Trails are more than simply lines on a map, a form of transportation or route to destinations. Trails are an experience. Engaging trails systems provide a sense of unique place, highlight natural topography and attract outdoor-based tourism. A vast and varied experience hooks trails users and leaves them wanting to return for more exploration. This tool kit offers suggestions for building destination-worthy trail systems.

Greenbelt Trail in Costilla County (courtesy of Root House Studio)

Best Management Practices For Developing Trail Systems

Sustainability Simplified. Sustainable trails provide an intended experience in a steady state with minimal undesired impacts. Sustainability does not have to mean "sanitizing" or "dumbing-down" trails... yet, expect to hear that concern. Well-designed trail systems need not come at the detriment of natural resources. Trails can actually help protect resources by fostering appreciation for the great outdoors and by managing users to minimize impacts while maximizing fun. Four components of trail sustainability:

- **Physical:** Trails remains in intended condition with minimal erosion, braiding, or degradation.
- **Environmental:** Trails minimize disturbance to flora + fauna and sedimentation to watersheds. Planned trails systems—even with increased mileage—can yield less impact than existing conditions by keeping users on trail, reducing erosion and avoiding areas of greatest habitat sensitivity.
- **Social:** Trails meet recreational needs, provide a high-quality experience, limit user conflict, and yield a net positive influence to neighboring communities.
- **Managerial:** Trail and facility maintenance, risk management, and visitor education (and regulation) can be accomplished with available agency/partner resources. Visitors appreciate and support public lands.

Think in terms of Experience. Visitors rarely seek a trail just to get somewhere. It's about the experience they have en route—sure, it's cliché, but "the journey IS the destination". Identify the types and desires of intended trail users. Beyond scenery, consider how the following attributes will shape the trail experience:

- Character describes the tread ruggedness (smooth vs. rough-&-Rocky), corridor width (wide clearing vs. tight squeezes), frequency of undulation (rolling vs.. stead elevation changes), flow (fluid and rhythmic vs. tight and twisty) and the distinctive qualities of a trail or system.
- Challenge tests fitness and ability. Treat each as a different measure. Ability refers to technical aptitudes like sure-footedness, bike handling, scrambling or even navigation. Fitness refers to the capacity for sustained effort required for extended ascents, steep climbs, long mileage, or high altitude.
- Length may be measured in distance or time. It differentiates a quick spin from an all-day epic. Consider how the same mileage may result in a widely different outing time for different user modes or abilities.
- Variety gives visitors options within the general theme of a trails system ... similar to a "choose you own adventure novel". It'll accommodate wider range of visitors and encourage them to return. For locals, it keeps local trails interesting.

Embrace Your Place. Trails consist of variable materials found in a variable natural setting. Use this variability to influence the character of the trail. Follow contours of site topography and mimic terrain features to show off the setting. Further enhance sense of place by incorporating cultural resources like or pictographs or community cues. In Bend, OR, local trail intersections are roundabouts with small sculptures ... just like the town's streets.

Be System-atic. It is possible accommodate a variety of users—and even experience—in the same trail, yet it is very difficult to meet all user desires in only one or two trails. Cover this spectrum by planning a full Trail System and designing each trail to provide a subset of complimentary user desires. A Stacked Loop system organizes trails into an interconnected network that allows users to self-select their outing and even helps reduce conflict. (Insert graphic: Stacked Loop Trail System)

Identify Control Points. Control points are locations that influence where trails go. Positive control points are places you want to take visitors: trails heads, vistas, points of interest, durable surfaces, mountain passes, etc. Negative Control Points are places to avoid: boggy areas, private property, natural and cultural sensitivities, safety hazards, etc. Control points occur on each macro and micro scales.

Resist Erosion with Rolling Contour Trails. User forces and water loosen and wash soil away from the tread. Steep grades, heavy use, incohesive soils and situations when water can focus on the trail hasten the process—degrading a once fun trail into rut. The solution is trail design that allows frequent, subtle drainage and adjusts trail grade—usually less than 10%—to fit the site's cross-slope and soil type. Such "Rolling Contour Trails" generally traverse slopes in an undulating fashion.

Lookout Mountain (courtesy of Root House Studio)

Understand User Conflict. Collisions and altercations are rare on most trails. Most "User Conflict" stems from one user or group interfering with the experience of another user. Common complaints include being startled or having too many interactions with other visitors; frequently this is between users traveling at different rates. Conflicts can be reduced by spreading out users, communicating expectations, designing to consider sight lines + speed, and in some cases, providing separate trails tailored to different user types.

Intuitive Navigation. A maze of unmarked trails and a hand-drawn map appeals to a very narrow group. Strive to make navigation intuitive and support it with tactics such as maps, signage, GPS downloads, difficulty ratings and even intersection design. Don't forget trail markers for winter use. The frequency and nature of navigational aids should support risk management strategies and be consistent within each system and with user expectations. In trail systems with multiple intersections, a trail markers will save trail users from frequent map checks.

Shared Use or Single Use? The principles of sustainable trails are consistent across multi-use, natural surface trails and provide a baseline for quality recreation. However, "Preferred Use" trails create opportunity to tune and optimize the trail for a given user experience, such as a mountain bike "Flow Trail". Consider Preferred Use trails once a baseline inventory of multi-use trails is established or to fill an un-met recreational need that requires exclusive access.

Get Hooked on Progression. People are more likely to return to a trail if they enjoy it the first time. Similarly, they are more likely to stick with an activity if they notice themselves improving and see a path to further gains. Build a spectrum of opportunities for incremental challenge and exploration. Progression keeps locals engaged and visitors returning.

What about Winter? Get double-duty out of trails by planning for winter uses such as Nordic skis, fat bikes, snowshoes and snowmobiles. Optimize some trails for a given use. For example, keep snowshoes and bikes off select ski-tracks or groom some roads for skate skiing. Having trail systems at various elevations and on various aspects improves trail availability during "mud season".

Convert Roads to Trails. Logging or mining roads were designed for efficient resource extraction, not long-term sustainability or enjoyable recreation. Where roads are generally along the contour, they can be successfully converted to meandering, undulating trails via a combination of earthmoving, placing anchors, and revegetation. Often it may be more cost-effective to reclaim the road and build a new sustainable trail.

Spice it up with Special Treatments. To reach destinations, avoid sensitive areas, or meet user desires, segments of trails may fall outside accepted "rolling contour" guidelines. A quiver of construction techniques exists for such situations. Armoring can harden wet areas, resist erosion on steep pitches and provide texture. Anchors and obstacles add challenge while keeping users on trail. Climbing turns, switchbacks, steps and walls help achieve elevation change and navigate rugged terrain. Use these treatments sparingly since their construction can be expensive and user desires can shift over time.

Cultivate Partners + Funding. Involve stakeholders in early planning stages to create a shared vision and set the expectation that they'll commit to roles even after trails are built. Volunteer organizations can build both trails and a network of funding sources. Public land agencies can collaborate to gain benefits of a larger land base. Partners that could assist with trail projects include:

- Wildlands Restoration Volunteers
- Colorado Mountain Club
- Volunteers for Outdoor Colorado
- Colorado Fourteeners Initiative
- High Valley Trails Riders (IMBA Chapter)
- Southwest Conservation Youth Corps
- Silverthread Outdoor Club
- Del Norte Trail Group

A trail traversing the alpine (courtesy of Heather Salaz)

Trail Development Checklist

A San Luis Valley community wanting to create, maintain or expand its opportunities for trail-based recreation should consider the following steps to speed its progress toward destination-worthy trail systems:

- **Assemble a Project Team.** Form a small group to define the project, start building support and gathering resources. Members may include land mangers, key stakeholder groups, community liaisons and professional experts.
- **Inventory + Assess Existing Trails.** Create an inventory of designated “system” trails and user-created “social” trails. Note which trails meet which recreational needs. Study the condition, sustainability, and difficulty of trail segments. Map it for a big-picture view.
- **Wish List:** Identify the types of recreation and the spectrum of experiences you wish to provide. Solicit input from stakeholder groups and public outreach. Consider trail character as well as difficulty and length. Compare it to current inventory and to nearby trail systems. Plan a continuum of challenge and exploration to keep users engaged and visitors returning for more.
- **Plot Points + Draw Lines:** Study maps to identify parcel boundaries and understand topography. Plot Control Points and Conceptualize new connections and trail experiences. Use broad strokes to capture the intent … the actual new trail usually looks different.
- **Flag It:** Ground-truth trail concepts and layout conservative corridors that blend with natural topography. Field work with a clinometer and GPS is critical. After “ologist” reviews and approvals, refine the corridors and design specific alignments based upon the intended trail experience. Volunteers and local staff learning alongside professionals feel ownership and become a perpetual resource.
- **Build It:** Phased trail development keeps visitors coming back to explore the “New Stash” and meters the blend of trail opportunities. Professional trail contractors can build trail quickly and tackle heavy lifting. Volunteers can produce a high-level of finish and stay atop maintenance. A “Hybrid Construction” approach builds both trails and community. Ensure the finished product matches expectations by clearly specifying the intended trail character and classification, expected usage and physical metrics.
- **Keep Momentum:** Maintain existing trails so they continue to provide the intended experience. Showcase fun trails as incremental progress to a larger plan and build more support. Maps may need frequent updating … and tell your story of progress.

Costs estimating for trail development

The following costs are provided as planning-level information to aid in developing and defining trail projects and projecting budgets for grant applications. The cost estimates reflect the expected typical conditions for terrain in San Luis Valley and are based on present trends. That said, the SLV spans a wide variety of terrain so trail project costs will vary depending on topographic features and soil conditions.

Trail Planning, Design, Engineering

Trail Planning and Design services:
$1,500-5,000 per mile.

Key factors influencing cost:

- Tasks in scope (ex: inventory, condition assessment, natural resource assessment, concept plan, corridor layout, alignment design, construction specifications)
- Extent of public input
- Number of alternatives or revisions desired
- Terrain and accessibility
- Extent of existing trails

Natural Surface Trails (multi-use, non-motorized)

Trail character varies as wildly as the terrain trails traverse. Trail construction costs reflect this range: typically **$15,000 – 40,000 per mile** of natural surface singletrack.

Key factors influencing cost:

- Terrain and soil type
- Desired character of trail or class specification (ruggedness, width, etc)
- Allowed construction methods, seasons
- Level of finish and naturalization
- Access to site and proximity to staging/lodging

Costs of typical trail treatments / structures:

- Armoring (tread hardening): $150-250 / square yard
- Switchbacks / Reinforced Turns: $1000-2500 ea
- Steps: $100-200 ea
- Retaining Walls: $30-50 / square foot of surface
- Causeway / Boardwalk / Puncheon: $100-250 per linear foot
- Pre-Fab Steel / Fiberglass Bridge: $1000-1500 per linear foot

Terrain and soil have large effects on cost: loamy soil on moderate cross-slope tends to be cheaper while steep hillsides of rock and deep duff tend to be expensive. Locating trails in flat areas or on poor soils can require hardening or structures that add expense. In difficult conditions, a hand-built trail in a remote area, through rocky terrain and possibly structures or blasting can mean a trail that costs over $100,000 per mile. In the easiest scenarios, with copious skilled volunteers, trail construction can cost less than $5,000 per mile. Estimates are construction costs and do not include planning, design, engineering or permits.

Tip: For long-term success, select trail character and width to meet management objectives and fit the setting, rather than hit target construction costs. Width and cost: a 12-18” wide hand-built trail may cost about the same as a 36-48” machine-built trail through similar terrain. However, a 48” hand-built trail would be more expensive.

Lookout Mountain trails in Del Norte (courtesy of Root House Studio)

Multi-use Trails (hard surface or crusher fines)

In some cases paved, concrete or crusher fines trails may be desired. These trails surfaces provide for universal access and can accomodate significant volumes of users including hikers, walkers, runners and cyclists. Typically, multi-use greenways or bike paths are either hard surface (concrete or asphalt) or crusher fines.

HARD SURFACE TRAILS			
	Item Unit	Unit Price	Notes
Asphalt Trail Section (2" thick)	Square Yard (SY)	$13.50	Ton price varies based on $105 per ton - this will vary
Asphalt Trail Section (3" thick)	SY	$18.50	
Concrete trail (Bikeway/Shared Use Path - 6" thick)	SY	$40.00	
Stabilized Grass (reinforced)	SY	$105.00	
Base course/crusher fines (6" thick)	SY	$7.00	
Retaining walls (gravity block/MSE type)	Square Foot (SF)	$43.00	Based on gravity "ready rock" type wall
Pre fab bridge 10' wide - 50 foot span - includes abutments	each	$90,000	Approximately $150 SF for a pre-fab bridge for greenways, etc.
Pedestrian Bridge	SF	$300	Based on CDOT average costs.

Motorized Trails

Motorized trails employ the same basic design principals as non-motorized, multi-use trails. To resist the forces of acceleration, consider flow and where additional tread hardening or anchoring may be required. Like all trail design, the costs are largely influenced by terrain, armoring needs, quantity and remoteness:

Motorcycle Singletrack: **$20,000-$40,000 / mile.**
Estimate assumes 18-36 inch width, often machine-cut with hand finish and sections of entirely hand-built. Tread ruggedness can vary dramatically and challenging sections may require anchors to keep users on trail.

Concrete, multi-use and accessible trail leading to the Rio Grande in Alamosa (courtesy of Root House Studio)

ATV Trails: **$15,000-25,000 / mile.**
Assumes 5-6 foot wide, often machine-built with minimal hand-finish work.

Purpose-Built Mountain Bike (MTB) Facilities

Terrain, soils and proximity are key influencers of trail cost. “Features” refer to sections of enhanced and playful challenge added in or alongside trails or in bike parks. Features may fully fabricated (wood and/or steel) or enhancements of naturally occurring rocks, logs, etc. Downhill trails are considered to be highly challenging, minimally finished (raw), rugged routes utilizing natural features and are generally shuttle accessible; rocky terrain is often preferred. Estimates are construction costs and do not include planning, design, engineering or permits.

	Typical construction cost per mile
Purpose-Built MTB Singletrack	**$ 15,000-40,000**
Flow Trail	**$ 25,000-40,000**
Flow Trail with Features	**$ 35,000-70,000**
Downhill Trail	**$ 20,000-40,000**
Downhill Trail with Features	**$ 25,000-70,000**

Purpose-built mountain bike trails are designed for bike riding and allow for a fast and flowy trail experience.

Downhill trails (left) are typical technical with man-made jumps and natural obstacles the rider must skillfully navigate. Flow trails (right) are gravity-oriented trails filled with banked turns, dips, and jumps.

Pump track (left) and a bike skills area (right). A bike park, like Valmont Bike Park in Boulder (below) typically contain a mixture of bike features such as jumps, skills areas, pump tracks, flow trails and cross-country trails.

PUMP TRACKS			
	Small Approx 6,000 sq ft	Medium Approx 10,000 sq ft	Large / Multiple Approx 15,000 sq ft
Cost	$ 12,000-20,000	$ 20,000-40,000	$ 30,000-60,000

SKILLS AREAS (a progression of technical features)			
	Small Approx 15,000 sq ft or 1,500 lf	Medium Approx 30,000 sq ft or 3,000 lf	Large / Multiple Approx 50,000 sq ft or 5,000 lf
Cost	$ 20,000-40,000	$ 25,000-50,000	$ 30,000-60,000

DIRT JUMPS (includes a pump track)			
	Small Approx 1/2 acre	Medium Approx 1 acre	Large / Multiple Approx 2 acre (may include "slope style" elements)
Cost	$ 40,000-60,000	$ 80,000-120,000	$ 175,000-200,000

Bike Parks			
	Pocket Park Approx 1/2 - 1 acre (pump track, skills area)	Medium Approx 5-10 acres (pump track, dirt jumps, skills area integrated with limited trails)	Large Approx 40-80 acres (pump track, dirt jumps, skills area integrated with limited trails, slope style, event facilities)
Cost	$ 30,000-50,000	$ 250,000-500,000	$ 2-3 million

Tip: Pump Tracks and Dirt Jumps require maintenance and access to an irrigation source (irrigation not include in estimates). Select a site with gentle slope (2-8%); for Bike Parks and larger Dirt Jump areas, some undulating terrain is desired. Design, basic drainage and limited landscaping are included in estimates. Key cost factors include availability of quality soil, irrigation, drainage and sediment control requirements.

Nordic Grooming

Two primary methods are used for Nordic grooming: Cat-based systems and Sled-Based systems. Below are the start-up, operating costs and relative advantages of each.

	Start-up Cost	Operation Cost per Kilometer per Season	Notes
Cat-Based (snow cat)	$ 150,000 - $200,000	Approx $1500-2000 Includes deprecation, maintenance, paid operator, storage, fuel. Based on 40+K trail system.	, Groom more distance per time , Plow blade can move and shape snow (useful if wind-drifted) , Better compression , Requires professional operator , Consider storage , Piston-Bully dealer in Grand Junction
Sled-Based (snowmobile)	$ 15,000 - $25,000	Approx $1500-2000 Includes deprecation, maintenance, volunteer operator, storage, fuel. Based on <10 K of trail	, Uses utility style snowmobile and towed implement , Can be operated by trained volunteers , Most useful at small trail systems or to avoid mix-in on shallow snow cover , Requires storage

Other Trail System Development Costs

The following table provides estimates for other costs that may be associating with upgrading or improving a trail system and building a recreation destination.

TRAILHEAD PARKING, SIGNS, and VISITOR AMENITIES			
	Item Unit	Unit Price	Notes
Trailhead Parking Area (gravel lot)	30 cars	$20,000	
Kiosk & Trail Information Sign (rules, regulations, maps)	each	$3500	simple, roofed wooden structure, 1 sided
Trail Markers / Navigational Signs (wood or plastic posts with metal markers)	each	$40	
Entrance Sign & Entrance Gate	each	$1500	
Interpretive Sign Panel	each	$2500	2 post stanchion, 24x36" panel, includes interpretive design
Primitive Camping Area (clearing, marked sites)	10 sites	$3500	
Campfire Gathering Area (fire pit, grill, log seating)	each	$4000	
Day Use Area (2-3 picnic tables, small kiosk w/ site map, shade structure, wheel stops to designate parking)	each	$15,000- 25,000	Cost will vary with the scope of the site design and the amount of amenities.
Compost Toilet	1	$7500-10,000	For trailhead or primitive camp areas.

Leveraging Volunteer Groups and Youth Crews

Trail projects built via “Hybrid Construction”, combining professional and volunteer or youth labor, can save 10-50%.

The actual cost savings is largely determined by the skill set, size and capacity of the volunteer pool and by how much additional coordination is required. However, hybrid construction also brings added value including:

- Community involvement and sense of ownership/pride
- Detailed level of finish work and naturalization
- A trained constituency for future maintenance
- Additional fundraising capacity
- Positive publicity

Youth Corps and AmeriCorps crews typically range from $0 to $7,500 per week. Skill level varies by crew and oversight is often required. While some Youth Corps fees can rival professional contractors, their services often earn favorable scoring on grant applications.

CASE STUDIES: Great Trail Systems

Find inspiration from—or copy—these model trail systems that support and distinguish outdoor recreation destinations and local economies:

Fruita, CO:

18-Road, Mary's Loop, Lunch Loops and Rabbit Valley trails systems collectively offer more opportunity than can be had in a long weekend ... which means visitors return to take in a favorite route and explore further. Each trail system has a distinct character derived from is site topography, soils and views. Within each system, a stacked-loop approach allows visitors to find a variety of difficulty, length, and subset of character.

18-Road and Lunch Loops trail systems cater in a preferred use fashion to mountain bikers. 18-Road boasts quintessential buffed-out flowing single track. Lunch Loops leans toward rugged, rocky character and purpose-built free-ride mountain bike terrain and dirt jumps. Mary's Loop area offers a dispersed feeling and capitalizes on rock-layer topography and views of the Colorado River canyon. With an overlapping network of trails for differentiated uses, Rabbit Valley offers a vast landscape that simultaneously draws cyclists, campers and motorized use.

Park City, UT:

Park City has committed to being a true trails town. Visitors can access trails from nearly every cul de sac of Park City and neighboring communities. The result is a 350-mile network of trails fed by dozens of access points. Additional trails are reaching to connect with adjacent trail systems. Recreation has permeated the culture and infrastructure—even the bus service has stops positioned for trail access. Steady trail development requires new maps nearly every year. Key to Park City's success is ongoing collaboration between local government, planning boards, ski resorts, developers, non-profits, and residents.

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Swampy SnoPark, Bend, OR:

"Swampy" is one of several interconnected sno-parks along the Cascade Lakes Highway in the Deshutes National Forest. Six warming huts are accessible by a network of trails managed for winter visitation. Trails are designated as snow-shoe or ski in order to keep ski tracks smooth. A selection of forest roads are groomed for skate skiing in partnership with Central Oregon Nordic Club. Snowmobile trails are located on the opposite side of the highway. The area is promoted by outdoor shops in the nearby town of Bend and maps are readily available online and at the trailhead kiosk.

Teton Pass Trail System, Jackson Hole, WY:

In 2004 a group of local mountain bikers partnered with the Forest Service in response to a heavily used trail system that was seeing problems with unsanctioned routes, erosion, user conflict and lack of maintenance. Now, the Local Trails Consortium estimates area trails generate $18,000,000 in revenue and $3,200,000 in salaries for local businesses each year. Part of the "trail-mix" includes a handful of purpose-built, gravity oriented MTB trails. These downhill only bike trails take pressure off the more heavily used multi use trails, while offering opportunity for an otherwise un-met need. Risk is managed via signage, filters and by passes around the most challenging features.

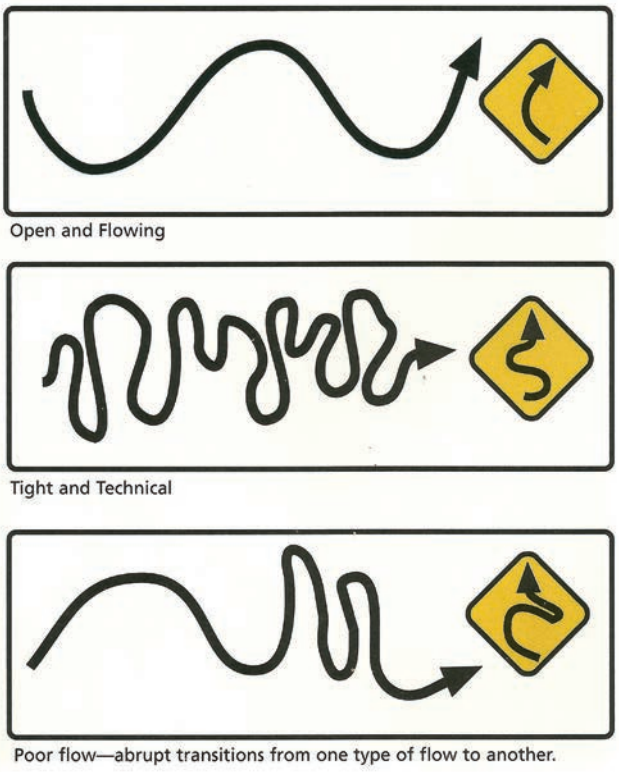
Staunton State Park, Conifer, CO:

Colorado's newest state park, opened in the spring of 2013. The park's trail system is a excellent example for high quality trail sign and clear navigation and wayfinding. At trailheads the a map (both on a sign and a printed brochure) orient visitors to the complete trail system. Along the trails, clear signs inform the visitor what trail they are on, what the permitted uses are and smaller signs with arrow keep visitors moving in the correct direction.

Planning a Stacked Loop Trail System.
This stacked loop system provides a spectrum of character and challenge. Trails can be combined into loops allowing a user to select a variety of distance. Note that easiest trails are nearest the Trailheads and challenge is found further afield. A user can also 'try-out" a moderate or difficult segment without committing to the full trail. Positive control points are places to take visitors (vistas, points of interest, intersections with other trails, etc). Negative control points are places to avoid (sensitive habitat, hazards, private property, etc).

When designing trails, consider the flow. Is the trail flow open or tight and technical?

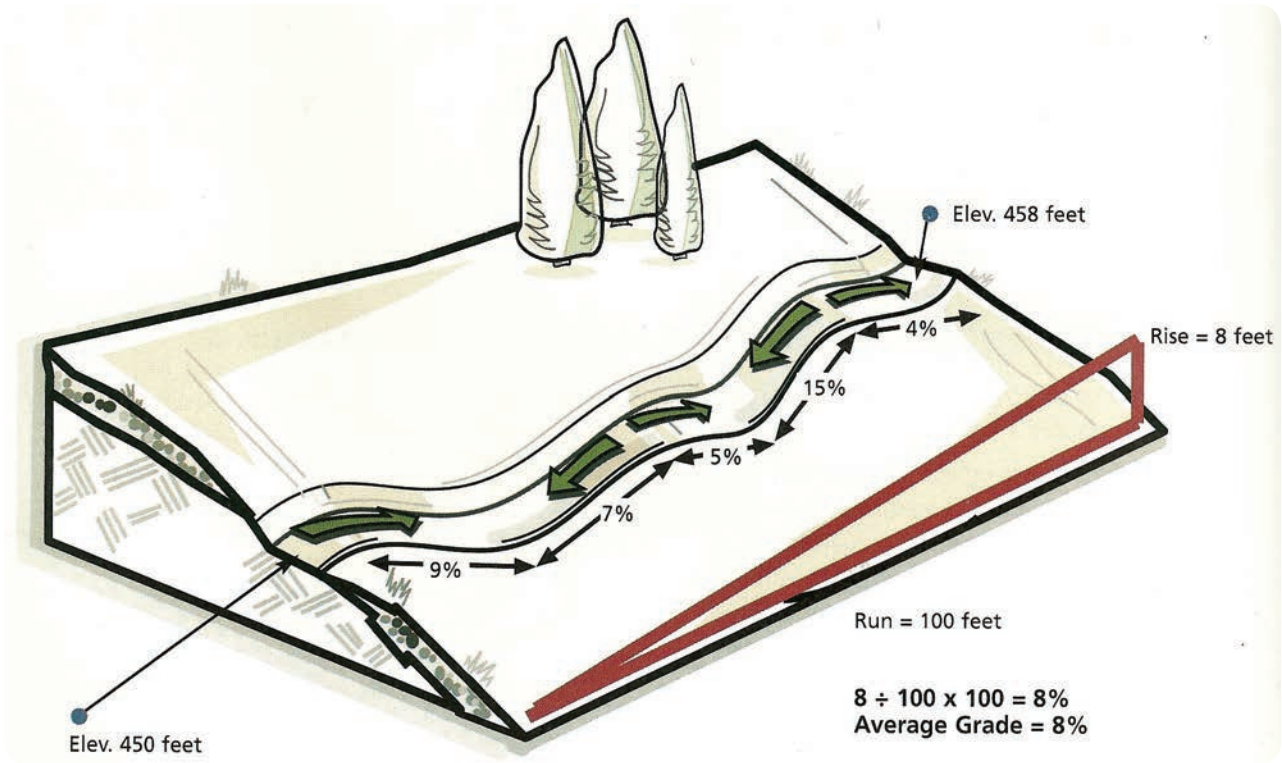
Illustration courtesy of ContourLogic and IMBA.



Elevated Tread. A puncheon / bog bridge used to cross wet area with minimal impact and add interest to trail near Brainard Lake, CO.

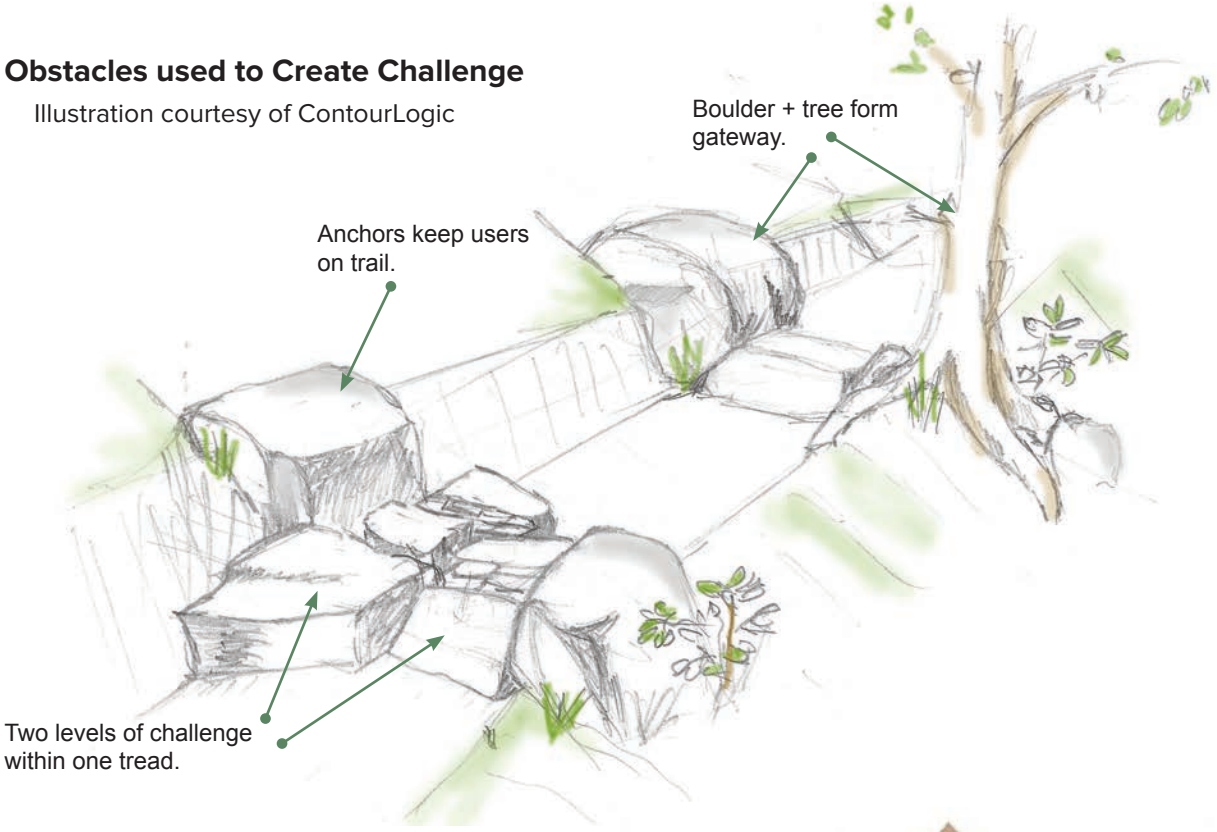
Rock Armoring. Rocks used to harden the landing of an enhanced natural rock drop-off for mountain bikers at West Magnolia, CO.

Rolling Contour Design. The trail corridor above on Boulder's Sunshine Valley Trail climbs at approx 5-8% grade across the contours but dips into natural draws. The trail alignment undulates at grades up to 15% and meanders within the corridor to add interest and provides frequent drainage via subtle grade reversals. *Photo above from Contour Logic, Illustration below courtesy of IMBA.*



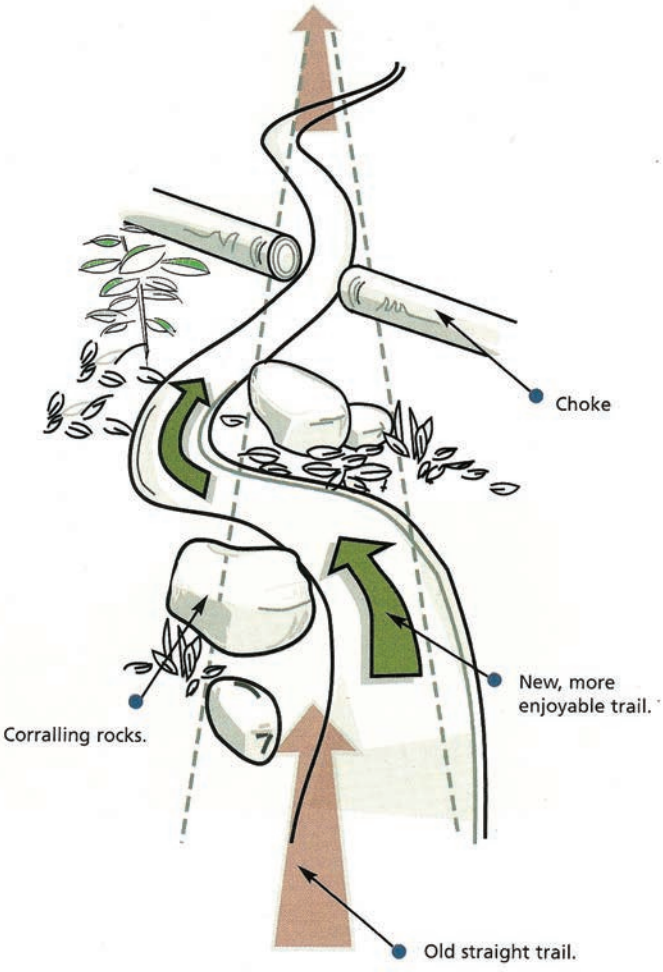
Obstacles used to Create Challenge

Illustration courtesy of ContourLogic

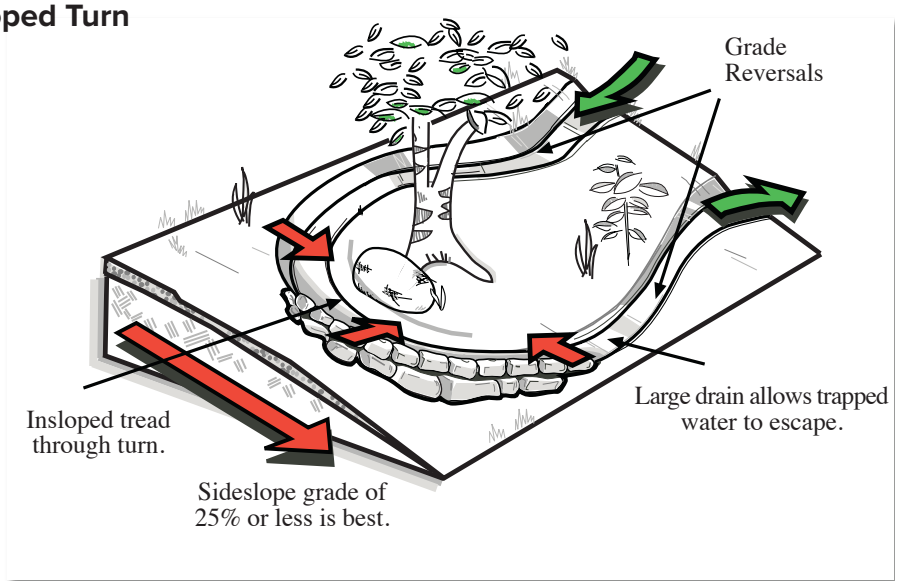
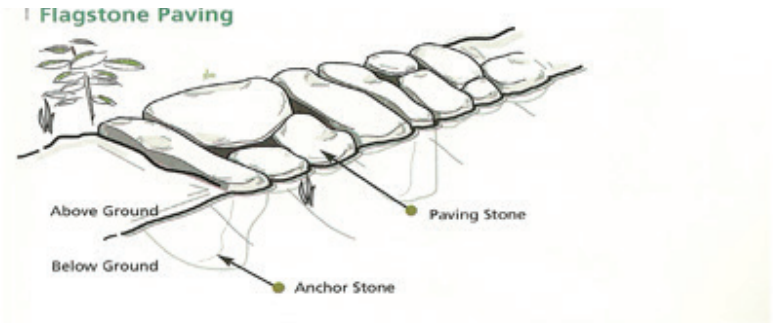
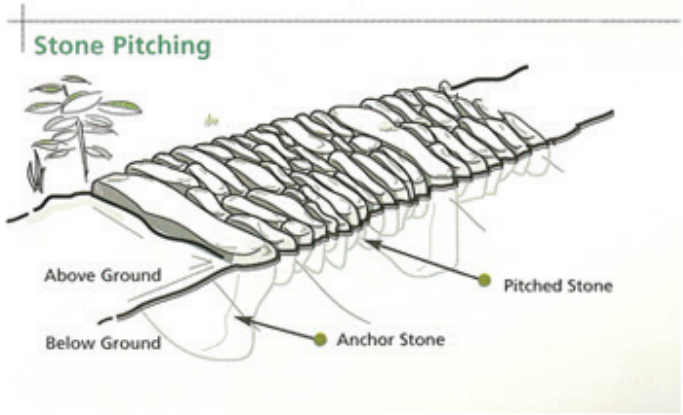
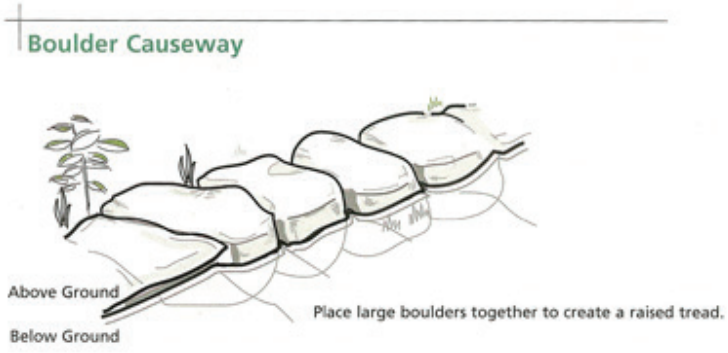


Anchors used to Create Meander

Illustration courtesy of IMBA



In-Sloped Turn



Armoring and Texture