Vermont Town Forest

TRAIL DESIGN GUIDE

Vermont Town Forest

Recreation Planning

Materials developed in partnership by

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THE UNIVERSITY OF VERMONT EXTENSION

FORESTS, PARKS & RECREATION VERMONT

VERMONT

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Photo: Liz Grades

WHAT IS THIS GUIDE?

The Vermont Town Forest Trail Design Guide was developed as part of the Vermont Town Forest Recreation Planning Toolkit, an initiative of the Vermont Urban and Community Forestry Program, to provide general guidance for designing and developing trails in town forests and beyond. For more information about the Toolkit visit, vtcommunityforestry.org/townforesttoolkit.

The guide provides trail planning, design, and development guidance, drawing from a combination of national standards and best practices, including the following documents, which were incorporated into the Vermont Town Forest Trail Design Guide, in many cases verbatim:

- Trail Solutions: IMBA's Guide to Building Sweet Singletrack (IMBA, 2004)
- Guidelines for Quality Trail Experience (IMBA, 2018)
- Trail Construction and Maintenance Notebook (U.S. Forest Service, 2007)
- Trail Planning, Design, and Development Guidelines (Minnesota Department of Natural Resources, 2007)

These guidelines are best practices for developing trails that are physically, ecologically, and economically sustainable. A comprehensive trail classification system was also developed to enhance consistency among agencies and trail advocates in how different types of trails are described and planned. The principles of trail design that make trails more visually appealing and enjoyable are also included.

Collectively, the guidelines provide a starting point for possibilities to get started in your town forest, but you will need to gather local information and input for your community and forest. Each trail situation is unique and requires site-specific evaluation to determine the most appropriate design approach. In some cases, refinements or adjustments to the guidelines will be warranted to ensure that the health, safety, and welfare of the public. Whereas the guide is an important reference, it is not a substitute for the in-the-field analysis required to make informed decisions about the design and development of a specific trail. Local decisions should ultimately be informed by site-specific information and in some cases, in consultation with a professional. Vermont is fortunate to have agency staff, local and regional trail groups and private consultants available to assist communities in providing on site assistance in trail planning. For more information on resources and partners, checkout VT Department of Forests, Parks and Recreation website (fpr.vermont.gov/recreation/partners-and-resources).

COMMON GOAL: A SUSTAINABLE TRAIL

Satisfying a trail user's desires for a specific type of trail experience is at the core of all trail planning. Whether for recreation, fitness, commuting, or utilitarian purposes, most trail users seek a fulfilling outdoor experience that does not unduly harm the environment.

The primary goal of this publication is to provide a set of practical guidelines for planning and designing sustainable trails that will meet the needs of Vermonters for generations to come. Other specific goals include:

- Promoting statewide consistency in how trails are classified, planned, and designed
- Promoting best practices to help ensure that all trail experiences are enjoyable, safe, and sustainable, with minimal impacts to Vermonts natural resources
- Promoting a high level of access to trails that serve the many needs and physical capabilities of trail users
- Reducing costs through the use of practical, time-tested methods for developing and maintaining trails

KEY TRAIL PLANNING AND DESIGN CONCEPTS

A number of key concepts underpin the trail guidance:

Sustainability Framework

The guidelines emphasize the development of physically and ecologically sustainable trails that serve the needs of users while preserving the place and protecting the surrounding environment.

Foster Stewardship

Develop a sense of ownership and responsibility with the public for stewardship of trails is a key ingredient of creating and maintaining sustainable trails.

Creating a Plan

Engaging in formal planning.

All Trails Have Impact

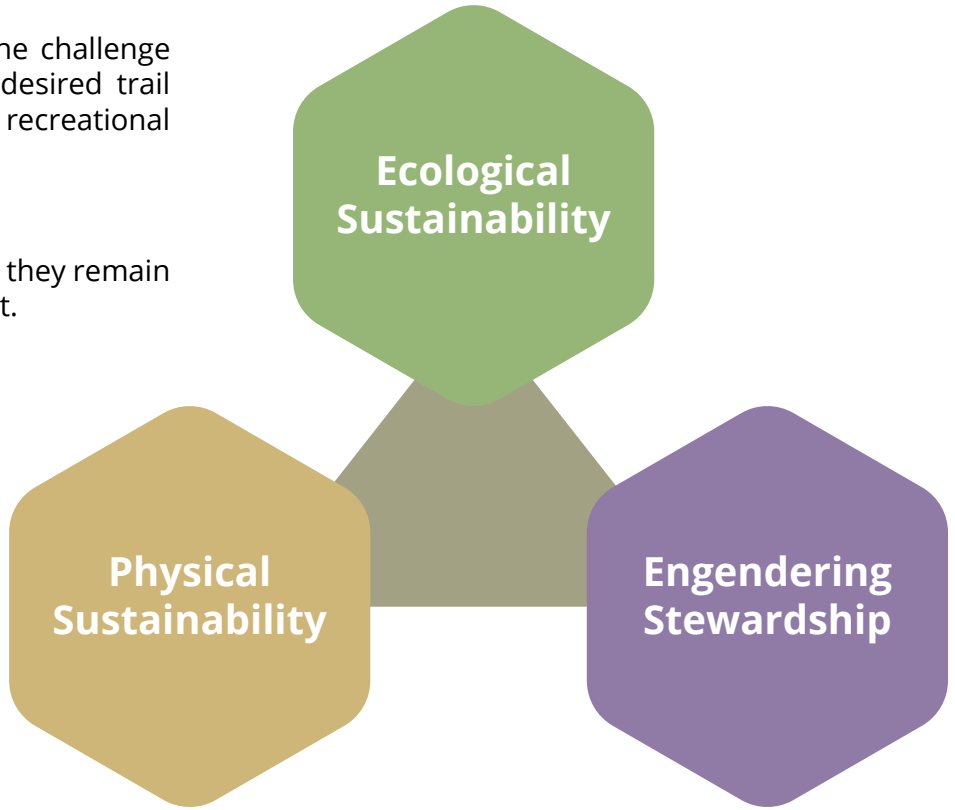
Placing any trail on the landscape has an ecological impact. The challenge is keeping those impacts to a minimum while providing the desired trail experience. All trails should be conceived as low-impact recreational experiences with a built footprint only to the necessary extent.

All Trails Change Over Time

Trails must be designed in anticipation of changes to ensure that they remain relatively stable with appropriate maintenance and management.

Economic Sustainability

An important consideration in developing trails is ensuring that the implementing agency or trail advocacy group has the capacity to economically support the trail over its life cycle. Developing a long-term maintenance strategy is a critical aspect of initial trail planning and fundamental to a successful trail program.



Trails Support a Wide Variety of Visitor Contexts

All trails must be developed and managed with an intended visitor experience. As a whole, the trail system should support a wide array of experiences and these guidelines support that.

Successful Trails are a Sequence of Events

Trails offering a rich experience do not just happen. They are the result of thoughtful consideration of the site's physical and scenic qualities using them to create trails that add interest, offer challenges, and exhibit scenic values that contribute to the trail experience. The more a trail responds to the nuances of the site, the higher its value to the user. Even in cases where existing roads and rights-of-way are used for trail corridors, creating a sense of place and trail context that are essential design objectives.

Using Common Language

The guidelines establish a common language to foster consistency in classifying and developing trails.

Guidelines Provide a Starting Point

The guidelines are based on best practices in line with state and national standards. It is important to connect to local trail building experts and statewide resources, such as VT Department of Forests, Parks and Recreation (fpr.vermont.gov/recreation) and the VT Trails and Greenways Council (vermonttgc.org).

GUIDING PRINCIPLES FOR SUSTAINABLE TRAILS

Guiding Principle #1
Avoid Sensitive Ecological Areas and Critical Habitats

Guiding Principle #2
Develop Trails in Areas Already Influenced by Human Activity

Guiding Principle #3
Provide Buffers to Avoid/Protect Sensitive Ecological and Hydrologic Systems

Guiding Principle #4
Use Natural Infiltration and Best Practices for Stormwater Management

Guiding Principle #5
Provide Ongoing Stewardship of the Trails and Adjoining Natural Systems

Guiding Principle #6
Ensure that Trails are Sustainably Designed, Built, and Maintained

Guiding Principle #7
Formally Decommission and Restore Unsustainable Trail Corridors

Application of these principles will minimize the impact of trails on natural resources and sensitive ecological systems. Importantly, the strict application of these guiding principles has to be balanced against the need to locate trails where they will be of high recreational value to the targeted users, who often want to be close to nature, enjoy beautiful scenes, and observe wildlife. This is an important consideration and underscores the need for resource managers and trail designers to work together to determine which values are most important for any given situation. For example, under the guiding principles, it is reasonable and desirable to buffer a given trail from sensitive ecological systems, such as a rare fen. However, once a trail alignment is agreed upon, the design of the trail should be consistent with the parameters set for that type of trail to avoid compromising its safety or value to targeted trail users.

SUSTAINABLE RECREATIONAL TRAILS

Building sustainable trails means providing recreational trail opportunities that limit impact on natural and cultural resources. On the ground, this means building trails that are long-lasting, at grades that will not erode easily, do not impact existing drainages, and are not easily affected by runoff. Trails can meet these conditions through proactive planning, proper siting, sustainable design, and maintenance.

Trails must be responsibly developed to avoid diminishing the natural environment or the experience of being in a natural setting. The objective of this manual is not to limit or preclude trail opportunities, but to embrace and promote them in a sustainable manner, striking a reasonable balance between resource protection and human access and enjoyment.

PRINCIPLES OF SUSTAINABLE TRAIL BUILDING

The following are high-level principles for building sustainable trails:

- Features and structures are in scale with the natural environment
- The visual quality of the landscape or specific landscape features is not diminished
- Soil resources are protected from human-caused erosion
- The introduction of invasive species is avoided

Key Factors for Developing Sustainable Trails

Three key factors are common to all sustainable trails, as illustrated in the diagram on the right.

For a trail to be sustainable, each of these factors must be considered in its planning, design, and development. The factors are also complementary, whereby trails that are the most physically sustainable also tend to be the most ecologically sustainable and appealing to use. This, in turn, encourages appropriate trail use and trail users taking personal responsibility for stewardship to ensure continued access. This basic concept is fundamental to all trail development projects.

Physical Sustainability

Designing trails to retain their physical form over years of use and natural forces acting on them is important. The specific guidelines in this manual related to a trail's classification, general and technical design, and stewardship are all based on developing trails that are physically sustainable .

Ecological Sustainability

Minimizing the ecological impacts of trails, especially in sensitive areas, is also a major theme of these guidelines. See discussions of tread, erosion, and water management for further details.

Engendering Stewardship

A sense of individual responsibility for stewardship is fostered when trail users:

- Use trails in an appropriate manner

- Avoid impacts to surrounding ecological systems
- Educate others about sustainable ethics and practices

People protect what they value and trails should be designed considering users' interests.

UNDERSTANDING THE USERS

Trail users in Vermont town forests include hikers, mountain bikers, equestrians, snowshoers, and cross country skiers—primarily using trails for recreation. This section defines the different user types typically seen on trails and paths and describes the types of trails and facilities that are appropriate for each type of user. It also recognizes those users with mobility challenges and addresses ways to accommodate those users. Trail designs for each user type begin on Page 34.

Hikers

Hiking is a recreational pursuit that connects people with nature – most often a long, vigorous walk on a natural surface trail.

Hiking Trail Classifications

Natural hiking trails are specifically designed to accommodate trail users seeking a natural setting. There are four main types of hiking trails.

General Hiking Trail

General hiking trails are natural surface trails used largely for recreation and experiencing the natural environment. The width and character of hiking trails relate to the setting, intended trail user, and site-specific trail needs. Typically, these trails will be marked on a map and have signage.

Nature Interpretive Trail

Nature interpretive trails have much in common with general hiking trails but place greater emphasis on interpretation and education. Typically, interpretive trails are found within designated nature or conservation areas and arboretums. Interpretive kiosks and signage are provided along the trail. These trails are often linked to an interpretive center or other educational facility. Significant emphasis is also placed on accessibility of nature interpretive trails to all populations.

Walker/Hunter Trail

Walker/hunter trails are typically old logging access roads and trails. The primary distinction between these trails and forest access routes is that they are designated specifically for non-motorized use. Typically, walker/hunter trails are defined by a geographical area in which all trails within that area follow old logging roads and trails and are frequently used for authorized forest management activities

Forest Access Route

Forest access routes have much in common with walker/hunter trails except that their use is broader and includes motorized and non-motorized uses. As non-designated, informal routes through the forest, these routes are not typically included as part of a designated recreational trail system.

Walker/Hunter Trails and Forest Access Routes do exist in many town forests, but going forward, it is expected that towns will construct only general hiking trails and nature interpretation trails. Some walker/hunter trails and forest access routes may be decommissioned.

Mountain Bikers

These cyclists are adults and children of varying skill levels who ride off-road on rugged, natural surface trails. To find desirable riding conditions, they often drive to a trailhead and unload specialized, heavy-duty bikes designed for durability and performance in rough terrain. Mountain bikers may ride on country back roads, fire roads, or off-road trails shared with all-terrain vehicles, but most prefer separation from motorized users and systems designated specifically for mountain biking use. These cyclists desire the following:

- Trails that traverse varied terrain, laid out in "stacked loop" systems that offer a variety of interconnected trails of different lengths and abilities originating from a common trailhead.
- Sustainable trails that create good experiences for visitors, minimize user conflict and environmental damage, and hold up over time. Trails need to be able to sustain tread compaction and soil displacement created by trail users, as well as erosion created by natural forces.
- Relatively narrow trails called "single track" that are laid out following the natural contours of the land. Properly designed single track will incorporate gentle undulations, grade reversals, corrals, chokes, and turns to slow mountain bikers to desired speeds and create interesting, challenging rides. Natural objects and technical trail features may additionally be introduced to add technical challenge.

Fat Bikers

Fat Bikes are becoming a popular category of mountain biking, allowing users to extend their riding season through the snowy months. Fat bikes have larger width tires (typically 3.8 inches or larger) that allow riders to traverse softer terrain such as sand and snow . Trails can be groomed or ungroomed and share characteristics with mountain biking and xc-ski trails

Equestrians

Equestrians, or horseback riders, are allowed user groups in some town forests. They require large parking areas for trailers or connected trail systems.

- Horses typically travel 4-5 mph and equestrians are interested in longer trails for rides that are 10-15 miles in length.
- Hard surfaces (asphalt and concrete) and coarse gravel can injure horse hooves, so equestrians have preference for loose or compacted dirt trail treads.
- Horse trails need to be wider than typical hiking trails especially for people or other horses to pass

Cross-Country Skiers

In the winter, people will look to cross-country ski in town forests. Cross-country skiers typically prefer wider trails and enjoy groomed trails for ease of skiing.

Snowshoers

Snowshoers have the same general characteristics as hikers for summer use natural trails, only they tend to go shorter distances due to winter conditions.

Snowmobile

Snowmobilers are generally looking for longer range trail options. On dedicated, well-groomed trails, I00 to 150 miles for a day outing is common, with 180 miles being the upper end. Providing connections to a lager trail system, such as the VAST trails, are important for these riders.

Trail Use Pattern:

- Heavy user of formal snowmobile trail system and is highly dependent on maps and signage
- Commonly rides from a meeting place and explores trail systems on day or overnight trips
- Most often stays on established trail system, often not familiar with local areas
- Will use ditches on occasion, primarily to get to services from an established trail
- Will routinely research routes well in advance, and check snow conditions before traveling to a trail

Recreation Setting Preferences:

- Grooming and snow quality is of primary importance
- Needs access to rest stops and local services, lodging, restaurants, and businesses, preferably directly from the trail
- Natural setting is desirable, with looped configurations preferred
- Variety of trail character is important

Motivation/Activity Style Elements:

- Motivation is to operate machines, escape, see new places, view scenery, and socialize
- Interest in speed is highly variable within group
- Frequently travels in groups of 5 to I 0 riders
- Will travel long distances to find good snow, even for a day's worth of riding

ATV's/OHV's

OHV riders generally prefer forested, hilly, and less-developed sites. Family outings are common, core trails need to have extensive easy sections so all riders can have fun and stay together. While preferences vary among OHV riders, most agree on the following as "fun" or "really fun"

- Trails with a destination of special interest - inferred to include towns, businesses, major site anchors such as lakes and rivers, and links to other riding areas
- Primitive roads, with narrower tracks being preferred
- Easy trails through scenic areas
- Series of escalating challenges spaced out along the trail or accommodated in interlinked challenge loops

Overall, trails should provide a sequence of events that range from easy to challenging in a scenic setting that entices repeat use and, of equal importance, keeps riders from venturing off-trail or excessively using local access trails.

DESIGNING SUSTAINABLE TRAILS

NATURAL SURFACE TRAILS SUSTAINABLE TRAILS

Natural surface trails, the predominant trail type in town forests, provide high-quality nature experiences. These trails are typically narrow, following the natural contours of the land, with careful attention paid to slopes, tread compaction, and water drainage to promote sustainable trail design and maintenance.

- The trail tread is compacted soil typically 12”- 48” wide and defined by using vegetation, boulders, and other natural features to create chokes and corrals that create an interesting, meandering hike or ride
- All natural surface trails should be designed as rolling contour trails - characterized by gentle grades, undulations called grade reversals, and an outsloped trail tread that allows water to drain off the surface without causing erosion.

Sustainable Trail Characteristics

With all natural trail types, a certain level of compaction and displacement is expected and acceptable. It is also acceptable to cross natural drainageways and create a corridor wide enough to accommodate the trail as long as site impacts are kept to a minimum.

In general, trails are considered sustainable if the following conditions are found:

- Trail tread is stable and compacted, with a constant outsloped grade preferred (the depression on a well-worn trail should average less than 3 inches in most soil types)
- Displacement of soils from the trail tread is minimal relative to the use and soil type (only limited berming on the outside of curves)
- Tread drains well with minimal to no signs of ongoing erosion, especially into water bodies of any kind
- Tread does not restrict site hydrology and impact surface- or ground-water quality
- Impacts to surrounding ecological systems is limited to the trail tread and directly adjacent clearance zone, with no bypassing and cross-country travel occurring

Placement of Sustainable Trails

Building a trail in the proper location can reduce maintenance costs far into the future. Elements of proper location and routing include a sustainable grade, an optimal cross slope, a curvilinear alignment, and other location considerations.

There is an optimal cross slope range and profile grade combination for building sustainable trails. Trails that climb at gentle grades and are less than half of the prevailing cross slope will last longer and have lower impact on soils. Steeper trails are prone to erosion and water can pool in flatter areas.

Routing trails on a curvilinear route that matches the terrain not only helps the trail blend into the landscape, it helps water flow over trails, lessening the impact to both the existing drainage and the trail. Where there are drainages crossing the trail, the trail should dip into and out of the drainage, not block it.

Other location considerations include soil types, the slope aspect of the trails, and the vegetation types encountered on the trail. Soil types that have a lot of clay contribute to muddy conditions during shoulder season. Those with too much sand are prone to erosion. Trails on south-facing slopes are preferred as they dry out more quickly. Trail builders should avoid building trails in areas with lots of weeds or invasive species. If this cannot be avoided, removing weeds and invasive species will prevent these plants from spreading along the trail corridor.

Data to Consider

- Topographic features such as high points, low points, rock outcroppings, features of topographic and/or geologic interest
- Physical, environmental, historic, and/or aesthetic points of interest
- Views
- Surrounding land uses
- Wind direction
- Environmental issues
- Soil types and drainage capabilities
- Water quality classifications of watersheds
- Riparian (streamside) buffer areas
- Wildlife areas
- Noise/Odors
- Zoning
- Deed restrictions
- Easements that limit use
- Steep slopes
- Potential environmental hazards
- Observations on compatibility with adjacent land uses
- Locations and recommended buffers around rare, threatened, and/or endangered species
- Potential vehicular conflicts, note posted speed, estimate traffic volume, and evaluate sight distances
- Locations of buildings and structures including observations of age and historical integrity
- Identification of erosion and sedimentation problems
- Preliminary observations on conditions of structures including bridges, canals, culverts, and/or tunnels
- Locations of infrastructure and utilities noting constraints to potential trail development
- Vehicular intersections and access points
- Potential off-site connections to main streets, adjacent trails, other environmental, cultural, and/or historic resources
- Proximity to motorized trails

Trail System Layout and Difficulty

The layout and difficulty of the trail system should be established based on the intended user groups and the forest itself.

Trail System Layouts

Trail designers typically lay out trail systems in one of the following ways:

- **Linear Trail Layout (Point-to-Point)** - The simplest trail layout has a point of origin and a destination. It connects two points or links two trails. This layout should be used where there are points of interest or destinations along a single narrow corridor or to connect other trail systems where the terrain or land ownership restricts the trail to a single narrow corridor. This system may consist of several point-to-point trails that meet. Multiple trail access points and trailheads may exist along the corridor. The trail must have a single level of difficulty over its entire length.
- **Single Loop System** - A single loop system is most often used for a single, long-distance trail and for a shorter duration trails around lakes, reservoirs, wetlands, and other topographic features. Multiple trailheads may be located along the loop. The trail must have a single level of difficulty over its entire length.
- **Stacked Loop System -** A stacked loop system consists of multiple loop trails, with a core loop and other loops branching out from it. This system can have multiple levels of difficulty, with each stacked loop becoming more difficult. This system generally has only one trailhead. A stacked loop system allows users to choose the length and duration of their trail experience. This system can allow a group of trail users with varying skill levels to enjoy an outing together.
- **Multiple Loop System -** The multiple loop system typically has a single trailhead, with several loops radiating out from one point of origin. Each loop may have differing level of difficulty, provide a different experience, or provide access to a destination.

Difficulty Ratings

In general, difficulty ratings are largely determined by total elevation gain and distance of a trail. While there are some nuances for each trail type, the following difficulty ratings can be applied to most user groups.

- **Easiest -** Suitable for beginning trail users and those who do not have the skill or desire to use "more difficult" trails. These trails have a low level of risk for the user and consequently offer less variety than those of greater difficulty. The layout of these routes are appropriate for novice to advanced users and generally follow obvious, well-marked routes. Grades are gentle and few obstacles should be encountered. They require little skill and entail little physical challenge. The tread should be smooth, level, and wide, with generous clearing of trees, limbs, and other vegetation above and to each side of the trail to permit easy passage. Elevation gain or loss is minimal. Stream crossings typically have bridges at this level of difficulty
- **More Difficult -** Designed to meet the expectations of the majority of trail users. These trails require skills beyond that of a novice and at times should challenge the average trail user. These routes are appropriate for intermediate to advanced users. Terrain may be steeper, trails narrower, and some obstacles may be encountered. They require a moderate skill level and provide a moderate physical challenge. The tread surface can contain roots and embedded rocks. Elevation gain or loss is moderate. Most often streams are crossed with fords.
- **Most Difficult -** Designed for trail users with advanced skill, who are seeking a higher risk level. Only advanced to expert users should attempt these routes. The design incorporates steep terrain. Trail users should have considerable skill in their chosen activity, as well as knowledge of navigation before attempting these trails. They require a high degree of skill and provide a definite physical challenge. Trail users should seldom encounter a graded tread except on steep side slopes, for safety and prevention of soil erosion. Minimal clearing of trees, limbs, and other vegetation hampers the progress of the user. Usually elevation gain or loss is significant. Streams crossings generally consist of fords and they can sometimes present a challenge.

Ecological Concerns

Stormwater Management

High volume and high velocities of concentrated water flow on a trail results in significant erosion. Erosion has a negative impact on water quality and adjacent habitats, as well as significantly increases the maintenance needs of the trail. Even on slight grades, erosion caused by water can wash away tread material. Soil already loosened by displacement is the first to go. The higher the water volume, the more extensive erosion will be, especially on steeper trail segments. Although light rains may not cause much erosion, heavy rains can cause significant damage to the trail. The following strategies should be deployed to limit stormwater erosion damage.

Avoid Steep Trail Pitches: To prevent water from concentrating on steep trails, avoid creating trail segments steeper than 10 percent. Water is more likely to concentrate on a steep trail, and significant erosion occurs where the water runs off the trail. Further, it is difficult to control drainage on steep earthen trails and repairs can be expensive.

Encourage Infiltration: Designs and materials should facilitate infiltration and prevent stormwater runoff.

Water Crossings: Perpendicular routes should descend to water crossing on both sides to prevent the stream from flowing down the trail. Consider armoring the trail in areas that dip down to avoid sediment and trail runoff from entering the watercourse.

Avoid Long, Sustained Grades: Do not construct trails with long, sustained grades that can concentrate runoff on their surface. By installing grade reversals, runoff will direct itself off the trail and grade breaks provide areas for users to rest.

Avoid Flat Ground and Steep Cross-Slopes: Trails on flat ground do not drain well. However, trails with steep slopes require larger excavations and run the risk of sloughing. Increased erosion and degradation can increase maintenance costs and lead to users forming bypass trails.

Avoid Discharging Trail Runoff: Concentrated runoff from trails can cause damage to fill slopes and unprotected soils adjacent to the

trail. Carefully select trail runoff locations to slow runoff velocity so sediments can settle out. Armor fill slopes where you intend to discharge runoff onto them or convey runoff off-site where it can be infiltrated. Trails can change the timing, quantity, and quality of the natural hydrological system by delivering both sediments and runoff directly to streams, wetlands, and riparian resources.

Avoid Removing Trees and Shrubs at Stream Crossings: Use existing roads and bridges to avoid removing trees and shrubs at crossings and to avoid new stream corridor disturbances. Consider routes that can handle drainage without affecting nearby water resources. Some measures to avoid these impacts include trail narrowing, encouraging filtration, providing frequent drainage, and spreading crushed aggregate to enhance drainage.

Erosion

Trail erosion is frequently linked to water and drainage issues. However, there are other strategies that can help prevent erosion caused by trail users. Trail users traveling off trail, especially on steep slopes, frequently causes erosion. To prevent this, signage should be put in place reminding trail users to stay on the trail and drainage issues should be prevented to the extent possible.

Compaction through trail use actually helps prevent erosion by hardening the tread materials, except in cases of pure sand and other large particles without binders.

Avoid Stacking Switchbacks and Climbing Turns: Carefully locate climbing turns and switchbacks to prevent user cut-throughs and short cuts. Offset them from one another to take advantage of natural benches, slope breaks, and natural screening. To discourage shortcuts, you may increase grades and use rocks, trees, or log barriers while constructing the turn.

Sustainable Natural Surface Treads

To be sustainable, a natural trail tread has to have the following characteristics and management:

1. Stable, compacted tread material. The tread material exhibits moderate to high stability in both wet and dry conditions. The tread is compacted for increased stability and resistance to displacement and erosion. If the tread material is less stable and/or does not compact well, sustainable tread may still be possible if all of the following characteristics are present.
2. Limited displacement. The tread material, tread shape, usage restrictions, and/or maintenance minimize and/or accommodate displacement. Wheeled uses may need super elevation on curves to minimize displacement.
3. Tread drainage with limited erosion. Tread shape and location frequently drain surface and subsurface water to somewhere lower than the tread itself, typically to the side, before average runoff from the tread and the site accumulates to erosive volumes and/or speeds.
4. Narrow tread. To concentrate compaction and reduce impacts, the tread and bare soil width are as narrow as feasible.
5. Minimal hydrologic impact. Tread shape, location, and drainage minimize changes in local hydrology.
6. Trail maintenance and management. Trail maintenance and management concentrate on proactive, frequent, small actions, including:
   - Performing routine light maintenance
   - Finding and correcting problems while still minimal
   - Predicting and preventing future problems
   - Closing trail during extremely adverse tread conditions, typically during spring thaw and other saturated soil conditions

- Protecting tread from overuse and from uses it was not designed to support
- Planning and supporting tread as a permanent facility with an indefinite lifespan

Primary Design Pattern for Sustainable Trails : Rolling Grade

"Rolling grade" is the primary design pattern used for developing sustainable natural surface trails. This pattern is best described as a series of dips, crests, climbs, drainage crossings, and edge buffers that are intrinsically linked and purposefully designed to form a sustainable trail. Unlike the geometric form associated with paved trails, rolling grade is inherently more responsive to the nuances of the landforms encountered on a site.

The rolling grade design pattern takes many variables into consideration, including: tread material and compaction, displacement, and erosion forces; types and amount of use; wet and dry conditions; topography and drainage patterns and flow rates; site vegetation; tread width and grade; and user safety.

The basic concept behind rolling grade is that a sustainable trail must be able to drain to somewhere lower than itself at all times. Rolling grade is used to manage water flows down or across the trail. By using a series of dips and crests like a roller coaster, the tread is divided into a series of small watersheds that drain into a dip. A tread watershed consists of the tread surface plus any uphill area where runoff flows onto the trail and down to a dip between two crests. The most sustainable way to arrange this is by traversing a slope and minimizing the risk of tread erosion.

There are two primary ways to minimize the risk of tread erosion: limiting tread grade and limiting the size of the tread watershed .

Limiting Tread Grade

Predictably, less erosion occurs when trail grades are less steep. In highly erosive situations, minimal grades provide the best erosion control. Tread should traverse slopes with a grade that is ideally less than one-half of the fall-line slope grade.

As tread grade increases, native soil treads need to be drained more frequently to prevent accumulation of erosive flow volumes. This is most often accomplished by placing tread crests closer together .

Limiting the Size of the Tread Watershed

Limiting the size of the tread watershed limits the amount of erosive runoff that can be produced and the amount of water the tread has to carry. The total water in each tread watershed is that which lands directly on the tread plus water that drains onto the tread from the surrounding upstream area. Note that the maximum possible flow from a severe storm must be handled without major damage to the trail, although some erosion should be expected. Lesser runoff events should cause no or minimal erosion. By making sure that each watershed is not excessively large, the damage caused by a larger storm can be controlled.

In most cases, the rainfall that causes the most erosion is that which falls on the tread itself. Compacted or hardened treads produce nearly significant runoff on the entire length and width of the tread. Grass-covered trails hold back more runoff and tend to be less erosive, However, these trails also are only suitable where use is limited. Placing crests closer together reduces the risk of erosion. Keeping the tread narrow and protecting it with adjacent vegetation also helps.

Using Structures in Sustainable Trail Building

Structures should be considered a last resort in sustainable trail building. Not only do they add to future maintenance costs, they take away from blending the trail into the scenery. However, they can contribute to the enjoyment of the trail, provide safe crossing of

waterbodies, and help mitigate drainage issues.

THE FIVE ESSENTIAL ELEMENTS OF SUSTAINABLE TRAILS

The design of sustainable trails begins during the planning phase. Sustainable trails follow the contour of the surrounding landscape, gradually climb, and direct water away from the trail. Regardless of trail type, your trail can be sustainably designed by following the International Mountain Bicycling Association's (IMBA) five essential elements of sustainable trails:

1. The Half Rule
2. The Ten Percent Average Guideline
3. Maximum Sustainable Grade
4. Grade Reversals
5. Outslope

1. The Half Rule

A trail's grade shouldn't exceed half the grade of the hillside or sideslope that the trail traverses. If the grade does exceed half the sideslope, it's considered a fall-line trail. Water will flow down a fall-line trail rather than run across it.

Measure the sideslope with a clinometer (we'll discuss how to do this shortly), the be sure to keep the tread grade below half of that figure in order to ensure good drainage. For example, if you're building across a hillside with a sideslope of 20 percent, the trail tread grade should not exceed 10 percent.

The half rule is especially important in gently clopping ares. A common mistake occurs when trails are routed down gradual slopes, based on the assumption that erosion won't be a concern in nearly flat areas. Yet, water will funnel down trails and cause erosion even on gentle slopes. A trail passing through an area with a mere 6 percent sideslope must have a trail tread grade less than half of that figure–only 3 percent–in order to escape the fall line.

There is an upper limit to this half rule: You must also apply knowledge about maximum sustainable grades. Very steep trails will erode even if their grade meets the half rule. For example a trail with a grade of 24 percent that traverses a steep, 50-percent sideslope may be unsustainable even though it complies with the half rule.

2. The Ten Percent Average Guideline

Generally, an average trail grade of 10 percent or less is most sustainable. Also called overall trail grade, average trail grade is the slope of the trail from one end to the other.

This does not mean that all trail grades must be kept under 10 percent. Many trails will have short sections steeper than 10 percent, and some unique situations will allow average trail grades of more than 10 percent.

For trails that undulate rather than climb or descend consistently, aver trail segment grade can be calculated for certain sections. For example, a trail that is relatively flat with only one small climb may have an average trail grade of only 2 or 3 percent. In this case, it would be more helpful to evaluate the average trail-segment grade in a critical climbing section only.

WHY 10 Percent?

Aids Planning

The 10 percent average figure provides a framework for sustainable design and can be very helpful when conceptualizing a trail. You'll be able to calculate the approximate length of trail needed to reach the top of a given hill at a sustainable grade, and you'll be able to plot possible trail corridors with sustainable grades on a topo map.

Applies to Most Soil Types

There are many types of soil and each has different qualities of cohesion and drainage. Some soils support steeper trail grades than others. By employing a 10-percent average, you won't need to rely on your soil identification skills. A 10-percent average grade is a trustworthy guideline for sustainable trails in all but the most unique soil conditions. (See page 84 for a more thorough discussion on soil.)

Minimizes User-Caused Erosion

Average grades of 10 percent or less help minimize erosion caused by users. Sustained grades of more than 10 percent can increase the amount of soil loosened by visitors who must work harder to travel up or down the slope. This loosened material is more easily carried off by water and gravity, resulting in a damaged trail.

Allows Design Flexibility

A trail that climbs at conservative grades allows flexibility in case there is an obstacle in the path. By staying at or below a 10 percent average, you can adjust the route without necessarily starting at the beginning or routing the trail too steeply to reach your targeted destination.

Helps Future Reroutes

Future reroutes are much easier if the average grade is roughly 10 percent. For example, if a trail with an average grade of 20 percent develops an erosion problem, a reroute around the problem area may require very steep grades or a switchback to reach the destination. When average grades are closer to 10 percent, there is greater flexibility for the trait's future.

Accommodates Undulations

Average grades of 10 percent allow the trail to rise and fall without resulting in overly steep sections. Visualize a trail climbing to a targeted destination at an average grade of 20 percent. The trail dips slightly to cross a drainage and then resumes climbing. Following the dip, the trail must now climb at 25 percent-an unsustainable grade-in order to reach the destination. A better design would have the trail climb at an average of 8 to 10 percent, with short sections of 15 percent when needed (as long as the sideslope grade is greater than 30 percent, to ensure the trail meets the half rule).

3. Maximum Sustainable Trail Grades

The 10 Percent Average Guideline advises that, generally, an average trail grade of 10 percent or less is most sustainable. But what about maximum grade?

Maximum grade is the steepest section of trail that is more than about 10 feet in length. When designing a trail, it is essential to determine early in the process the precise maximum trail grades the trail will be able to sustain in your local conditions. This target figure will help guide your layout and ensure sustainability. Although maximum sustainable trail grade is typically about 15 to 20 percent, it is site-specific and fluctuates based on several factors. The variables to be considered when setting your target maximum trail grade include:

- **Half Rule** A trail's grade shouldn't exceed half the grade of the sideslope. If the trail grade is steeper than half the grade of the sideslope, it is considered a fall-line trail.

  Note: the maximum sustainable grade on a gentle hillside will be half the grade of the sideslope.

- **Soil Type** There are many types of soil and each has different qualities of cohesion and drainage. Some soils will support steeper trail grades than others. See page 84 for a more thorough discussion of soil types
- **Rock Trail** grades can be steeper on solid rock. However, steep earthen sections between rocks may need to be fortified or armored to prevent soil loosening and erosion.
- **Annual Rainfall** Amount Trails in regions with either very high or very low annual rainfall may need to be designed with gentler trail grades. Lots of rain can lead to water-caused erosion. Low rain levels can lead to very dry and loose tread surfaces.
- **Grade Reversals** A grade reversal is a short dip followed by a rise, forcing water to drain off the trail. It is an essential technique for preventing water from channeling down the trail. Frequent grade reversals will allow for slightly steeper trail grades. We'll describe grade reversals more thoroughly in a moment.
- **Type of Users** Trails restricted to relatively low-impact visitors such as hikers and mountain bikers can sustain maximum grades as high as 15 to 25 percent for short distances depending on soil and rainfall. Trails open to visitors with higher impact, such as horses or motorized users, should have more gentle maximum grades.
- **Number of Users** Trails with high anticipated use may need shallower maximum trail grades.
- **Difficulty Level** Trails with a higher level of technical challenge may incorporate steeper grades, but construction techniques such as frequent grade reversals and armoring may be necessary to ensure sustainability.

4. Grade Reversals

A grade reversal is just what it sounds like-a spot at which a climbing trail levels out and then changes direction, dropping subtly for 10 to 50 linear feet before rising again. This change in grade forces water to exit the trail at the low point of the grade reversal, before it can gain more volume, momentum, and erosive power. Grade reversals are known by several different terms, including grade dip, grade brake, drainage dip, and rolling dip.

Frequent grade reversals are a critical and often overlooked element of sustainable trail design. Most trails will benefit from grade reversals every 20 to 50 feet, depending on soil type and rainfall. Bear this in mind: It's much easier to build a trail with grade reversals in it than to come back a year later and try to retrofit them into a poorly designed trail. For best results, incorporate them in your design from the start!

Grade reversals can help trails endure, even with minimal maintenance. Older trails often have a deeply compacted, concave trail

tread that collects water. With regular grade reversals, this water will only be trapped on the trail for a short distance before it can drain. Grade reversals effectively divide the trail into short, individual watersheds, so the drainage characteristics of one section of trail won't affect any other section.

Grade reversals also make a trail more enjoyable. For mountain bikers, long runs of constant grade encourage excessive speed on a downhill and they're boring on an uphill. Short climbing interludes on a downhill provide variety, challenge, and let cyclists get off their brakes for a bit. Brief descents mixed into long climbs help users regain momentum and catch their breath.

5. Outslope

As the trail contours across a hillside, the downhill or outer edge of the tread should tilt slightly down and away from the high side. This tilt is called outslope, and it encourages water to sheet across and off the trail instead of funneling down its center. Outslope is one reason why contour trails last for years and years. IMBA I Sheet Flow recommends that all trail treads be built with a 5-percent outslope. Outslope can be difficult to maintain in loose soils. Tires, feet, and hooves constantly compact the center of the trail and push loose soil to the sides, creating a concave tread. Frequent grade reversals are essential in order for water to drain in this situation.

CREATING QUALITY RECREATIONAL TRAILS

CONTROL TRAVEL SPEED THROUGH THE USE OF CURVES CLEARANCE, AND SIGHTLINES

Shaped curves and limited clearance and sightlines will tend to reduce travel speed. Sightlines should be long enough for safe travel at design speed but no longer. In particular, long, straight segments with wide clearances, long sightlines, and smooth treads tend to encourage faster travel for wheeled uses - which is fine if the trail is intended for that purpose . With natural trails, surface roughness and frequent changes in direction through natural shape - preferably in all three dimensions - also helps control speeds. A high tread texture is formed by:

- Rough and irregular tread surface
- Frequent tread dips and crests
- Native or imported rocks Any combination of these tread textures tends to improve sustainability of natural surface trails and encourage slower speeds for most types of uses .

TRAIL ETIQUETTE AND SAFETY

The planning and design of a multiple use trail system entails facility design that takes the needs of each user into consideration while also balancing the manner in which these different users encounter one another. Trail safety remains a priority concern while high quality visitor experience for all users is the ultimate goal. Despite all efforts at designing to prevent user-conflict, it is important to communicate expectations for trail etiquette in order to minimize negative experiences. By providing information through programs, media and signs, trail users become accustomed to how best to interact with other users, land owners and land managers which enhances the trail experience for everyone.

Following are guidelines for trail etiquette for multiple-use trails, developed by the Montana Chapter of the Continental Divide Trail Alliance. A broad coalition of user groups supported the effort:

Signage and wayfinding

A goal of any forest plan is a more complete, connected and user-friendly network of community trails.

Some barriers that keep people from using town forest trails include:

- Lack of navigation tools such as signs and maps.
- Lack of awareness about what facilities are available.
- Lack of people similar to them to go with.
- Perceived lack of safety.
- Fear of getting lost or being unprepared

Creating trails and trail connections may be a critical priority in the town forest, but providing the community with the tools to utilize the trails is an important and separate effort. A community must be provided the tools to be able to use the trail system without hesitation. These "tools" are the essence of a trails wayfinding program, which are made up of trail maps and signs guided by the following elements:

- Establishing a naming system for long continuous corridors.
- Establishing a hierarchy of trails to differentiate between corridors and shorter connections.
- Establishing a hierarchy of signs to differentiate between corridors and connections.
- Identifying and signing safe on-street routes to and from the forest

BUILDING TRAILS

The following outlines the basic step-by-step process for developing a natural surface trail. Typical trail-building steps include:

1. **Confirm property limits** to ensure that the trail is being built on the forest.
2. **Confirm trail users** to understand the exact trail requirements and the design parameters that must be applied. Refer to layout

and difficulty section for design.

3. **Layout the trail** including desired places to visit and avoid. Loop configurations, trail flow, and rolling grade character are all important factors in creating an appealing trail.
4. **Flag the trail corridor** incorporating all of the desired features and creating a sequence of events that will make the trail interesting and meet the desired level of challenge. Remember that trail quality is closely related to how well the trail builders pay attention to detail design issues.
5. **Prepare a construction plan** which includes input of key participants and land managers to ensure that construction techniques and equipment used are well suited for the type of trail being built. Equipment selection is particularly important in that its size and maneuverability will be reflected in the final form of the trail. For example, an intimate hiking trail is often better built with hand tools then a mechanized dozer if keeping the trail narrow with limited disruption to the surrounding landscape is important.
6. **Construct the trail** following the construction plan and making sure that each section of trail is stable and sustainable before moving on to the next section. Avoid exposing extensive sections of the trail to erosion during construction .
7. **Formalize a management and maintenance plan** to ensure that ongoing maintenance is being considered at the point when the trail is being constructed. Routine inspections are especially important during the initial season or two that the trail is open to ensure that it is stable and sustainable. Problem areas should be immediately addressed before use patterns are established and realignments become more difficult.

Advice For All Shared Use Trails

RESPECT: Education about friendly respect for all users will diminish negative encounters on the trail for all users. It's a simple concept: if you offer respect, you are more likely to receive it.

COMMUNICATION: Let folks know you're there — before you're there.

YIELD APPROPRIATELY: Do your utmost to let your fellow trail users know you're coming - a friendly greeting is a good method. Anticipate other trail users as you ride around corners. Bicyclists should yield to other non-motorized trail users, unless the trail is clearly signed for bike-only travel. Bicyclists traveling downhill should yield to ones headed uphill, unless the trail is clearly signed for one-way or downhill-only traffic. In general, strive to make each pass a safe and courteous one.

RESPECT THE RESOURCE: Help protect your accessibility by playing nicely with your neighbors and treating trails with reverence. Always practice Leave No Trace ethics and pitch in to give back - pick up trash, volunteer on a trail project or become a member of your local trail club.

AVOID SPREADING SEEDS: Help keep weeds out of our forests. Noxious weeds threaten our healthy ecosystems and livelihoods. Stay on trails and designated roads, use weed seed free hay, check your socks, bikes and horse tails for hitchhikers when you get back to the trailhead.

BE INFORMED: Questions about where to ride, trail closures, outdoor ethics and local regulations are important to know before you head out on the trails. Contact your local land manager if you are unsure about what you can and can't do in a given area.

Photo: US Forest Service

MAINTENANCE GUIDELINES

The following maintenance guidelines provide general recommendations for monitoring and maintaining natural surface trails. The objective is to keep the trails sustainable and minimize adverse impacts such as compaction, displacement, and erosion. Note that the guidelines are generic and not a substitute for trail-specific maintenance procedures that respond to local site conditions, soils, types and levels of use, and other factors.

MONITORING AND INSPECTION SCHEDULE

Trail monitoring and inspection should occur throughout the year to detect potential maintenance issues before unsustainable conditions or safety concerns arise. The following table provides an overview of inspections that can be completed during each season.

Inspections Schedule

A routine inspection schedule is primary to staying on top of maintenance issues and taking care of problems at an early stage. The following suggests an overall seasonal approach to inspections .

SEASON	INSPECTION FOCUS
SPRING	Inspect for damage due to winter seasonal uses and freeze-thaw cycles. Check for erosion, plugged culverts, user- and maintenance vehicle-caused damage, unauthorized uses, and other visible signs of tread imperfections. Record all occurrences and schedule maintenance on a priority basis. Also clear debris from the trails as soon as possible in the spring
SUMMER	Conduct ongoing inspections to keep trail in a safe, usable condition. In addition to items listed for spring, also inspect vegetation growth and encroachment. Pay special attention to erosion issues, drainageways, and ditches that may have received heavy spring runoff. Record all problems and schedule maintenance on a priority basis.
FALL	Conduct ongoing inspections to keep the trail in a safe, useable condition. Focus on maintenance issues that should be taken care of before winter to avoid more damage during spring thaw . Special attention should be given to tread dips, drainage crossings, culverts, and drainageways that must be operational for spring runoff .
WINTER	This is good time of year to check low areas and drainages that cannot be easily accessed during the summer. This includes culverts, ditches, and beaver ponds .

GUIDELINES FOR GENERAL MAINTENANCE PRACTICES

Maintenance practices for natural surface trails falls into three basic categories.

Vegetation Management

Vegetation along the trail must be managed to maintain an acceptable clearance zone and preserve the integrity of the trail surface. This includes removal of encroaching vegetation by cutting and/or spraying of an approved herbicide by a licensed applicator . Cutting is the preferred method whenever possible, and the only acceptable approach in ecologically sensitive areas.

Where erosion has taken out vegetative cover, the cause should be addressed prior to restoration.

Routine Maintenance

Routine maintenance should be performed on natural trails to prevent simple problems from becoming unsustainable conditions. Routine maintenance typically includes:

- Finding and correcting problems while still small
- Predicting and preventing future problems
- Protecting tread from overuse and from uses the trail is not designed to accommodate
- Closing a trail during extremely adverse tread conditions, typically during spring breakup and other times when saturated soil conditions exist

Of the items listed, the last one is the most important in terms of preventive maintenance. Implementing agencies are encouraged to have set policies defining when trails are to be closed due to adverse tread conditions.

Trail Monitoring

Trail monitoring is typically done for four primary reasons:

1. To monitor for trail conditions that would present safety concerns for users
2. To determine relative amounts of use and use patterns
3. To determine impacts to the environment
4. To monitor for and immediately address any invasive plant incursions that occur along the trail

Trail monitoring will result in one time maintenance needs as well.

TRAIL MAINTENANCE ACTIVITIES

Routine maintenance and assessment of the entire trail network on a seasonal basis will keep trails clean, safe, and maintained at a high standard in both the short and long-term. Maintenance can include everything from removing downed trees to installing new drainage structures, to repairing steps or bridges. It also includes the upkeep of trail signage and parking, the removal of trash, and an assessment of trail conditions.

Vegetation

The following should be completed each season:

- Remove blowdown
- Brushing/clearing of overgrown sections
- Remove hazard trees
- Brush in herd paths/switchback cuts
- Remove leaf litter and weeds in tread
- For mountain bike trails this should be done in the Spring and Fall
- Mow and weed a two-foot buffer on each side (on appropriate trails)
- Remove invasive species

Drainage/Tread

The following should be completed each season:

- Clean waterbars, ditches, and dips (only in Spring and Fall)
- Clean culverts (only in Spring and Fall)
- Replace damaged drainage structures
- Install new drainage structures where needed
- Repair damaged tread, such as washouts, slumping, spot surfacing (only in Spring and Fall)
- Knock down outslope berms to maintain drainage (only in Spring and Fall)
- Restore backslope
- Remove markings on pavement trails
- Clean up transition areas where two types of surfaces meet
- Repair turnpikes and checkdams
- Repair frost heaves and cracks on paved trails
- Clear hazardous roots, stumps, and rockfall debris

Structural Maintenance

The following should be assessed yearly, and completed as needed:

- Repair or replace railings and guardrails
- Repair bridges and boardwalks
- Examine tread, railings, and ramps on these structures
- Replace bridges that exhibit structural damage
- Repair cribbing and retaining walls
- Repair or replace any steps that exhibit damage
- Repair or replace bicycle racks and parking that exhibit damage
- Clean any vandalized structures
- Repair light fixtures and replace light bulbs in fixtures
- Repair or replace gates, fences, fence posts, and sign posts that exhibit damage
- Repair or replace shelters that exhibit damage

Signage

The following should be completed each season:

- Replace any missing trail markers or signs
- Repair or replace damaged signs and sign posts
- Mark or blaze trails where needed
- Repair cairns where needed

Trailhead Parking

The following should be completed each season:

- Assess drainage and repair where necessary
- Repair and update maps and kiosks
- Replace missing or damaged signs
- Ensure trail can adequately be accessed from the trailhead

Trail Clean Up

Each season it is advised to get a volunteer crew out on the trail network to pick up litter. This can be done in conjunction with assessing damage and repair needs for the other maintenance categories.

TAKING ACTION ON UNSUSTAINABLE TRAILS

Occasionally, trails will become unsustainable due to poor design, improper use, or higher-than-expected use levels for the given classification. Whatever the cause, action is necessary to avoid further degradation of the trail and surrounding ecological systems. When an unsustainable threshold is reached, the options are to restrict use, reclassify, or decommission the trail.

Restricting Use of a Trail

Restricting use is one option when trails become unsustainable. Of all of the options, use restrictions offers the most flexibility in that they can be applied as warranted by a given situation. With respect to recreational pursuits, options for restricting use of trails and forest access routes include the following:

- Temporary closure to allow time to resolve the situation with user groups
- Limited restrictions on the type of use allowed on either a seasonal or specified time basis (e.g., closing an area for a year or two to allow it to recover)
- Full restrictions on a given type of use

Decommissioning a Trail

Decommissioning a trail simply means taking it out of use and restoring it to some semblance of the pretrail conditions. The goal is to enable nature to reclaim the site quickly and in a cost-effective way.

Renaturalizing Decommissioned Trail Corridors

Renaturalizing a decommissioned trail refers to restoring the ecosystem and surface drainage of the corridor to reasonably replicate its original condition. Renaturalization cannot fully restore a site to its pretrail condition, but it can significantly enhance natural ecosystem structure and function. Hence, site repair is important and should be performed at some level on all decommissioned trail segments .

General Renaturalization Considerations

Ideally, all decommissioned trail corridors should be renaturalized as thoroughly as possible to replicate surrounding natural systems. Realistically, major re-naturalization can prove difficult or even undesirable because of associat~d costs, risk of introducing exotic species, or risk of causing excessive damage during repair operations. Therefore, different parts of the same corridor can be repaired to varying standards depending on the extent of impact, location, and type of ecosystem. For instance, the ends of a decommissioned trail may be extensively repaired to restore the original landform and vegetation as much as practical, while in the center of the trail repair may simply involve stabilizing the site and encouraging natural vegetation succession with or without soil amendment, seeding, planting, or transplanting.

If the repair budget is limited, concentrate on stabilizing the most unstable sections, restoring the most visible or ecologically critical sections, and naturalizing sections that lend themselves to recovery. Volunteers may provide valuable assistance.

Limit Impacts of Renaturalizing Operations

The collateral impact of site repair should be kept to a minimum and generally not exceed more than 20 percent of the surface area being repaired. If the desired level of site repair would cause more extensive adjacent impact, a lower level of naturalization or an alternate means of repair should be used. For wet or fragile sites, consider working while the ground is frozen.

On deeply eroded trails too narrow to be repaired with ground machinery, or in sites where machine access would cause excessive further impact, ATVs and/or pack animals can sometimes be used without creating additional damage. Volunteers can also do small-scale site repair by hand or with ATVs (where appropriate) with minimal impact. Develop a Vegetative Management Plan

All renaturalizing activities should follow a vegetative management plan to encourage growth of native plants and control exotic species. The larger the impact area, the more comprehensive the vegetative management plan should be.

During excavation and new construction, organic soil should be stockpiled for revegetation. To be effective, the organic soil layer should be at least 4 inches thick and preferably match that of the surrounding undisturbed area.

Avoid Introducing or Spreading Invasive Plant Species

The following practices will limit the introduction and spreading of invasive plant species:

- Soil for fill should be obtained nearby to avoid importing invasive seeds or organisms
- All imported seeds and mulch should be certified as weed-free
- Hand-harvested native local seed and/or transplants can be used when restoring vegetation in highly sensitive areas or areas to be kept as biologically undisturbed as possible.
- Seeding a nurse crop that will die off over time can also help prevent exotic species from becoming established, especially if native seeds are seeded along with the nurse crop. The nurse crop creates a quick vegetative cover which improves germination and survival for slower-growing natives while occupying the ecological niche that might otherwise be filled with invasives
- In ecologically sensitive sites, all seeding can optionally be avoided, with revegetation relying on transplanting nearby plants, scarification, and natural regrowth
- The vegetative management plan should address invasive species eradication or control, including exotic species that are already be growing on the site

Nonvisible Decommissioned Trail Segments Brought to Various Levels of Renaturalization

Decommissioned trail segments not visible from any access point can be renaturalized to different levels depending upon the character of the site, the level of damage, and the risk of creating additional physical or ecological damage during repair. The following criteria should be used for determining which level is most appropriate for a given site:

- Stabilization at a minimum, this is required along the full length of decommissioned trails and surrounding areas. This includes adding drainage control and/or erosion control measures to prevent erosion from increasing; adding slash to eroded ruts to keep visitors out and create protection for seeds; and draining introduced mudholes
- Scarification should be performed where soil is compacted to the point where natural revegetation will be slow, stunted, or will likely consist mostly of weeds. This includes loosening of compacted soil by manual or mechanical means and partially restoring the predamaged landform by reshaping and/or through the use of erosion control devices. The soil surface is typically left relatively rough so seeds have many protected and moist niches in which to sprout. The area may or may not to be reseeded
- Naturalization - should be performed where accelerated revegetation, quick visual concealment of damage, and reestablishment of historic surface water movement is needed. This includes filling or reshaping trail ruts and site scars

to blend with or match the original landform; seeding with indigenous plants or transplants from the surrounding areas according to the vegetative management plan; covering bare soil with forest duff and fallen trees as appropriate using a natural pattern to seamlessly blend the site into the surrounding area; and planting or transplanting indigenous live trees of various age classes as appropriate for the ecosystem

Blend Trail Back Into the Original Landform

For naturalization and rehabilitation, the trail bed, trail ruts, and associated earthwork should be blended back into the original landform. In level areas, this often requires substantial filling of trail ruts and erosion.

On a sideslope alignment, the cutslope and fillslope (below the tread) should be considered impacts. Even if these slopes have revegetated, renaturalization may require pulling the fillslope back up onto the cutslope in order to restore the original surface drainage and landform. Since this creates a larger scar in the short term, the extent to which this should be done can be decided on a case-by-case basis. It can also be done intermittently so that some existing trees or plant species of concern can be preserved.

Vegetated berms, including superelevated curves on OHV and mountain bike trails, may form on one or both sides of many trail segments. These berms should also be considered as a site impact and be removed during renaturalization.

Remove Structures Requiring Ongoing Maintenance

Culverts, boardwalks, bridges, and other structures that are no longer needed or that will fail over time should be removed when a trail is decommissioned. Exceptions can be made for well-crafted structures or those of historic significance, such as stone bridge abutments or a stone-paved drainage crossing.

Reshape Stream Crossings and Creating Breaks in Floodprone Areas

When removing water crossing structures, the crossings should be reshaped to approximate the original channel and stabilize the stream-banks and approaches. If the decommissioned trail has any long fills across floodprone areas, removal of sections of fill should be considered to accommodate natural water fluctuation.

Backfill Decommissioned Trails With Material from New Trails

If a new trail is being constructed nearby, use excavated material to backfill the old trail as needed. Although some organic soil should be reserved for topping cuts and fills associated with the new trail, some can often be used for nearby site repair. Native plants salvaged from the new trail can also often be transplanted into the decommissioned trail. If heavy equipment is used, salvageable plants should be removed by hand and transplanted as quickly as possible. If plants have to wait, their soil should be kept moist. Plants should also be watered thoroughly after transplanting.

Photo: Liz Grades

NATURAL SURFACE TRAILS: NON-MOTORIZED

	Trail Corridor	Tread Width	Longitudinal Slopes	Cross Slope	Notes
Hiking (high challenge)	4' - 6' width, 8' height	12" - 24"	• 0 - 12% 15%+ for short segments with trail hardening	2% - 10%	Native material, variable surface, naturally occurring obstacles, trail structures minimal but can include steps/ladders, bridges, bog, bridges, walls, waterbars, grade reversals, turnpikes, and switchbacks.
Hiking (moderate challenge)	4' - 6' width, 8' height	18"- 36"	• 0 - 10% • 8% or less average grade • 12% -15% for short segments with trail hardening	2% - 8%	Native material, variable surface, naturally occurring obstacles, trail structures minimal but can include steps/ladders, bridges, bog, bridges, walls, waterbars, grade reversals, turnpikes, and switchbacks.
Hiking (Universal Access Trail)	6' - 12' width, 8'-12' height	36"- 60"	• 0 - 5% average • 5% - 8.33% for 200' Max between resting interval • 8.33% - 10% for 30' Max between resting interval • 10% - 12% for 10' Max between resting interval	2% - 3%	Firm and stable surface material. Generally imported but native material may be used if suitable. Generally free of obstacles. Passing spaces needed on trails with tread under 60"
Walking/Nature Trail	6' - 12' width, 8'-12' height	36"- 60"	• 0 - 8% • 5% or less average grade prefered, 10% max	2% - 5%	Native material, surface generally free of obstacles. Short loops, can include interpretive signage, benches for resting, boardwalks
Mountain Biking (easy)	4' - 8' width, 8'-12' height	24"- 48"	• 0 - 5% • 5% or less average grade • Short sections 10%-15%	2% - 5%	Native material, surface generally free of obstacles, unavoidable obstacles 2" or less. Singletrack trail can incorporate small structures or parallel trail features for skills advancement, bridges should be minimum 36" width
Mountain Biking (moderate)	4' - 6' width, 8'-10' height	18"- 36"	• 0 - 10% • 10% or less average grade for sustainable tread • 15% max for short segments with trail hardening	2% - 8%	Native material, unavoidable obstacles 8" or less. Singletrack trail can incorporate technical features, rocky sections, tree roots, and include berms, rollers, banked/insloped turns, switch-backs, rock gardens, drops, jumps, and so forth. Bridges should be minimum 24" width.
Mountain Biking (advanced)	4' - 6' width, 8' height	12"- 24"	• 0 - 12% • 10% or less average grade for sustainable tread • 15%+ max for short segments with trail hardening	2% - 10%	Native material, unavoidable obstacles 15" or less. Singletrack trail can incorporate technical features, rocky sections, tree roots, and include berms, rollers, banked/insloped turns, switch-backs, rock gardens, drops, jumps, and so forth. Bridges 24" or less, short sections may exceed criteria
Mountain Biking (uphill only route)	4' - 8' width, 8'-12' height	18"- 48"	• 2 - 5% • 5% or less average grade, 10% max	2% - 5%	Native material, surface generally free of obsta-cles, unavoidable obstacles 2" or less, usually benched/sidehilled with grade reversals before and after turns, climbing turns used on shallow slopes 7% or less, 20'+ radius. Steep climbing turns that follow the fall line should be avoided

		Trail Corridor	Tread Width	Longitudinal Slopes	Cross Slope	Notes
NST: NON-MOTORIZED	Equestrian	6′ - 8′ width, 8′-12′ height	18″- 48″	• 0 - 5% preferred • 10% or less average grade for sustainable tread • Up to 15% grade for no more than 200 feet	2% - 5%	Native material, surface generally free of obstacles, unavoidable obstacles 6″ or less. Structures such as steps will need wider landings (4′-5′) to accommodate the horses stride. Turns should have a radius of 5′-8′, climbing turns are easier for a horse to navigate than a regular switchback. Passing areas should also be used on steeper terrain.
	Multi-use (hike, bike, horse)	4′ - 8′ width, 8′-12′ height	18″- 48″	• 0 - 5% preferred • 10% or less average grade for sustainable tread • Up to 15% grade for no more than 200 feet	2% - 8%	Native material, variable surface, naturally occurring obstacles, trail structures minimal but can include bridges, berms, insloped turns, walls, grade reversals, turnpikes, and switchbacks. Structures such as steps will need wider landings (4′-5′) to accommodate the horses stride. Turns should have a radius of 5′-8′, climbing turns are easier for a horse to navigate than a regular switchback. Passing areas should also be used on steeper terrain.
NST: MOTORIZED	ATV/OHV Easy	6′ - 14′ width, 8′ - 10′ height	5′ - 6′ One Lane 9′ - 12′ Two Lanes	• 0 - 10% • 10% or less average grade for sustainable tread • 15% max for short sections	3% - 5% 8% max	Native material or imported gravel, surface generally free of obstacles, unavoidable obstacles 4″ or less. Intermittently rough Sections of soft or unstable tread on grades < 5% may be present Structures such as bridges should be a minimum of 6-1/2′ wide. 20′ minimum radius for climbing turns, no switchbacks.
	ATV/OHV Difficult	5′ - 10′ width, 8′ - 10′ height	4′ - 8′	• 0 - 10% • 10% or less average grade for sustainable tread • 25% max for short sections	3% - 8% 10% max	Native material, minimal imported gravel, surface can be rugged with embedded rock, holes, and protrusions up to 6 inches, Sections of soft or unstable tread on grades < 5% may be common and continuous, Structures such as bridges should be a minimum of 5′ wide. 15′ minimum radius for climbing turns, switchbacks only when absolutely necessary

		Trail Corridor	Tread Width	Longitudinal Slopes	Cross Slope	Notes
WINTER NON-MOTORIZED	Snowshoeing	4' - 6' width, 8' - 10' height	18"- 48"	• 0 - 12%	2% - 8%	Snowshoe trails are compatible with most other summer natural surface trails. They can be on grooomed, packed or loose snow surfaces, which may be shared with xc-skiers.
	XC - Skiing	6' - 12' width, 10' - 12' height	3' - 12'	• Easy 0-4% average grade, 10%-12% max hill grade • Intermediate 6%-12%, average grade, 12%-18% max hill grade • Advanced 12%+ average grade, 18%-40%+ max hill grade for short distances	2% - 5%	XC_trails can be single or bi-directional with enough terrain variation for interest based on ability level. Trail surface can be on grooomed, packed or loose snow. In general ensure sight distances of 50 feet and 100 feet on downhills and tight curves. Bridges should be 6' - 12' wide, avoid placing at the bottom of a steep hill. Provide a runout. Curves should be wider than other trail types with a radius of 20' min - 100'.
	Fat Biking	4' - 6' width, 10' - 12' height	18"- 48"	• 0 - 5% • 5% or less average grade • Short sections 10%-15%	2% - 5%	Similar to singletrack although the bench should be slightly wider to accommodate a groomer in the winter. Mechanically groomed, the hard packed trail is approx 20" wide. Turns should be wider and flatter than typical singletrack to accommodate the grooming machine, 25' Radius works well for most situations.
WINTER MOTORIZED	Snowmobiling	6' - 22' width, 8' - 12' height	4' - 14'	• 0 - 8% average grade • 10% or less preferred for safety and sight lines	2% - 5%	Snowmobile trails generally have a uniform natural surface base that will create a better riding experience and hold snow longer in the season, grass helps hold snow and prevent erosion. Bridges should be 8' minimum width, 12' is ideal. Curves should be gentle especially at higher speeds. Provide a 50' minimum turning radius. Sight lines needs will vary based on speed at road crossings from 100' minimum to 600' + on roads that are posted 55 MPH

*Trail Matrix and Profiles draw from the following standards:

- Trail Solutions: IMBA's Guide to Building Sweet Singletrack (IMBA, 2004)
- Guidelines for Quality Trail Experience (IMBA, 2018)
- Trail Construction and Maintenance Notebook (U.S. Forest Service, 2007)
- Trail Planning, Design, and Development Guidelines (Minnesota Department of Natural Resources, 2007)

Photo: US Forest Service

HIKING TRAIL

(HIGH CHALLENGE)

Trail Character

A rugged natural surface trail that varies in difficulty and responds to the surrounding terrain. Generally found in and around areas of natural interest such as woodlands, meadows, streams, scenic vistas, and areas with wildlife viewing opportunities. High challenge trails tend to be longer in length (5+ miles) providing an opportunity for solitude and physical challenge. Natural obstacles are common within the treadway. Structures are minimal but can include steps/ladders, bridges, bog bridges, boardwalks, walls, waterbars, grade reversals, turnpikes, and switchbacks. Route finding signs and markers needed.

Photo: US Forest Service

Photo: US Forest Service

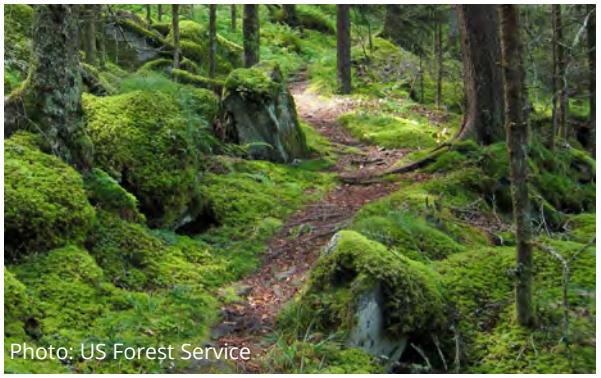


Photo: US Forest Service

Trail Profile

Tread Width
12”-36”

Corridor Width
4’ - 6’

Corridor Height
8’

Longitudinal Slope
0 - 12%, 10% or less average grade for sustainable tread, 15%+ for short segments with trail hardening

Cross Slope
2%-10%

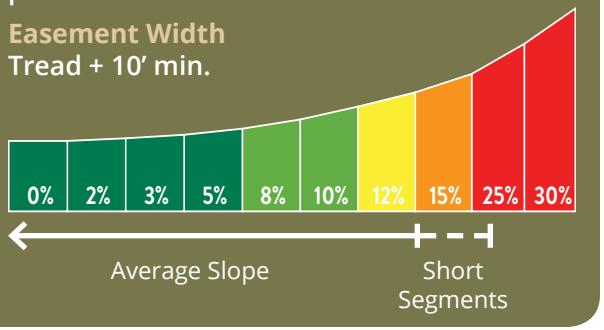
Construction/Material
Soil, Native Material (wood, rocks) Generally hand built, sometimes small machines are used

Turn Radius
N/A

Sight Lines/Distance
Limited/Varies

Accessibility
N/A, Steeper slopes and many obstacles present

Easement Width
Tread + 10’ min.



HIKING TRAIL

(MODERATE)

Trail Character

Slightly less rugged than the high challenge hiking trail with more moderate slopes. Slopes average 8% or less. Generally found in and around areas of natural interest such as woodlands, meadows, streams, scenic vistas, and areas with wildlife viewing opportunities. Loop trails that provide some physical challenge are preferred (2-5 miles average length). Obstacles are still present in the treadway but generally smaller and less numerous than high challenge hiking trails. Structures are minimal but can include steps/ladders, bridges, bog, bridges, walls, waterbars, grade reversals, turnpikes, and switchbacks.

Photo: US Forest Service

Photo: Tahawus Trails LLC

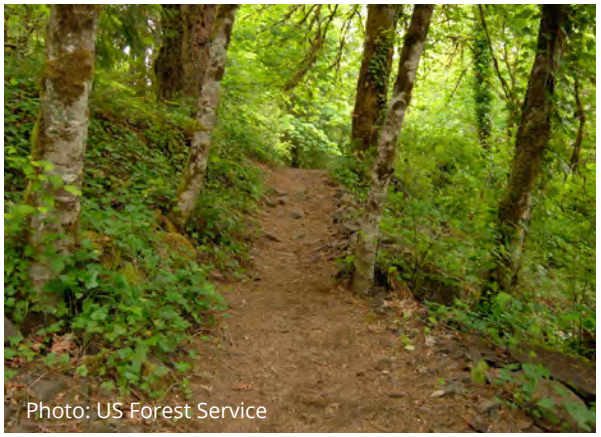


Photo: US Forest Service

Trail Profile

Tread Width
18”-36”

Corridor Width
4’ - 6’

Corridor Height
8’

Longitudinal Slope
0 - 10%, 8% or less average grade, 12% -15% for short segments with trail hardening

Cross Slope
2%-8%

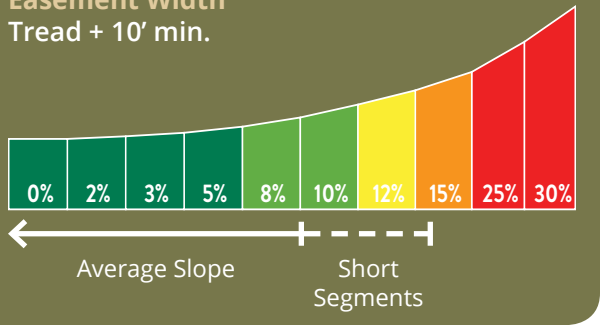
Construction/Material
Soil, Native Material (wood, rocks) Generally hand built, sometimes small machines are used

Turn Radius
N/A

Sight Lines/Distance
Limited/Varies

Accessibility
N/A

Easement Width
Tread + 10’ min.



HIKING

(UNIVERSAL ACCESS)

Trail Character

Universal access trails provide recreational opportunities for people of all ability levels allowing them to experience the natural environment and the many benefits it provides. While generally located on gentler terrain these trails should provide a variety of user experiences and take advantage of naturally occurring features along the route. These don't need to be lowland/ wetland only trails. Natural features such as changes in topography, views, waterways and other places of interest should be considered during layout.

Full guidelines can be found at:

USDA Accessibility Guidebook for Outdoor Recreation and Trails

https://www.fs.fed.us/recreation/programs/accessibility/pubs/pdfpubs/pdf12232806/pdf12232806Pdpi300.pdf


Photo: Tahawus Trails LLC


Photo: Tahawus Trails LLC


Photo: Tahawus Trails LLC


Photo: Liz Grades

Trail Profile

Tread Width
36"- 60"

Corridor Width
6' - 12'

Corridor Height
8'-12'

Longitudinal Slope
0 - 5% average, 5% - 8.33% for 200' Max between resting interval, 8.33% - 10% for 30' Max between resting interval, 10% - 12% for 10' Max between resting interval

Cross Slope
2%-3%

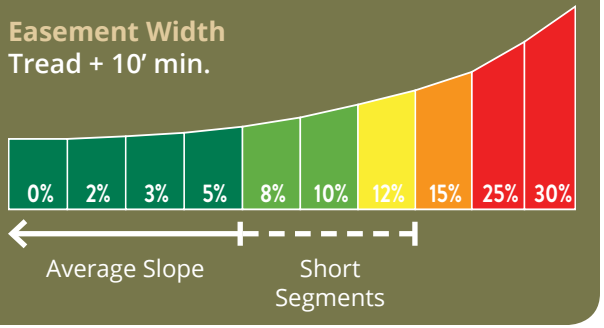
Construction/Material
Firm and stable surface material. Generally imported but native material may be used if suitable. Generally free of obstacles. Passing spaces needed on trails with tread under 60"

Turn Radius
Varies

Sight Lines/Distance
Varies

Accessibility
Follow USDA Accessibility Guidebook for Outdoor Recreation and Trails Standards

Easement Width
Tread + 10' min.



WALKING/NATURE TRAIL

Trail Character

Short natural surface trails located close to trailheads, nature trails are usually short loops under 1 mile that include interpretive signage. Located on gentle terrain, nature trails are similar in character to universal access trails although these trails do not need to adhere to Accessibility guidelines.


Photo: Liz Grades


Photo: US Forest Service


Photo: Tahawus Trails LLC

Trail Profile

Tread Width
36”- 60”

Corridor Width
6’ - 12’

Corridor Height
8’-12’

Longitudinal Slope
0 - 8%, 5% or less average grade prefered, 10% max

Cross Slope
2%-5%

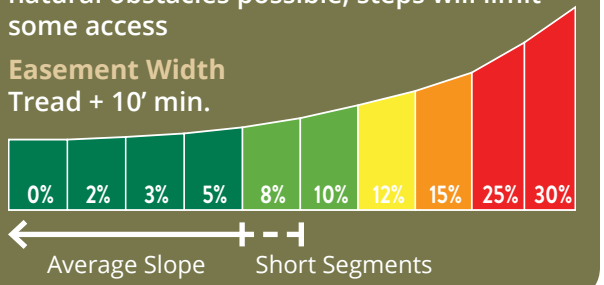
Construction/Material
Native material, surface generally free of obstacles. Short loops, can include interpretive signage, benches for resting, boardwalks, steps (wood or rock)

Turn Radius
N/A

Sight Lines/Distance
Varies

Accessibility
Generally provides universal access, some tread materials may not be firm enough, natural obstacles possible, steps will limit some access

Easement Width
Tread + 10’ min.



MOUNTAIN BIKING

(EASY)

Trail Character

Bike optimized trails incorporate sustainable trail design while providing a more tailored recreation experience. Many bike optimized trails follow a rating system based on ability level like used for ski trails. Easy (green circle) trails are characterized by mellow grades and a flowy, less technical layout that allow the user to experience the natural setting in a fun manner while also developing more advanced skills. Parallel trail features are a great way to provide interest for more advanced riders and allow for skill advancement. Stacked loop systems also allow for progression with the easiest trails located closer to the trailhead.


Photo: Barkeater Trail Alliance


Photo: Barkeater Trail Alliance


Photo: Barkeater Trail Alliance

Trail Profile

Tread Width
24”- 48”

Corridor Width
4’ - 8’

Corridor Height
8’- 12’

Longitudinal Slope
0 - 5%, 5% or less average grade, short sections 10%-15%

Cross Slope
2%-5%

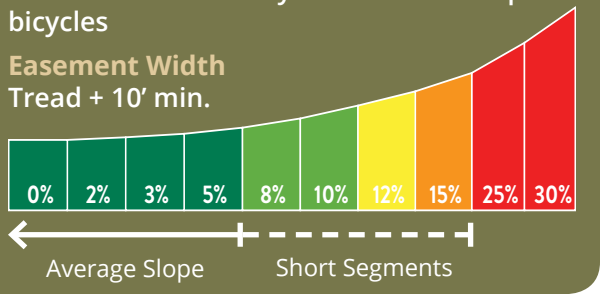
Construction/Material
Native material, surface generally free of obstacles, unavoidable obstacles 2” or less. Singletrack trail can incorporate small structures or parallel trail features for skills advancement, bridges should be minimum 36” width

Turn Radius
10’-15’ Insloped turns with grade reversals before and after turn, turns best located on slopes 25% or less, cribbing needed on steeper slopes

Sight Lines/Distance
10’-100’

Accessibility
Consider making trails 36”- 48” wide to accommodate handcycles or other adaptive bicycles

Easement Width
Tread + 10’ min.



MOUNTAIN BIKING

(MODERATE)

Trail Character

Singletrack rated moderate is a natural surface trail that is narrow in width and tend to wind around obstacles such as trees, large rocks and bushes. It often follows the natural contours of a site and can be flowing, but may also feature technical rocky sections, go over tree roots, and include berms, banked turns, switch-backs, hills, drops, jumps, and so forth. Most singletrack trails are bi-directional and allow for multiple user groups but one-way downhill/uphill only tracks can be used to provide a variety of user experiences. This can also help reduce congestion on popular trails.

Photo: BLM

Photo: Barkeater Trail Alliance

Photo: Barkeater Trail Alliance

Trail Profile

Tread Width
18”- 36”

Corridor Width
4’ - 6’

Corridor Height
8’- 10’

Longitudinal Slope
0 - 10%, 10% or less average grade for sustainable tread, 15% max for short segments with trail hardening

Cross Slope
2%-8%

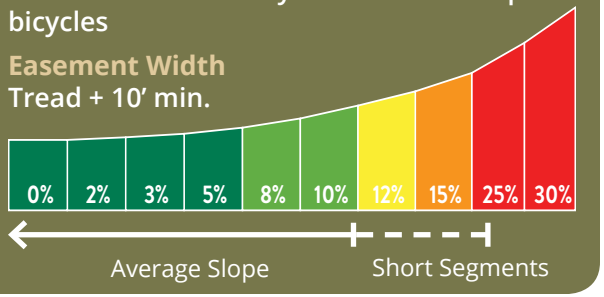
Construction/Material
Native material, unavoidable obstacles 8” or less. Singletrack trail can incorporate technical features, rocky sections, tree roots, and include berms, rollers, banked/ insloped turns, switch-backs, rock gardens, drops, jumps, and so forth. Bridges should be minimum 24” width.

Turn Radius
10’-25’ Insloped turns with grade reversals before and after turn, turns best located on slopes 25% or less, cribbing needed on steeper slopes

Sight Lines/Distance
10’-100’

Accessibility
Consider making some trails 36” wide to accommodate handcycles or other adaptive bicycles

Easement Width
Tread + 10’ min.



MOUNTAIN BIKING

(ADVANCED)

Trail Character

Advanced mountain bike trails are similar in design to easy and moderate trails. They incorporate sustainable trail construction practices but provide a more challenging experience for riders offering plenty of opportunities to test their skills. These trails can be technical or flowing to create an experience that touches on play, challenge, escape and risk.


Photo: Barkeater Trail Alliance


Photo: Barkeater Trail Alliance


Photo: BLM


Photo: Richmond Regional Ride Center

Trail Profile

Tread Width
12”- 24”

Corridor Width
4’ - 6’

Corridor Height
8’

Longitudinal Slope
0 - 12%, 10% or less average grade for sustainable tread, 15%+ max for short segments with trail hardening

Cross Slope
2%-10%

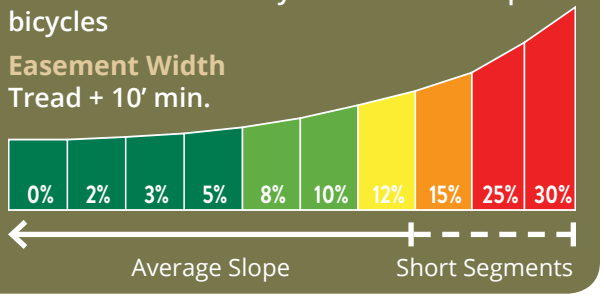
Construction/Material
Native material, unavoidable obstacles 15” or less. Singletrack trail can incorporate technical features, rocky sections, tree roots, and include berms, rollers, banked/insloped turns, switch-backs, rock gardens, drops, jumps, and so forth. Bridges 24” or less, short sections may exceed criteria

Turn Radius
10’-15’ Insloped turns with grade reversals before and after turn, turns best located on slopes 25% or less, cribbing needed on steeper slopes

Sight Lines/Distance
10’-100’

Accessibility
Consider making some trails 36” wide to accommodate handcycles or other adaptive bicycles

Easement Width
Tread + 10’ min.



MOUNTAIN BIKING

(UPHILL ONLY TRAIL)

Trail Character

Climbing trails are similar in character to singletrack trails but optimized for uphill traffic. Full bench construction is used to create a moderately smooth tread surface, gentle grades and turns that correspond to the surrounding terrain. Use climbing turns on sideslopes of 7% or less, for steeper slopes use a switchberm (see IMBA blog https://www.imba.com/blog/advanced-trail-building-introducing-switchberm) Steep climbing turns that follow the fall line should be avoided. Climbing trails are a core part of a directional trail system and can help reduce user conflicts. They allow for a separation between more gravity based downhill trails and are compatible with other users groups such as hikers and equestrians.

Photo: BLM

Photo: Mad River Riders

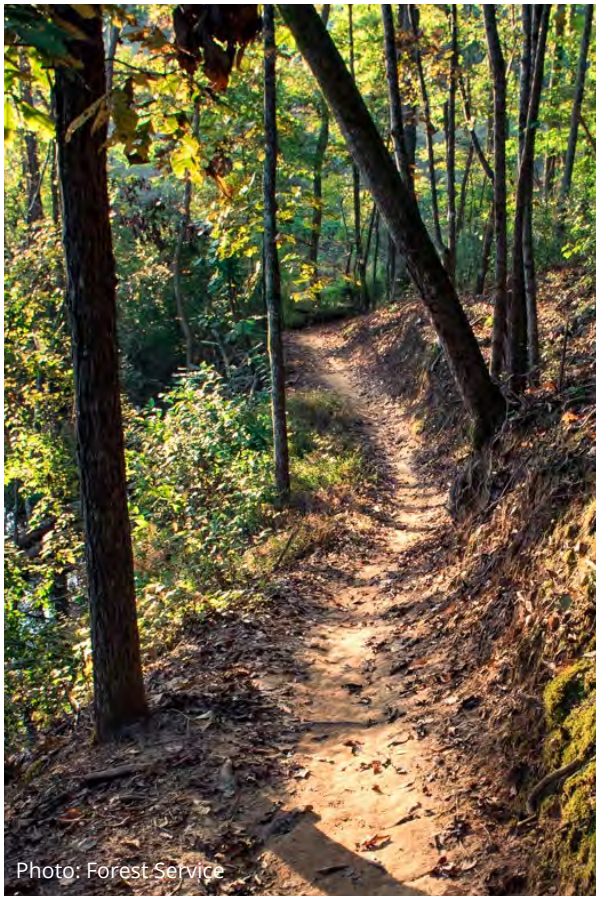


Photo: Forest Service

Trail Profile

Tread Width
18”- 48”

Corridor Width
4’ - 8’

Corridor Height
8’ - 12’

Longitudinal Slope
2 - 5%, 5% or less average grade, 10% max

Cross Slope
2%-5%

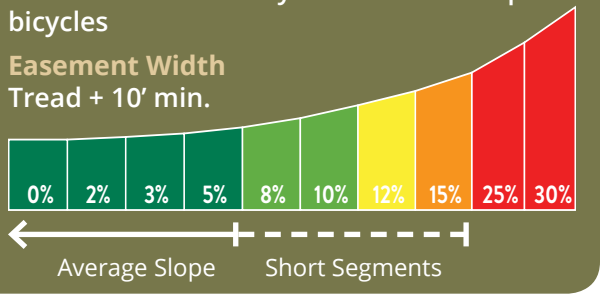
Construction/Material
Native material, surface generally free of obstacles, unavoidable obstacles 2” or less, usually benched/sidehilled with grade reversals before and after turns, climbing turns used on shallow slopes 7% or less. Steep climbing turns that follow the fall line should be avoided

Turn Radius
20’+ for climbing turns with grade reversals before and after turn. Use switchberms for steeper slopes with a 14’-18’ radius

Sight Lines/Distance
10’-100’

Accessibility
Consider making some trails 36” wide to accommodate handcycles or other adaptive bicycles

Easement Width
Tread + 10’ min.



EQUESTRIAN

Trail Character

Equestrian trails tend to be slightly wider with a larger clearing corridor to accommodate riders comfortably. While some trail users like rugged trails, most equestrian trails are built to accommodate the larger stride of the horse. Natural surfacing is preferred but some soils, such as fine silts and clay, may not be appropriate to support horse traffic. Imported material such as crushed rock fines can be used. Avoid hard surfaces such as exposed rock as it offers poor footing and can cause the horse to slip. Some trail features such as steps and turns are harder for horses to navigate safely. Steps will need wider landings (4'-5'), turns should have a radius of 5'-8'. Passing areas should also be used on steeper terrain. Sight lines are also important especially on shared use trails so the horses will not become spooked.


Photo: Liz Grades


Photo: Liz Grades


Photo: Forest Service

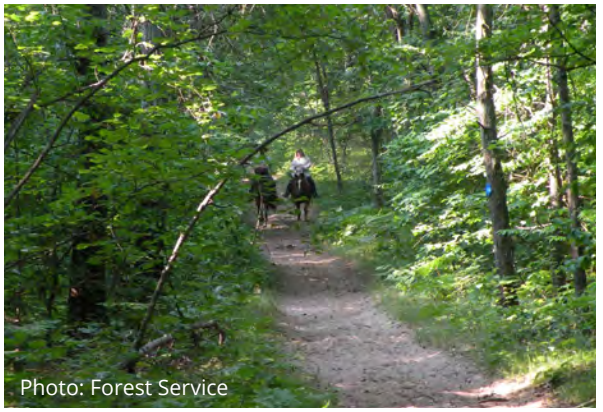


Photo: Forest Service

Trail Profile

Tread Width
18"- 48"

Corridor Width
6' - 8'

Corridor Height
8'- 12'

Longitudinal Slope
0 - 5% preferred, 10% or less average grade for sustainable tread, Up to 15% grade for no more than 200 feet

Cross Slope
2%-5%

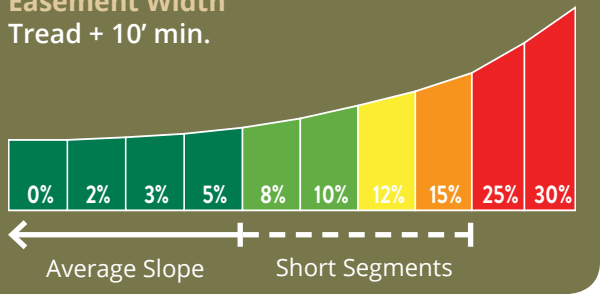
Construction/Material
Native material, surface generally free of obstacles, unavoidable obstacles 6" or less. Structures such as steps will need wider landings (4'-5') to accommodate the horses stride. Passing areas should also be used on steeper terrain.

Turn Radius
5' - 8' climbing turns are easier for a horse to navigate than a regular switchback.

Sight Lines/Distance
50'-100'

Accessibility
N/A

Easement Width
Tread + 10' min.



MULTI-USE TRAIL

(HIKE/BIKE/HORSE)

Trail Character

A multi-use trail that accommodates hikers, bikers, and horses must be built to meet the guidance for all user groups. For example, the trail should meet the minimum width for hiking, biking, and equestrian trails. Typically, the equestrian trails have the largest requirements for width and height.

Given the many user types on the trail, a wide tread and large turning radius are extremely important.

Some multi-use trails may only be built to accommodate hikers and bikers. See the above guidance for hiking and mountain biking trails to determine appropriate widths, heights, and slopes.

Photo: John Atkinson

Photo: Barkeater Trail Alliance

Photo: Liz Grades

Trail Profile

Tread Width
18”- 48”

Corridor Width
4’ - 8’

Corridor Height
8’ - 12’

Longitudinal Slope
0 - 10%, 10% or less average grade for sustainable tread, 15% for short segments with trail hardening

Cross Slope
2%-8%

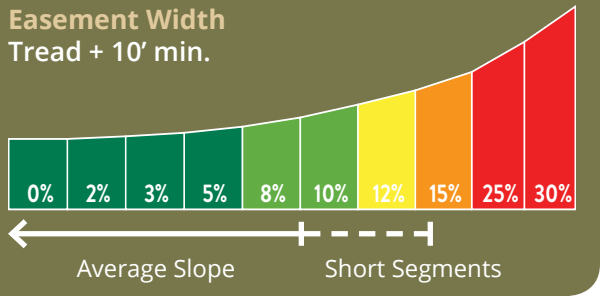
Construction/Material
Native material, variable surface, naturally occurring obstacles, trail structures minimal but can include bridges, berms, rollers, rock gardens, insloped turns, walls, grade reversals, turnpikes, and switchbacks

Turn Radius
10’-25’ Insloped turns with grade reversals before and after turn, turns best located on slopes 25% or less, cribbing needed on steeper slopes

Sight Lines/Distance
10’-100’

Accessibility
N/A

Easement Width
Tread + 10’ min.



ATV/OHV EASY

Trail Character

ATV/OHV trail construction should be based on the same sustainable trail principles used for non-motorized trails. They should follow a contour curvilinear alignment, control the linear grades by keeping them under 10%, integrate drainage by utilizing grade reversals, construct the surface using a full bench side hill avoiding flat areas as much as possible (they become muddy and rutted easily), provide a durable tread surface generally free of obstacles, and provide routine maintenance. Trails that follow these principles will provide a better riding experience and minimize degradation to the surrounding landscape.

Easy ATV/OHV trails should provide a fairly uniform surface for riders of all ability levels. They can be designed for one or two land travel with passing lanes provided.


Photo: Forest Service


Photo: Forest Service


Photo: Forest Service


Photo: Forest Service

Trail Profile

Tread Width
5’ - 6’ one lane, with 12’ passing areas provided frequently

9’ -12’ two lane

Corridor Width
6’ - 14’

Corridor Height
8’- 10’

Longitudinal Slope
0 - 10%, 10% or less average grade for sustainable tread, 15% max for short segments

Cross Slope
3%-5%, 8% max

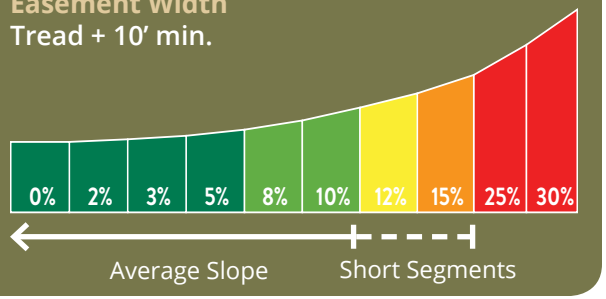
Construction/Material
Native material or imported gravel, surface generally free of obstacles, unavoidable obstacles 4” or less. Intermittently rough Sections of soft or unstable tread on grades < 5% may be present Structures such as bridges should be a minimum of 6-1/2’ wide.

Turn Radius
20’ minimum radius for climbing turns, no switchbacks

Sight Lines/Distance
50’-100’

Accessibility
N/A

Easement Width
Tread + 10’ min.



ATV/OHV DIFFICULT

Trail Character

Difficult ATV/OHV trails provide riders with a more challenging riding experience where they can test their riding skills. These trails should still follow sustainable trail principles but are often one lane with a rugged tread surface. Like mountain bike trails, stacked loop trail systems provide opportunities for riders of differing ability levels to challenge themselves on a variety of technical features. Challenging sections include features like rock gardens, short steep sections, short vertical curves, sideslopes that create the feeling of exposure, constructed mudpits with barriers to prevent widening, rough tread, log obstacles, and pinch points.


Photo: US Forest Service


Photo: US Forest Service


Photo: Ontario Travel

Trail Profile

Tread Width
4′ - 8′, passing lanes may be infrequent

Corridor Width
5′ - 10′

Corridor Height
8′ - 10′

Longitudinal Slope
0 - 10%, 10% or less average grade for sustainable tread, 25% max for short segments with trail hardening

Cross Slope
3%-8%, 10% max

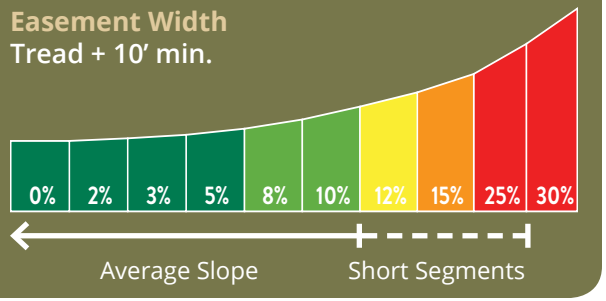
Construction/Material
Native material, minimal imported gravel, surface can be rugged with embedded rock, holes, and protrusions up to 6 inches, Sections of soft or unstable tread on grades < 5% may be common and continuous, Structures such as bridges should be a minimum of 5′ wide.

Turn Radius
15′ minimum radius for climbing turns, switchbacks only when absolutely necessary

Sight Lines/Distance
10′-100′

Accessibility
N/A

Easement Width
Tread + 10′ min.



SNOWSHOEING

Trail Character

Snowshoe trails are compatible with most other summer natural surface trails. They typically follow the path of summer hiking, equestrian, and mountain biking trails. They can be on groomed, packed or have loose snow surfaces. Wider snowshoe trails are often shared with cross-coutnry skiers. Signs indicating shared use trails should be used to help avoid conflicts and promote winter trail etiquette.

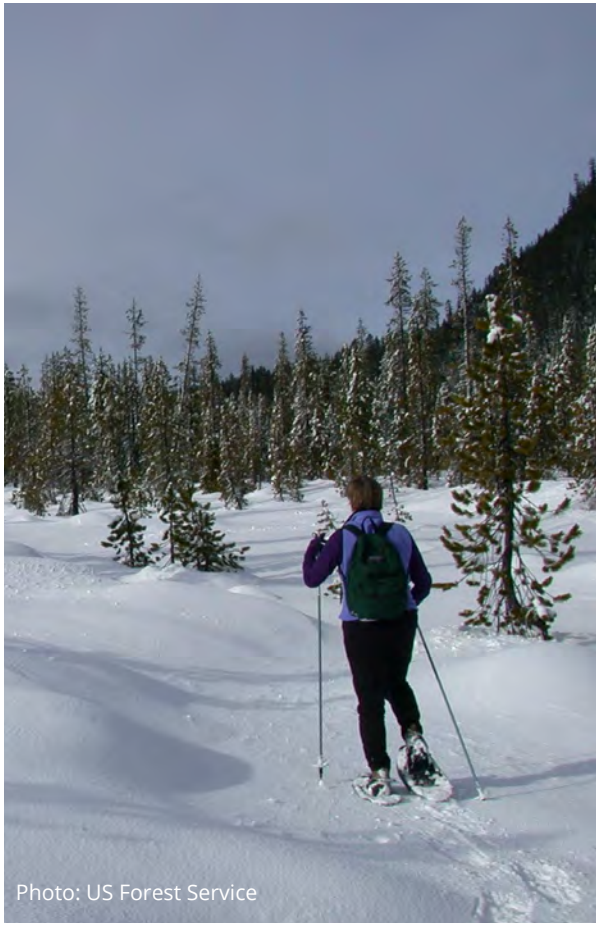


Photo: US Forest Service


Photo: US Forest Service

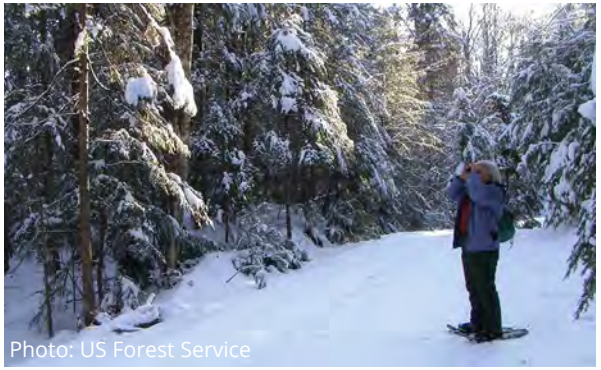


Photo: US Forest Service

Trail Profile

Tread Width
18″- 48″

Corridor Width
4′ - 6′

Corridor Height
8′ - 10′

Longitudinal Slope
0 - 12%

Cross Slope
2%-8%

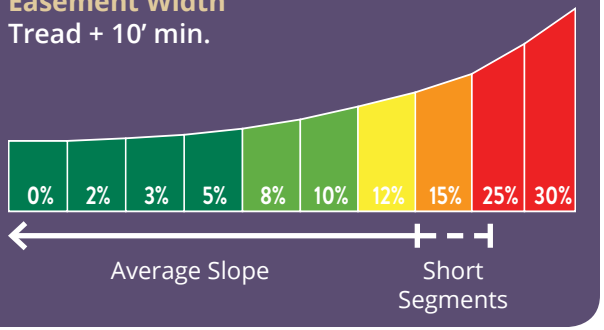
Construction/Material
Fresh, Packed or Groomed snow on natural surface trail. Seasonal use only trails can be a cleared corridor with undisturbed forest floor.

Turn Radius
N/A

Sight Lines/Distance
50′-100′

Accessibility
N/A

Easement Width
Tread + 10′ min.



XC-SKIING

Trail Character

Cross-country ski trails are winter snow trails that are typically wider than snowshoe trails. The trails can be groomed, packed, or loose snow. Although widths will vary, groomed trails should be wider to accommodate more skiers and faster speeds. Trails can be bi-directional or one way. One way trails are typically found on groomed trails systems on trail sections with steep slopes and sharp curves. The terrain, or the slope of the trail, determines the ability-level rating of the trail. In general ensure sight distances of 50' to 100' for downhills and tight curves. Bridges should be 6' - 12' wide, and should not be placedat the bottom of a steep hill. At the bottom of steep slopes, a run-out should be provided to help skiers stops. Curves should be wider than other trail types with a radius of at least 20'.

Photo: US Forest Service

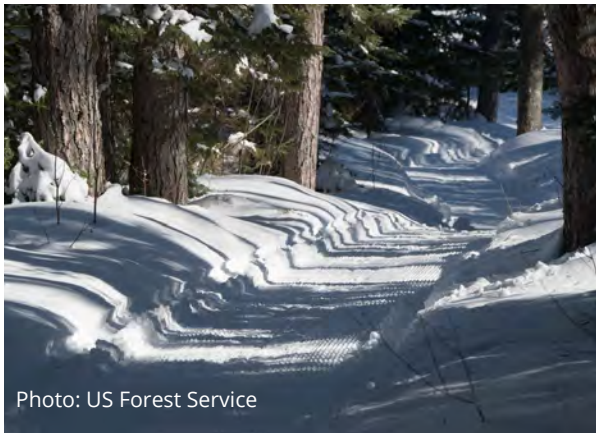


Photo: US Forest Service


Photo: Liz Grades

Trail Profile

Tread Width
3'-12'

Corridor Width
6'-12'

Corridor Height
10' - 12'

Longitudinal Slope
Easy 0-4% average grade, 10%-12% max hill grade; Intermediate 6%-12% average grade, 12%-18% max hill grade, Advanced 12%+ average grade, 18%-40%+ max hill grade for short distances

Cross Slope
2%-5%

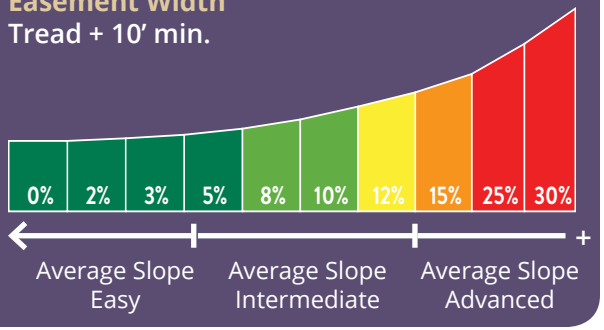
Construction/Material
Fresh, Packed or Groomed snow on natural surface trail. Seasonal use only trails can be a cleared corridor with undisturbed forest floor.

Turn Radius
20'-100'

Sight Lines/Distance
50'-100'

Accessibility
N/A

Easement Width
Tread + 10' min.



FAT BIKING

Trail Character

Fat biking is an emerging winter recreational activity and can be a part of existing summer trail systems. Fat biking is generally done on a groomed or packed snow surface. Most existing singletrack can accommodate winter fat bikes with minimal modifications to the corridor/bench width and turning radius if a grooming machine is going to be used. Fat biking trails that are mechanically groomed, should be at least 20" wide and a 25’ min turning radius. Single direction trails can be created with uphill only routes to ease conflict with other trail users. XC-Ski and snowshoe trails are also compatible with fat biking.

Photo: Visit Lakeland

Photo: Jeff Mose

Photo: Visit Lakeland

Trail Profile

Tread Width
18”- 48”

Corridor Width
4’ - 8’

Corridor Height
10’ - 12’

Longitudinal Slope
0 - 5%, 5% or less average grade, short sections 10%-15%

Cross Slope
2%-5%

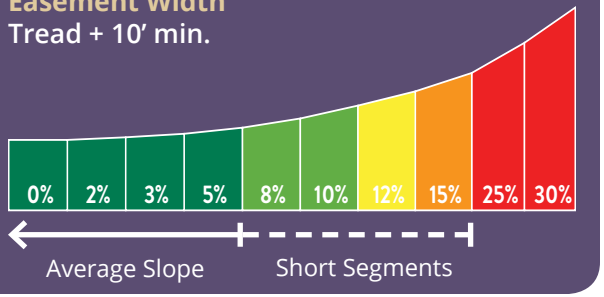
Construction/Material
Packed or groomed snow on natural surface trail. Compatible with other summer mountain bike trails. Can be co-located with xc-ski trails.

Turn Radius
25’ turning radius, possible to allow for grooming machine

Sight Lines/Distance
10’-100’

Accessibility
N/A

Easement Width
Tread + 10’ min.



SNOWMOBILING

Trail Character

There are generally two types of snowmobile trails in Vermont, corridor trails and secondary trails. Corridor trails are the main access routes in the system and tend to be wider allowing for two lanes of travel. Corridor trails are groomed and provide a uniform surface for riding. Secondary trails provide local connections to the main corridor trails. These trails may or may not be groomed and conditions may vary and be less uniform. Some considerations for snowmobile trails are to avoid steep slopes, provide drainage(avoiding places that hold water), avoid wetlands, avoid deer wintering areas, avoid elevations over 2,500', and avoid altering historic sites.


Photo: US Forest Service


Photo: US Forest Service


Photo: US Forest Service

Trail Profile

Tread Width
4'-14' or min width of grooming equipment

Corridor Width
6'-22'

Corridor Height
8' - 12'

Longitudinal Slope
0 - 8% average grade, 10% or less preferred for safety and sight lines, Steeper grades require run-outs as long as the slope to provide riders with enough space to control machines before a curve.

Cross Slope
2%-5% on hillsides all benched trails should be in-sloped for safety in icy conditions

Construction/Material
Fresh, Packed or Groomed snow on natural surface trail. A uniform surface is preferred, grass helps hold snow and prevent erosion, 8' minimum width for bridges, 12' is ideal

Turn Radius
50' min - 100' + preferred, the width of the trail will need to be wider at curves for grooming equipment and safe sight lines.

Sight Lines/Distance
100' min, up to 600' depending on trail speed and at road or rail road crossings

Easement Width
Tread + 10' min.