

APPENDIX C | Trail Design Standards

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DESIGN STANDARDS

The design of natural surface trails should consider the type of use and how developed or undeveloped the trail should be. The trail design standards summarized in this Plan are based on the USFS *2016 Trail Fundamentals and Trail Management Objectives*. Additional resources for trail design guidelines can be found on the USFS Trail Management Tools webpage: <https://www.fs.fed.us/managing-land/trails/trail-management-tools> and from national and state organizations promoting specific trail use, such as the Bureau of Land Management's *2017 Guidelines for a Quality Trail Experience*. The latter document is a good reference guide for developing sustainable mountain biking trails.

As of 2022, the USFS trail guidelines use the below elements to determine design parameters. It is recognized that the Tahoe National Forest (TNF) is modifying their trails program standards to vary from the USFS trail guidelines. These revisions will be considered as the County moves forward to develop County trail guidelines.

- **Trail Type:** The predominant trail surface (ground, snow, or water).
- **Trail Class:** The level of development, from minimally developed to fully developed.
- **Managed Use:** The mode of travel that is actively managed and appropriate for a trail. There can be more than one Managed Use.
- **Designed Use:** The single Managed Use of a trail that requires the most demanding design, construction, and maintenance parameters. In conjunction with the Trail Class, the Designed Use determines which design criteria apply to a trail.

Suggested guideline revisions from the TNF include:

Design Trail Grade

- **Target Grade** – The TNF has determined that for trails constructed on natural soil surfaces a maximum trail target grade of 5% with frequent drainages (every 100 feet or less) is optimal for long-term trail sustainability for all design use group categories and for an enhanced user experience. These lower target trail grades maximums would not apply to instances where trail segments are located on rock slabs or hardened trail (i.e., pavers blocks, placed natural rock).
- **Maximum Pitch Density** - The TNF would apply the Trail Class 4 percentage range guidelines to the lower Trail Classes for all the design use group categories.

Design Turn

- **BICYCLE Radius** – Trail Class 3 (increase to 6'-12') Trail Class 4 increase to (8'-12')
- **MOTORCYCLE Radius** - Trail Class 3 (increase to 6'-12') Trail Class 4 increase to (8'-12')

Drainage Design

- (Not in National Design Standards table) To minimize trail erosion on soil-based trails and the associated sediment delivery to stream courses trail drainage spacing should generally be no more than 100 foot apart. For new trails, drainages should be incorporated through the trail's alignment itself by utilizing a "curvy linear" design. The "curvy linear" design utilizes the terrain's side slope to create a reverse grade (low point in the trail tread) by undulating the trail's alignment [left and right] [up and down] about the trail's main contouring alignment and target grade. This design strategy not only minimizes water concentration on the trail, it also significantly reduces maintenance frequency as the trail alignment itself ensures the low points in the trail remain.

The figures on the following pages summarize the trail design parameters for the hiking, horseback riding, and mountain biking, as presented in the USFS's *2016 Trail Fundamentals and Trail Management Objectives*. Design parameters for other uses, such as all-terrain vehicles and cross-country ski, can be found in the primary document.



Example of a "Fully Developed" Trail (Class 5)



Example of a "Developed" Trail (Class 3)



Example of a "Minimally Developed" Trail (Class 1)

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Figure 1: Trail Design Parameters | Hiking

Designed Use Hiking		Trail Class 1 Minimal Development	Trail Class 2 Moderate Development	Trail Class 3 Developed	Trail Class 4 Highly Developed	Trail Class 5 Fully Developed
Design Tread Width	Wilderness (Single Lane)	0" – 12"	6" – 18"	12" – 24" Exception: may be 36" – 48" at steep side slopes	18" – 24" Exception: may be 36" – 48" at steep side slopes	Not applicable
	Non-Wilderness (Single Lane)	0" – 12"	6" – 18"	18" – 36"	24" – 60"	36" – 72"
	Non-Wilderness (Double Lane)	36"	36"	36" – 60"	48" – 72"	72" – 120"
	Structures (Minimum Width)	18"	18"	18"	36"	36"
Design Surface	Type	Native, ungraded May be continuously rough	Native, limited grading May be continuously rough	Native, with some onsite borrow or imported material where needed for stabilization and occasional grading Intermittently rough	Native with improved sections of borrow or imported material, and routine grading Minor roughness	Likely imported material, and routine grading Uniform, firm, and stable
	Protrusions	<24" Likely common and continuous	<6" May be common and continuous	<3" May be common, not continuous	<3" Uncommon, not continuous	No protrusions
	Obstacles (Maximum Height)	24"	14"	10"	8"	No obstacles
Design Grade	Target Grade	5% – 25%	5% – 18%	3% – 12%	2% – 10%	2% – 5%
	Short Pitch Maximum	40%	35%	25%	15%	5%
	Maximum Pitch Density	20% – 40% of trail	20% – 30% of trail	10% – 20% of trail	5% – 20% of trail	0% – 5% of trail
Design Cross Slope	Target Cross Slope	Natural side slope	5% – 20%	5% – 10%	3% – 7%	2% – 3% (or crowned)
	Maximum Cross Slope	Natural side slope	25%	15%	10%	3%
Design Clearing	Height	6'	6' – 7'	7' – 8'	8' – 10'	8' – 10'
	Width	>24" Some vegetation may encroach into clearing area	24" – 48" Some light vegetation may encroach into clearing area	36" – 60"	48" – 72"	60" – 72"
	Shoulder Clearance	3" – 6"	6" – 12"	12" – 18"	12" – 18"	12" – 24"
Design Turn	Radius	No minimum	2' – 3'	3' – 6'	4' – 8'	6' – 8'

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Figure 2: Trail Design Parameters | Horseback Riding

Designed Use Horseback Riding		Trail Class 1 Minimal Development	Trail Class 2 Moderate Development	Trail Class 3 Developed	Trail Class 4 Highly Developed	Trail Class 5 Fully Developed
Design Tread Width	Wilderness (Single Lane)	Typically not designed or actively managed for equestrians, although use may be allowed	12" – 18" May be up to 48" along steep side slopes 48" – 60" or greater along precipices	18" – 24" May be up to 48" along steep side slopes 48" – 60" or greater along precipices	24" May be up to 48" along steep side slopes 48" – 60" or greater along precipices	Typically not designed or actively managed for equestrians, although use may be allowed
	Non-Wilderness (Single Lane)		12" – 24" May be up to 48" along steep side slopes 48" – 60" or greater along precipices	18" – 48" 48" – 60" or greater along precipices	24" – 96" 48" – 60" or greater along precipices	
	Non-Wilderness (Double Lane)		60"	60" – 84"	84" – 120"	
	Structures (Minimum Width)		Other than bridges: 36" Bridges without handrails: 60" Bridges with handrails: 84" clear width	Other than bridges: 36" Bridges without handrails: 60" Bridges with handrails: 84" clear width	Other than bridges: 36" Bridges without handrails: 60" Bridges with handrails: 84" clear width	
Design Surface	Type	Native, with limited grading May be frequently rough	Native, with some onsite borrow or imported material where needed for stabilization and occasional grading Intermittently rough	Native with improved sections of borrow or imported material, and routine grading Minor roughness		
	Protrusions	<6" May be common and continuous	<3" May be common, not continuous	<3" Uncommon, not continuous		
	Obstacles (Maximum Height)	12"	6"	3"		
Design Grade	Target Grade	5% – 20%	3% – 12%	2% – 10%		
	Short Pitch Maximum	30%	20%	15%		
	Maximum Pitch Density	15% – 20% of trail	5% – 15% of trail	5% – 10% of trail		
Design Cross Slope	Target Cross Slope	5% – 10%	3% – 5%	0% – 5%		
	Maximum Cross Slope	10%	8%	5%		
Design Clearing	Height	8' – 10'	10'	10' – 12'		
	Width	72" Some light vegetation may encroach into clearing area	72" – 96"	96"		
	Shoulder Clearance	6" – 12" Pack clearance: 36"x36"	12" – 18" Pack clearance: 36"x36"	12" – 18" Pack clearance: 36"x36"		
Design Turn	Radius	4' – 5"	5' – 8'	6' – 10'		

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Figure 3: Trail Design Parameters | Mountain Biking

Designed Use Mountain Biking		Trail Class 1 Minimal Development	Trail Class 2 Moderate Development	Trail Class 3 Developed	Trail Class 4 Highly Developed	Trail Class 5 Fully Developed
Design Tread Width	Single Lane	6" – 12"	12" – 24"	18" – 36"	24" – 48"	36" – 60"
	Double Lane	36" – 48"	36" – 48"	36" – 48"	48" – 84"	72" – 120"
	Structures (Minimum Width)	18"	18"	36"	48"	60"
Design Surface	Type	Native, ungraded May be continuously rough Sections of soft or unstable tread on grades <5% may be common and continuous	Native, limited grading May be continuously rough Sections of soft or unstable tread on grades <5% may be common and continuous	Native, with some onsite borrow or imported material where needed for stabilization and occasional grading Intermittently rough Sections of soft or unstable tread on grades <5% may be common and continuous	Native with improved sections of borrow or imported material, and routine grading Stable, with minor roughness	Likely imported material, and routine grading Uniform, firm, and stable
	Protrusions	<24" Likely common and continuous	<6" May be common and continuous	<3" May be common, not continuous	<3" Uncommon, not continuous	No protrusions
	Obstacles (Maximum Height)	24"	12"	10"	8"	No obstacles
Design Grade	Target Grade	5% – 20%	5% – 12%	3% – 10%	2% – 8%	2% – 5%
	Short Pitch Maximum	30% 50% on downhill segments only	25% 35% on downhill segments only	15%	10%	8%
	Maximum Pitch Density	20% – 30% of trail	10% – 30% of trail	10% – 20% of trail	5% – 10% of trail	0% – 5% of trail
Design Cross Slope	Target Cross Slope	5% – 10%	5% – 8%	3% – 8%	3% – 5%	2% – 3%
	Maximum Cross Slope	10%	10%	8%	5%	5%
Design Clearing	Height	6'	6' – 8'	8'	8' – 9'	8' – 9'
	Width	24" – 36" Some vegetation may encroach into clearing area	36" – 48" Some light vegetation may encroach into clearing area	60" – 72"	72" – 96"	72" – 96"
	Shoulder Clearance	0" – 12"	6" – 12"	6" – 12"	6" – 18"	12" – 18"
Design Turn	Radius	2' – 3'	3' – 6'	4' – 8'	8' – 10'	8' – 12'