switchback, except that less material is excavated, and the amount of retaining wall is reduced significantly, which also reduces the cost.

Photo 12.3 - Climbing Turn with Native Rocks and Trees as Barriers

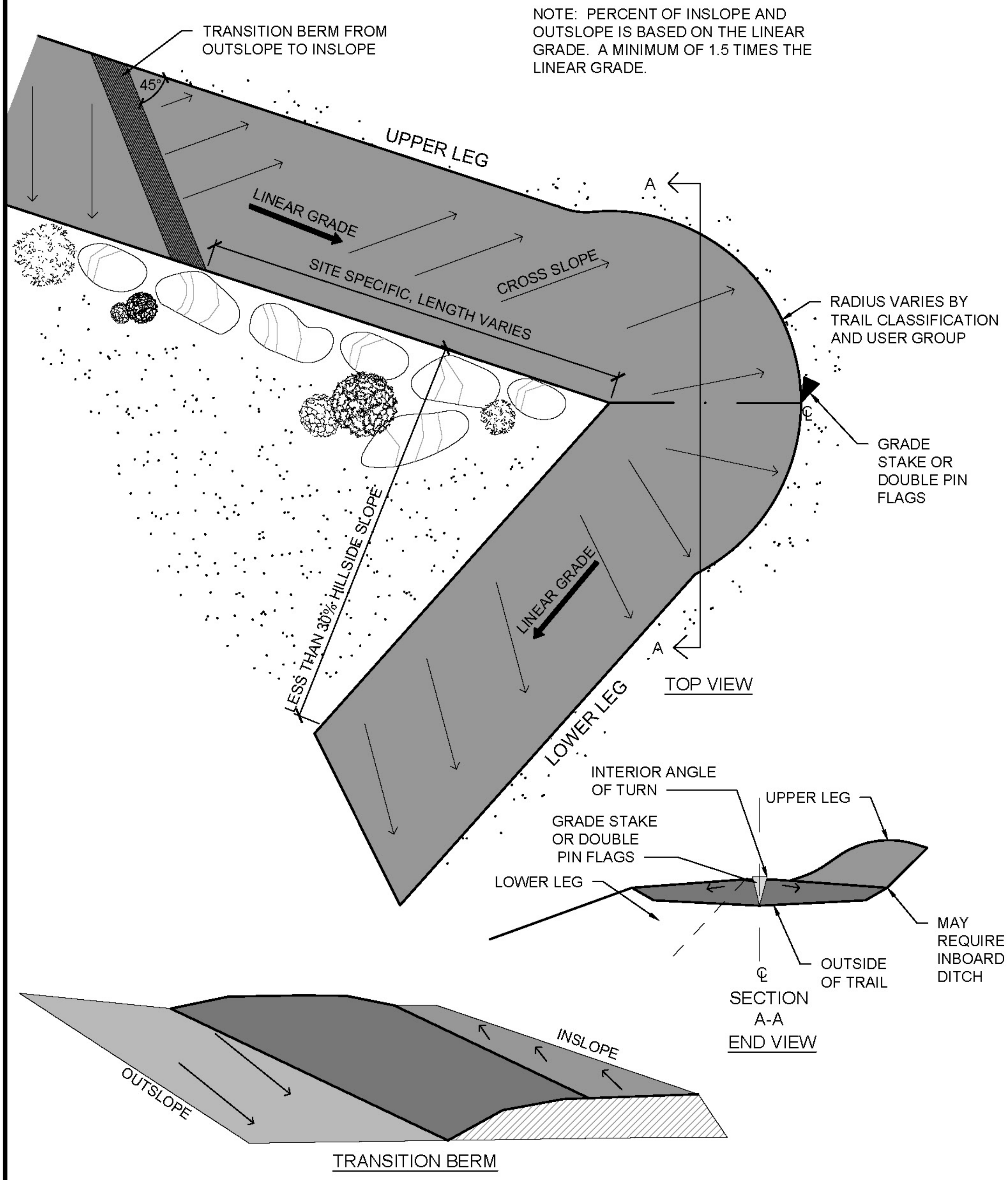

Figure 12.4 - Climbing Turn

CLIMBING TURN

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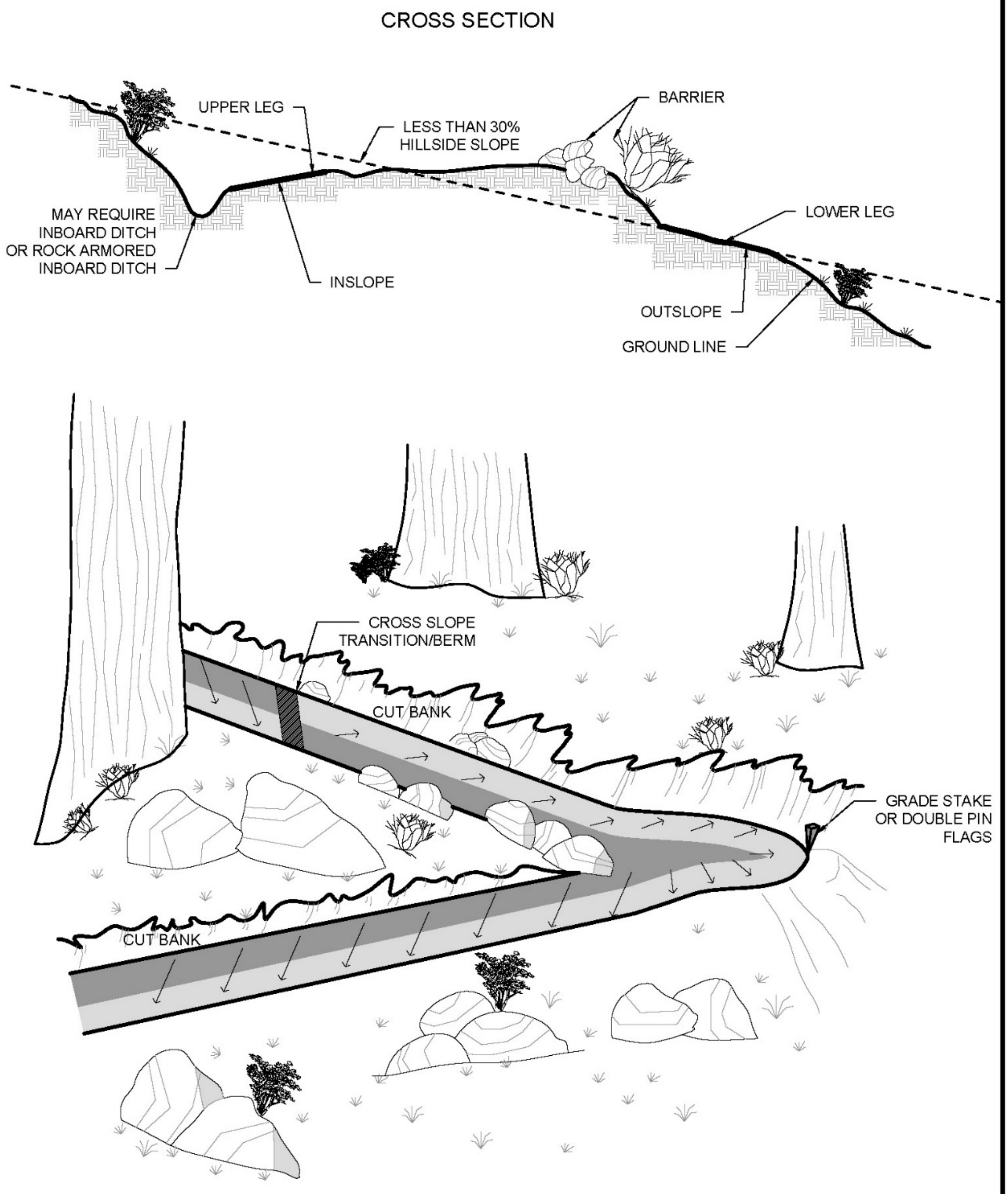

Figure 12.5 - Climbing Turn Continued

CLIMBING TURN CONTINUED

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12.3. Accessibility

For climbing turns and switchbacks on accessible trails, the linear grade of the approaching legs is limited to 12% for a maximum run of 10 feet, 10% for 30 feet, 8% for 200 feet, and 5% for any distance. The cross-slope is also limited to a maximum of 5%. (See Chapter 8, *Accessible Trail Design.*) Given the need for separation between the two legs, the 5% grade is too shallow and the 12% grade is too short to accommodate these structures. The only practical linear grades for use in these structures are 8% and 10%. With its longer length and more user-friendly angle, the 8% grade is preferable. However, both grades can be used if there is a landing between the two. At the end of an 8% or 10% linear run, a minimum 5-foot long resting interval with a maximum 5% linear grade and cross-slope is required.

Most accessible climbing turns and switchbacks will have approaching legs with an 8% or 10% linear grade and a 5% cross-slope, and a landing with a 5% linear grade and cross-slope. In addition, the center of the outside edge of the turn should not have a berm for the transition from inslope to outslope. Traversing a berm using a mobility assistive device can be difficult due to the compound angles associated with the linear grade and cross-slope of the berm.

Because of the cross-slope limitations in accessible trails, providing adequate drainage on a switchback or climbing turn can be difficult. Using a lower linear grade helps to offset some drainage issues, but in most cases, the trail tread will need to be hardened to make it less susceptible to erosion. In addition, the low linear grade of the approaching legs makes it more difficult to separate the two legs. To compensate, barrier structures may need to be installed between the legs.

12.4. Trail Intersections

Where two hillside trails meet, the intersection is constructed as a modified climbing turn or switchback, depending on the percent grade of the hillslope. (See Photo 12.4.) These intersections present a number of challenges. Ideally, the two trails should be going in opposite directions, with one trail descending while the other trail ascends. Trying to join two trails that are both ascending or descending will result in trails paralleling each other for a long distance before they come together, which will encourage users to cut between them. The location of the intersection needs to meet the same physical and visual separation criteria as switchbacks and climbing turns. The intersection should be located at a point that will facilitate drainage from the upper trail because it will have an inslope. (See Figure 12.6.)

Photo 12.4 - Trail Intersection with Armored Drain Dip

Depending on the steepness of the hillslope, the location of trees and rocks, and the strength and durability of the parent soil, retaining walls may be required to support the upper or lower trails or the intersection itself. In addition, an armored drain dip should be installed to facilitate the flow of water from the upper trail inboard hinge and across the lower trail. (See Figure 12.7.) Use the standard turn location criteria (e.g., ridge nose or watercourse) to identify a location that will allow for this type of drainage.

When two intersecting trails go in the same direction, it may be necessary to construct additional turns to provide adequate separation between the upper and lower trail. (See Figure 12.6.)

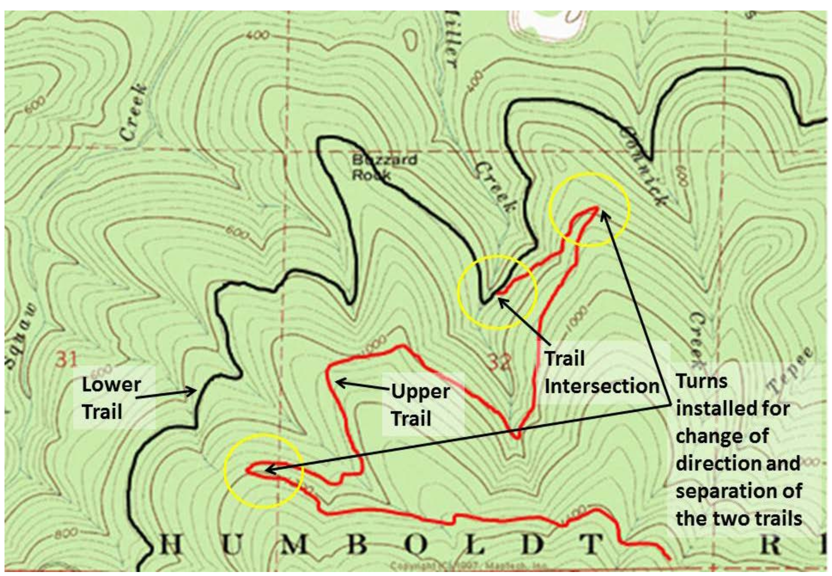

Figure 12.6 - Illustration of the Intersection of Two Descending Trails

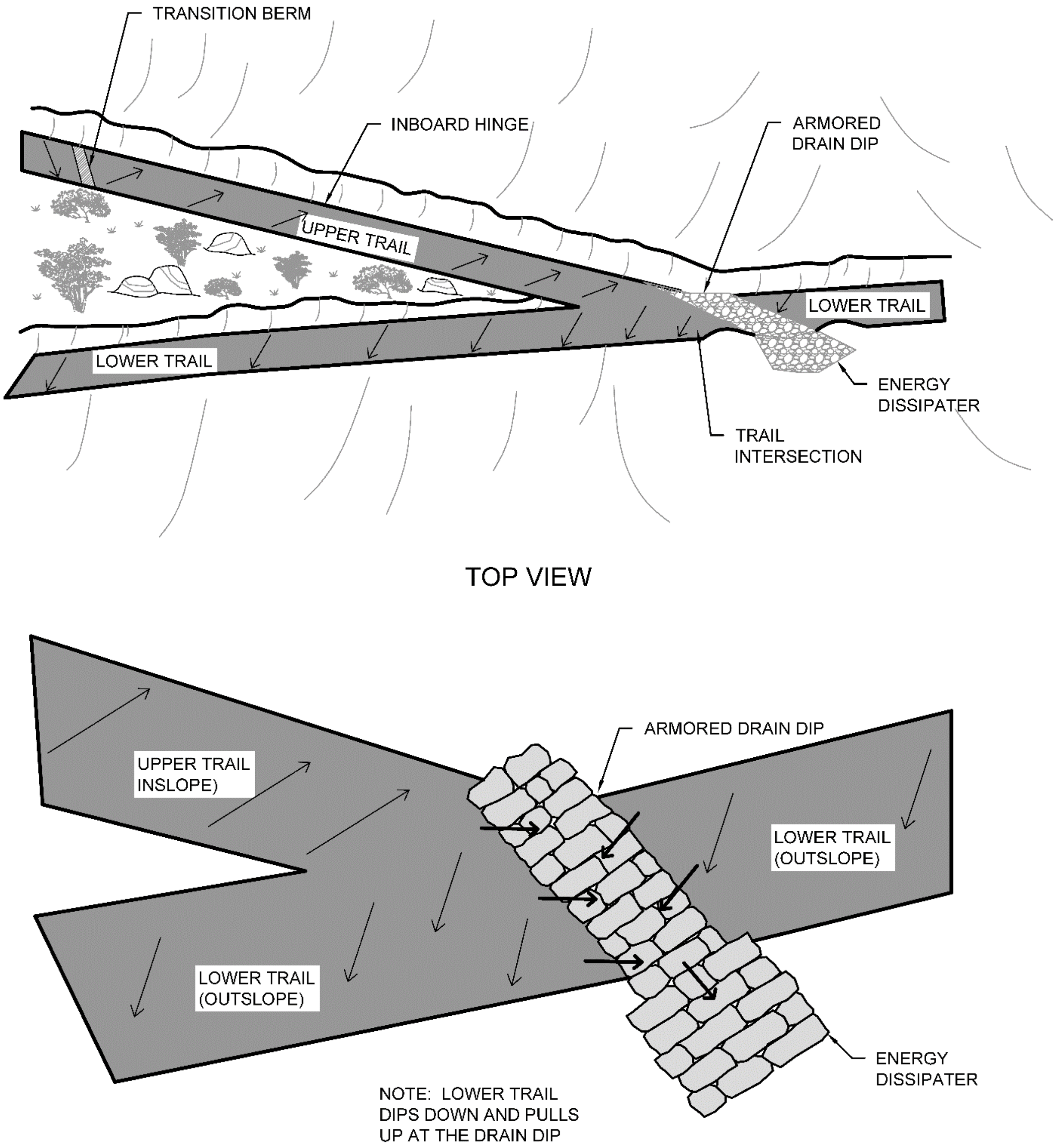

Figure 12.7 - Trail Intersection Drainage with Armored Drain Dip

TRAIL INTERSECTION DRAINAGE WITH ARMORED DRAIN DIP

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