



Outdoor Sports Institute – Online Trail Build School

Building Great Trail Experiences



INTERNATIONAL MOUNTAIN BICYCLING ASSOCIATION

IN PARTNERSHIP WITH



OSI

OUTDOOR SPORT
INSTITUTE



INTERNATIONAL MOUNTAIN BICYCLING ASSOCIATION



IMBA TRAIL UNIVERSITY PART 3 - CONSTRUCTION



INTERNATIONAL MOUNTAIN BICYCLING ASSOCIATION

IMBA's mission is to create, enhance and protect great places to ride mountain bikes.



TOC

- Recap – Trails Design
- Design to Construction
- Parts of a trail
- Tools of the trade
- Basic trail construction
- Basic trail maintenance
- Advanced topics



REVIEW OF DESIGN

Trail Design Considerations

- The plan informs the design
- Project phasing
- What is the SOW?
- Trail type informs corridor
- Trail guidelines (specs)
- Iterative design
- Passive design/shared-use trails

Compliance

- Federal, State, and Local
- NEPA, SWPPP, 401/404
- Corridor vs. zone review
- Avoid or interpret

Sustainable Design Fundamentals

- Contour, fall line, and flats
- Half rule and maximum grade
- Grade vs. slope
- Using a clinometer
- Grade Reversals

Design Fieldwork

- Flagging Conventions
- Minor control points
- Inventory
- Cost estimating



BUILD IT RIGHT, BUILD IT ONCE



FROM DESIGN TO CONSTRUCTION

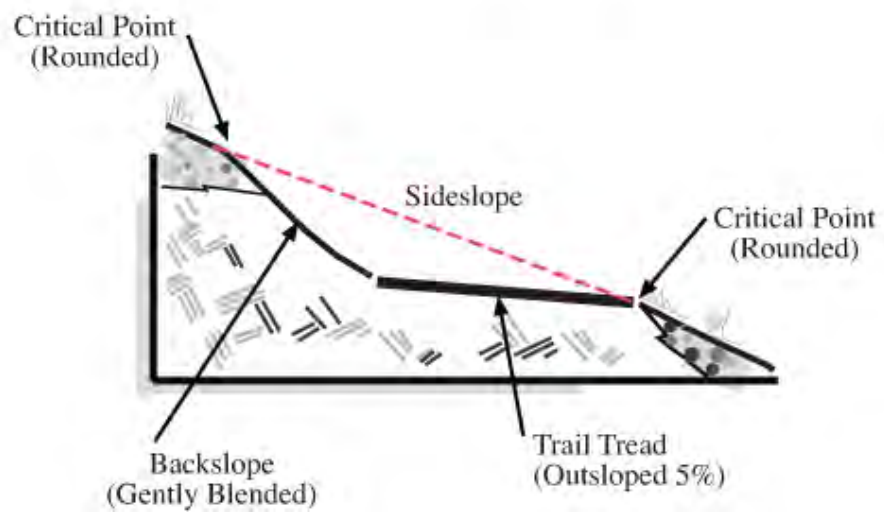
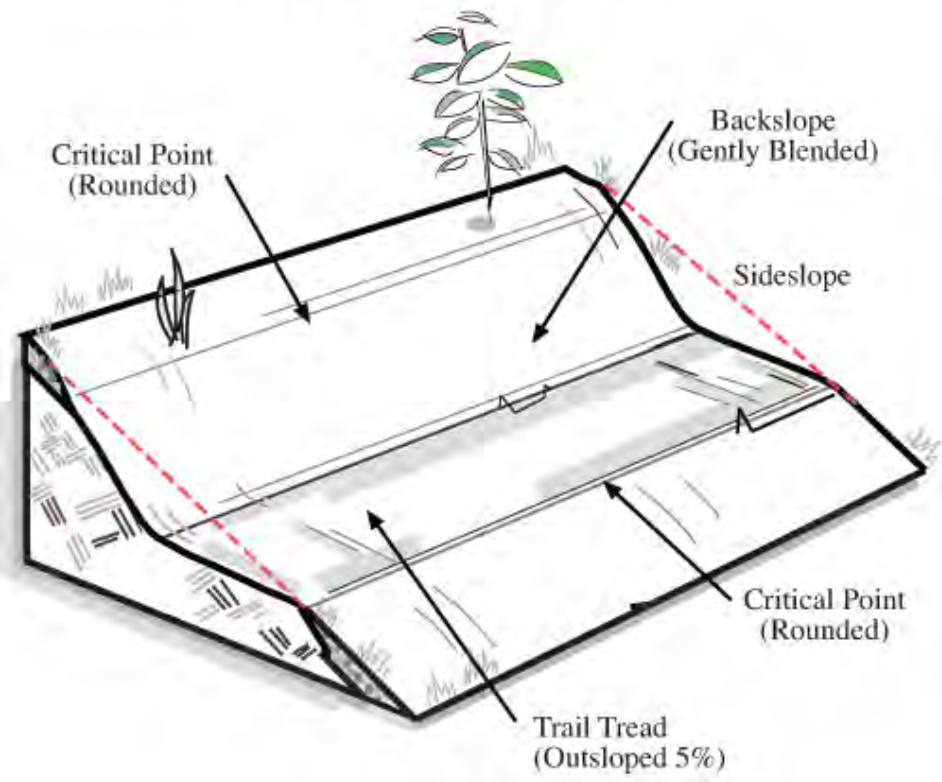


FROM DESIGN TO CONSTRUCTION

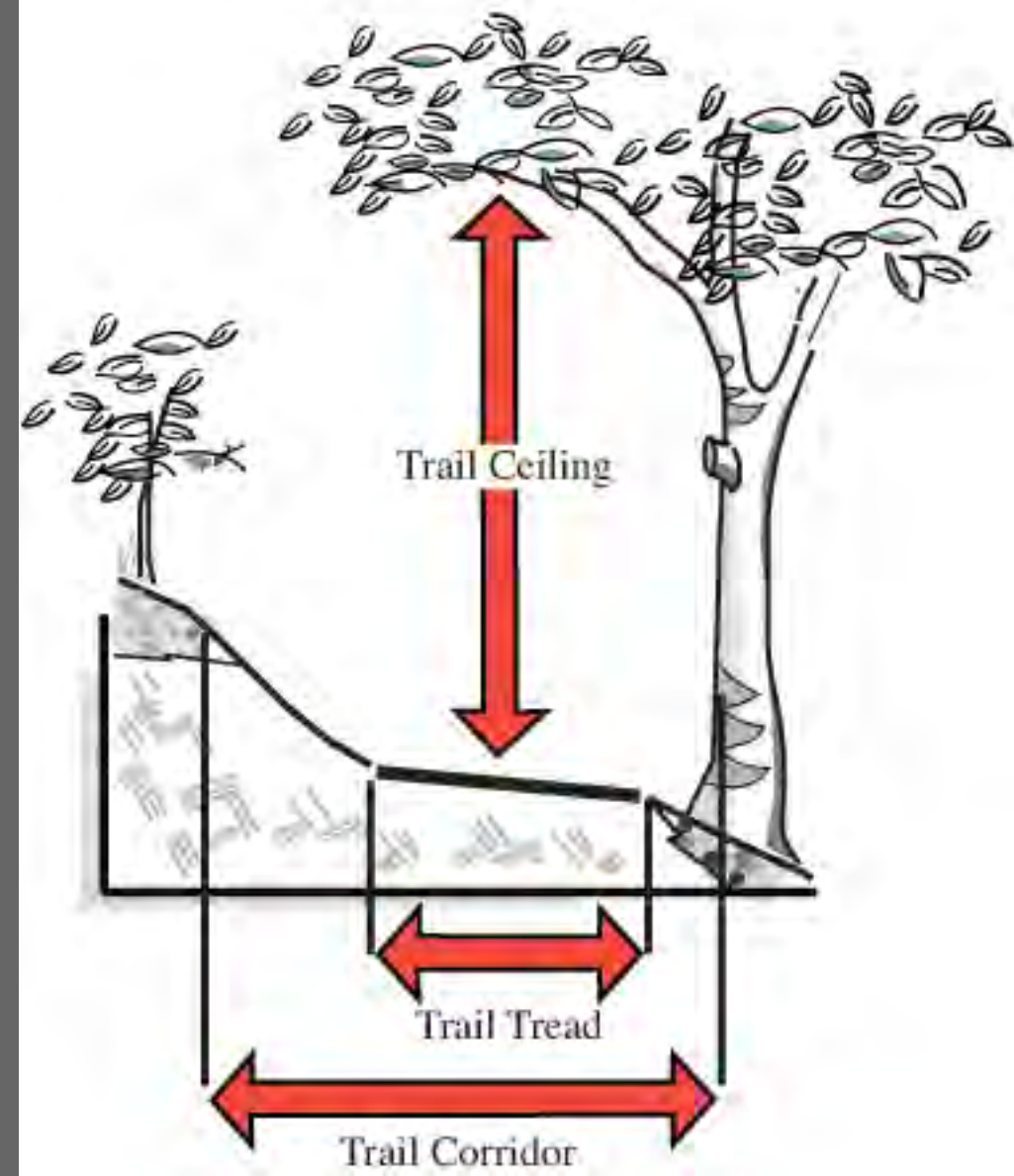
- How wide is the acceptable/reviewed corridor?
- What is your role? Builder? Volunteer management? Professional?
- Is there a plan to review? Get familiar with the intent of the trail. What are the experience goals?
- What are the trail specifications? Do they match the planned experience objectives and designed trail type?
- Walk the flagline, bring a clino, ensure the corridor meets all the plan and design goals. Ask questions.
- How will you get into and out of the site? Have a mobilization plan. Then have a backup plan for if something goes wrong.
- What will be your impacts? How will you mitigate?
- Are there regulatory compliance practices? Wattles? Silt fence? Posting permits? Inspections? Reports?
- Do you have all permits and licenses to complete the work?
- Personal protective equipment. Know what it is and always have it.
- Trail building is essentially backcountry work; do you have good backcountry skills? First aid? Leave no trace?



Full Bench Trail



Trail Corridor



PARTS OF A TRAIL

- Trail ceiling – the height above the trail tread to impeding vegetation or natural objects
- Trail corridor – the width outside the trail tread to impeding vegetation or natural objects
- Trail tread – the surface upon which visitors travel during trail use
- Backslope – the disturbed surface which ties the trail tread back to native/natural earth
- Toe/downside edge (lower critical point) – the downside or outside point or edge where trail tread meets native/natural earth
- Top of the backslope (upper critical point) – the higher side or inside point or edge where backslope meets native/natural earth



TOOLS



TOOLS



TOOLS



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TOOLS



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TOOLS OF THE TRADE

Personal Protective Equipment

Helmet
Eye protections
Ear protection
Gloves
First aid kit
Emergency communication

Corridor Clearing Tools

Handsaws
Pruners
Loppers
Polesaws
Lead blowers
Chainsaws (*require PPE and training*)
Mechanical mowers/mulchers

Trail Building Hand Tools

Clinometer
Hoes
McCleods
Pulaskis
Rakes
Buckets

Trail Building Mechanized Tools

Dump/Loaders
Excavators
Dozers

Rock Work Tools

Hammers
Chisels
Rock nets
Buckets
Gripchoist

Rock bars
Brush

Trail Finishing Tools

Rakes
Pruners
Loppers
McCleods
Compactors

Broom

Naturalization Tools

Leaf blowers
Rakes
Loppers
Pruners



HOW CAN MACHINES HELP?

- Human power is slow and expensive
- Move more/larger...dirt, rock, etc.
- Tools to be used, need training and expertise on when to use what and where
- Machines are only as useful as the operator using them
- More efficiency but more responsibility

PPE AND SAFETY

- Width and height requirements will be in the trail guidelines, they will be dependent upon trail visitors and trail type.
- Some vegetation is more visually appealing and can add to the trail experience. However, plants that grow very fast should be removed or heavily trimmed.
- Consider the mix of visitors. Equestrians need a wider corridor and higher trail ceiling. Jump trails will also require a higher than average trail ceiling.
- A tighter corridor will slow trail users. An open corridor may invite more speed. But a tight corridor on a shared-use trail may not create adequate sightlines for good experiences.
- Trails with high anticipated traffic may need a larger corridor to allow for passing and visibility.
- Corridor size can greatly affect a trail's technical challenge. Narrow openings between trees (gateways), low branches, thorny bushes, or cactus close to the trail tread will make for a tight and tricky pathway, adding to the challenge of the trail.
- What is your maintenance schedule? If you know that you can only clear the corridor once a year, trim a little higher and wider.
- Determine the desired experience before you begin "beating back the jungle." A trail with a tight corridor can help visitors feel a closer connection with nature. Your goal should always be to minimize your impact on the environment and leave the area looking as natural as possible while meeting the land manager and trail experience goals.



CORRIDOR CLEARING

Tools

Loppers

Pruners

Hand saws

Straps (for pulling)



CORRIDOR CLEARING

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Digging Out Roots



CORRIDOR CLEARING

- Don't leave sharp points that can become hazards.
- Stubs and stumps create easily mitigated risks.
- Trim branches back to the tree collar for healthier recovery.
- Remove stumps, even if flush cut compaction will make them "pop" over time.
- When in doubt, you can always cut after the build.

CORRIDOR CLEARING

- Flush cut, no coat hooks.
- Don't leave sharp points that create hazards.
- Only cut at branch junctions.
- Leave canopy intact when possible.
- Don't leave sharp points or butts in corridor
- Cut limbs and branches further away from trail
- Drag slash out of sight with cut ends away from trail
- Straps are handy
- Consider if you're increasing the fall risk.



CORRIDOR CLEARING



CORRIDOR CLEARING



SIGHTLINES

- Sightlines are extremely important for shared-use trails. Trails with visitors who have large speed differences will require longer sightlines.
- Where sightlines are impossible to lengthen (such as rounding a steep slope, meeting on a ridge, etc.) the trail design should mitigate visitor speeds through uphill.
- Sightlines can be outside the trail corridor. There may be a large chicane or meander in a relatively fast flat trail, trimming the straight line through the S-curve will open up the view for riders and walkers to see each other.
- A crowded trail with a mix of runners, dog walkers, and children calls for greater visibility. However, if the tread surface is smooth and the corridor is wide, mountain bikers may be tempted to ride too fast. Creative corridor cutting can help. Keep some vegetation below waist level to control trail width and anchor turns but still allow for clear sightlines. Don't remove trees near the trail tread, just trim their branches for visibility.
- A one-way trail can be trimmed differently than a two-way trail, as sightlines only need to be clear in one direction of travel. Though it is always good to keep good sightlines all around, in case of emergencies or human error.



SIGHTLINES



| MPH | FPS | 3 seconds |
|-----|------|-----------|
| 5 | 7.3 | 22 |
| 10 | 14.7 | 44 |
| 15 | 22.0 | 66 |
| 20 | 29.3 | 88 |
| 25 | 36.7 | 110 |
| 30 | 44.0 | 132 |
| 35 | 51.3 | 154 |
| 40 | 58.7 | 176 |
| 45 | 66.0 | 198 |

Know the preferred sightline distance for the trail. 100' to 150' is a good dual direction sightline.

BASIC TRAIL CONSTRUCTION

- Depending on the builders, management, and design you may want to detail pin flag a build line. There are many options and choosing the best one will depend upon your requirements and knowledge.
- Remove the organics – during corridor clearing it may be easiest to use a leaf blower to blow loose debris upslope. This will be used later during the naturalization process.
- Grubbing – continue removing the organic layer, in general you want to move it up slope to use later. Tools such as hoes, McCleods, Pulaskis, and mechanized equipment are used for this stage.
- Digging the tread – once the organic is removed you have mineral soil, which is what is used to create stable and long lasting tread surfaces. A benchcut on sideslopes (contour alignment) will start with excavating soil from the upper critical point (where the backslope will meet native earth). As one excavates soil, move the soil towards the downside edge.
- It may be easiest to dig a minimum length of trail. For instance, a complete grade reversal or 25 to 50-feet of trail may allow you or volunteers to better see the entire trail, versus getting mired in the detail on 1 or 2 feet.
- Work in layers, excavate soil from the uphill critical edge and then move down the line, don't excavate the entire tread for just a few feet.
- As you excavate the trail tread, pay attention to drainage. Where will the trail drain? Is the entire trail tread outsloped? Is it insloped to a rolling grade dip or reversal? This will likely go back to the trail plan and design.
- Once you've established a rough trail tread that meets the basic tread width and grade requirements of the plan and design, it's time to sharpen the shaping and dial it in before naturalizing it.

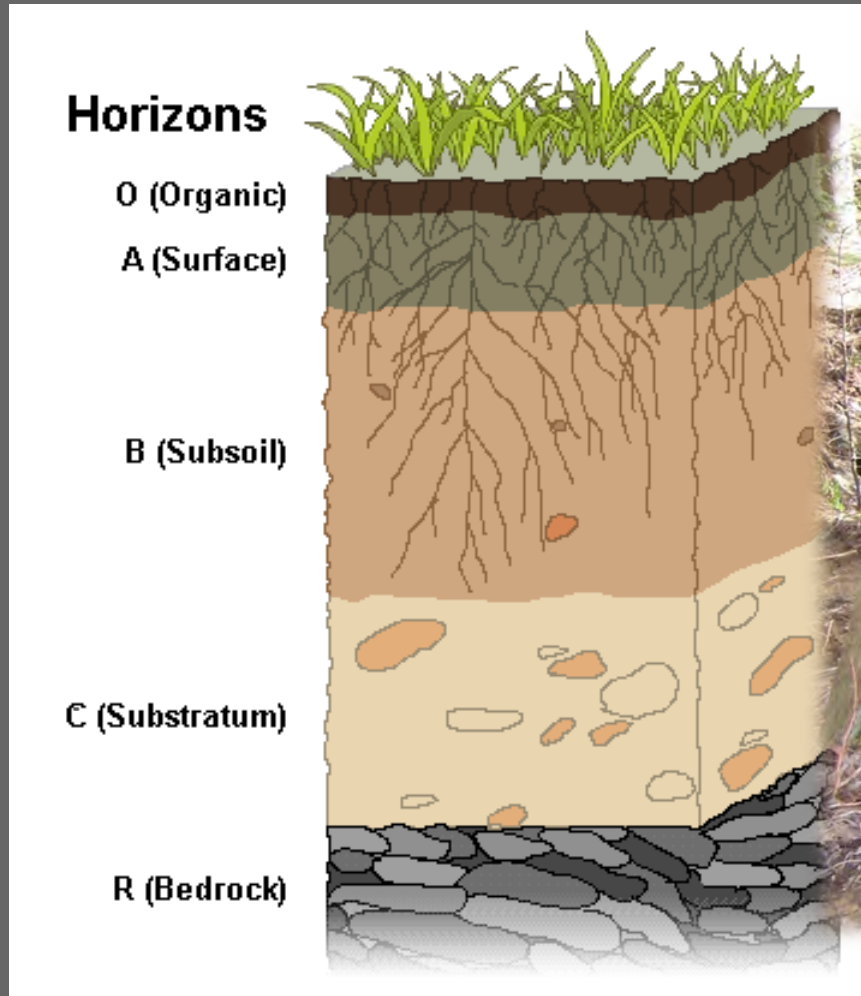


BASIC TRAIL CONSTRUCTION

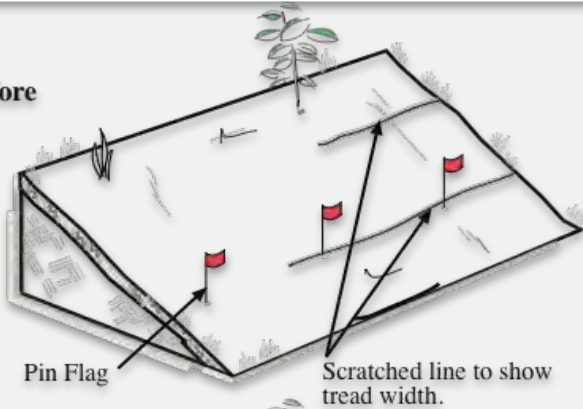
- Create the backslope – blend the uphill side of the trail down to the trail tread. Ideally the backslope should be gentle, 3:1 slopes are common, steep backslopes will facilitate more potential for soils to slump and slide, creating more maintenance needs.
- Steep backslopes also narrow the tread up considerably, especially for mountain bikers who are mindful of their pedals/feet.
- Some cases require steep backslopes, for instance if you're excavating in very rocky soil (or even bedrock).
- Once the backslope is set and the upper critical edge is rounded to promote sheet flow over the backslope to the trail tread, you can focus on dialing in the trail tread.
- If the trail tread is insloped, runoff will flow down the "gutter line" of the tread and backslope, ensuring this drains properly is key. Debris can build up in this "gutter line", clogging it and creating dams that alter drainage patterns and therefore erosion patterns.
- Where ever runoff should exit the trail, outsloped length of trail or grade reversal, ensure there is nothing to dam or impede flow.
- The lower critical edge should be rounded and compacted. On a full bench excavation this should be native unexcavated soil, partial bench construction means this edge is a fill slope and will settle and compact over time. The more compaction you do at the beginning, the less the trail will drastically change.
- Once your backslope, tread, grades, drainage, and critical edges are set the trail is ready to be naturalized.



REMOVE ORGANIC LAYER



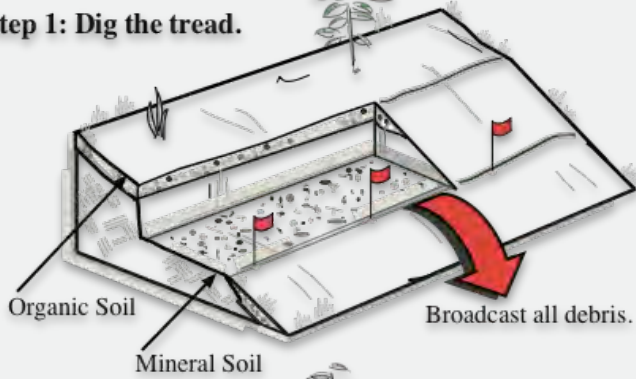
Before



Pin Flag

Scratched line to show tread width.

Step 1: Dig the tread.

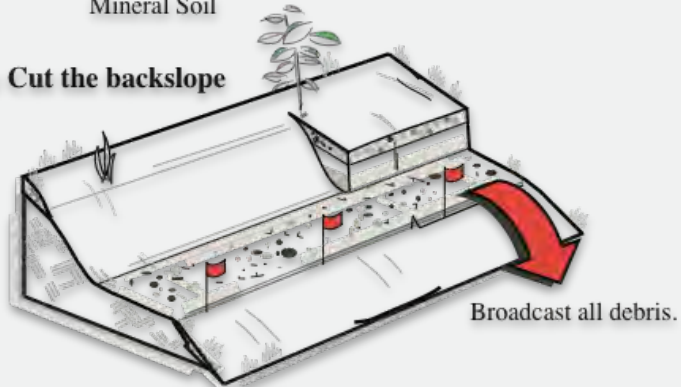


Organic Soil

Mineral Soil

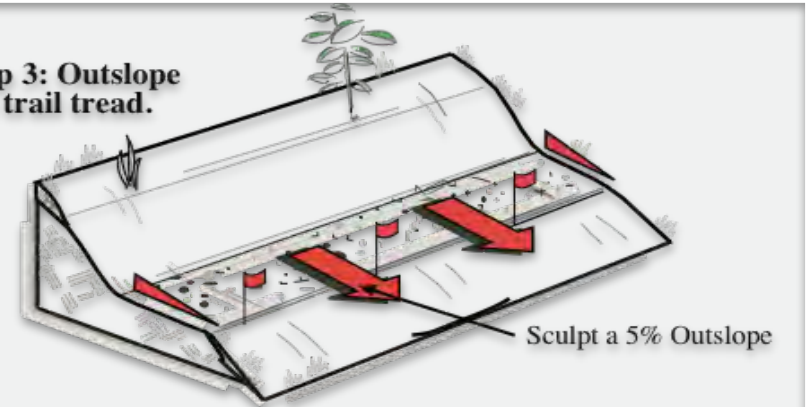
Broadcast all debris.

Step 2: Cut the backslope



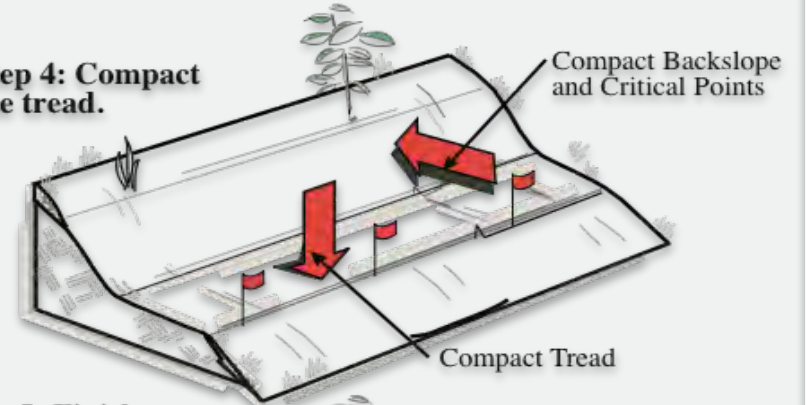
Broadcast all debris.

Step 3: Outslope the trail tread.



Sculpt a 5% Outslope

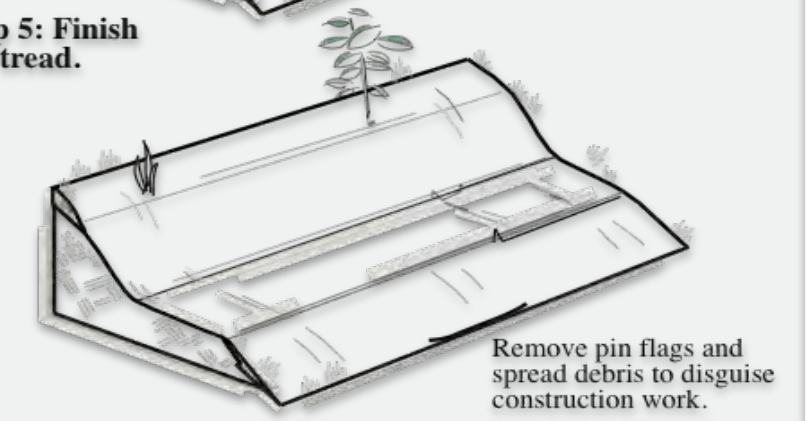
Step 4: Compact the tread.



Compact Backslope and Critical Points

Compact Tread

Step 5: Finish the tread.



Remove pin flags and spread debris to disguise construction work.

TYPES OF TREAD CONSTRUCTION

Full Bench

- On rolling contour alignment
- Most stable over time
- Most stable during construction
- Will remain closer to original tread width over time
- Insloped tread possible, recommend for some trail visitor/type combinations

Partial Bench

- On rolling contour alignment
- Less stable over time than full bench
- Semi stable during construction, watch the outside/fill edge
- Will narrow over time as the fill edge compacts and settles
- Useful when you want to avoid impacting something (roots, rocks, etc.)

Minimal/No Bench/Rake-n-Ride

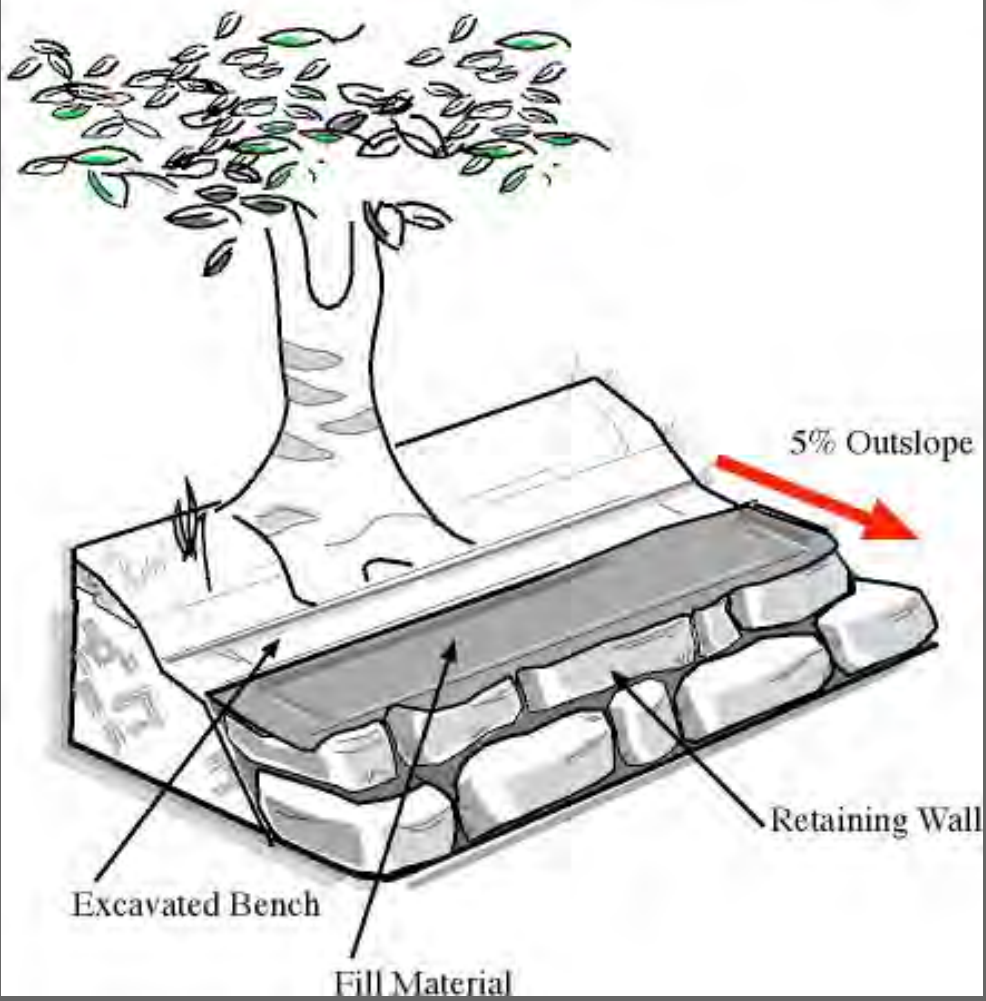
- Generally on flatter soils or the fall line
- Will create very outsloped tread on the contour
- On steeper slopes can create issues with trail creep, as roots wear through and organic is pushed downhill

Lift-n-Tilt

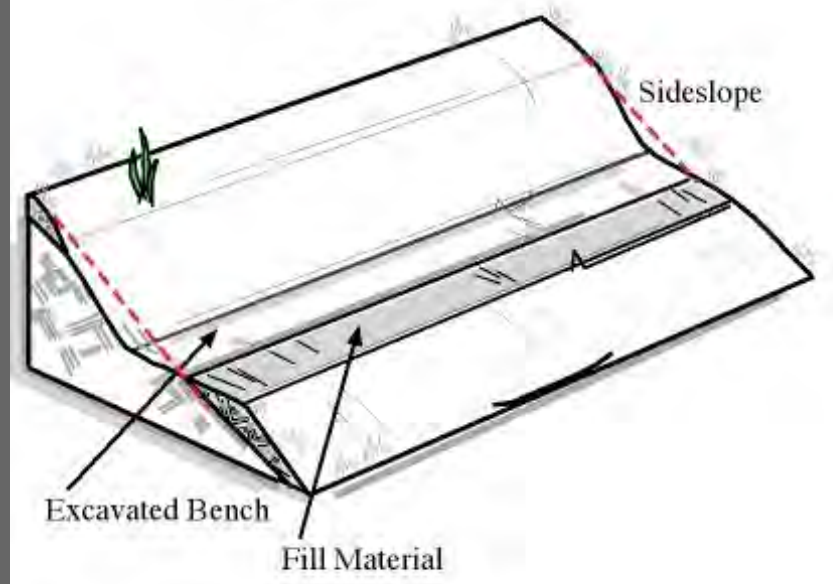
- Generally on flattest slopes
- Easiest with mechanized equipment
- Involves borrow pits to harvest useable soil and placement, shaping, and compacting to create micro-drainage
- Results in trail on flat ground that will drain water off tread, may create puddling or pooling beside trail



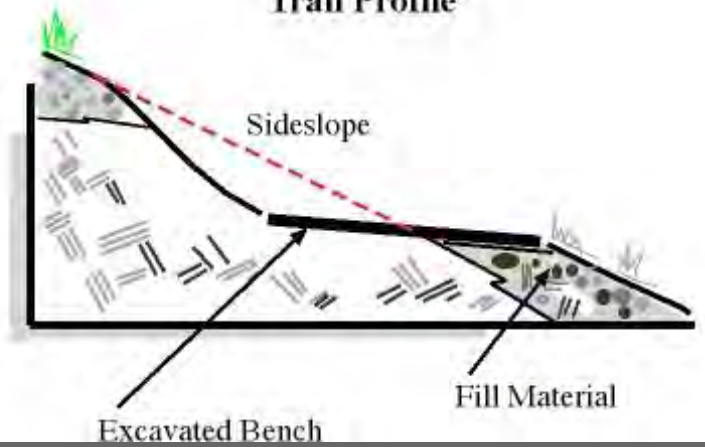
Partial Bench Trail with Retaining Wall



Partial Bench Trail

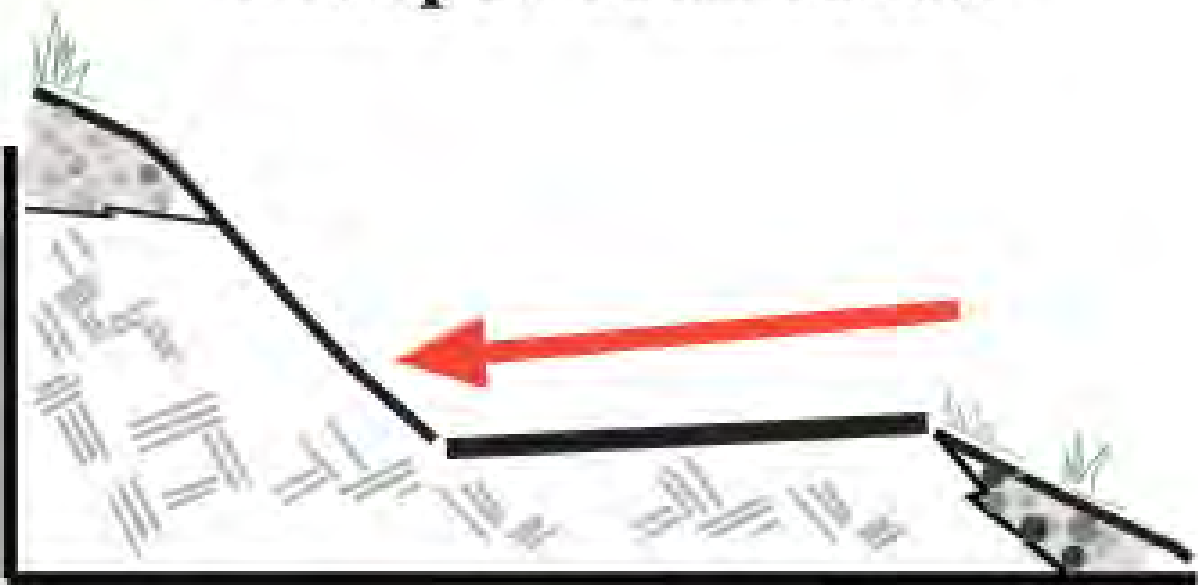


Trail Profile

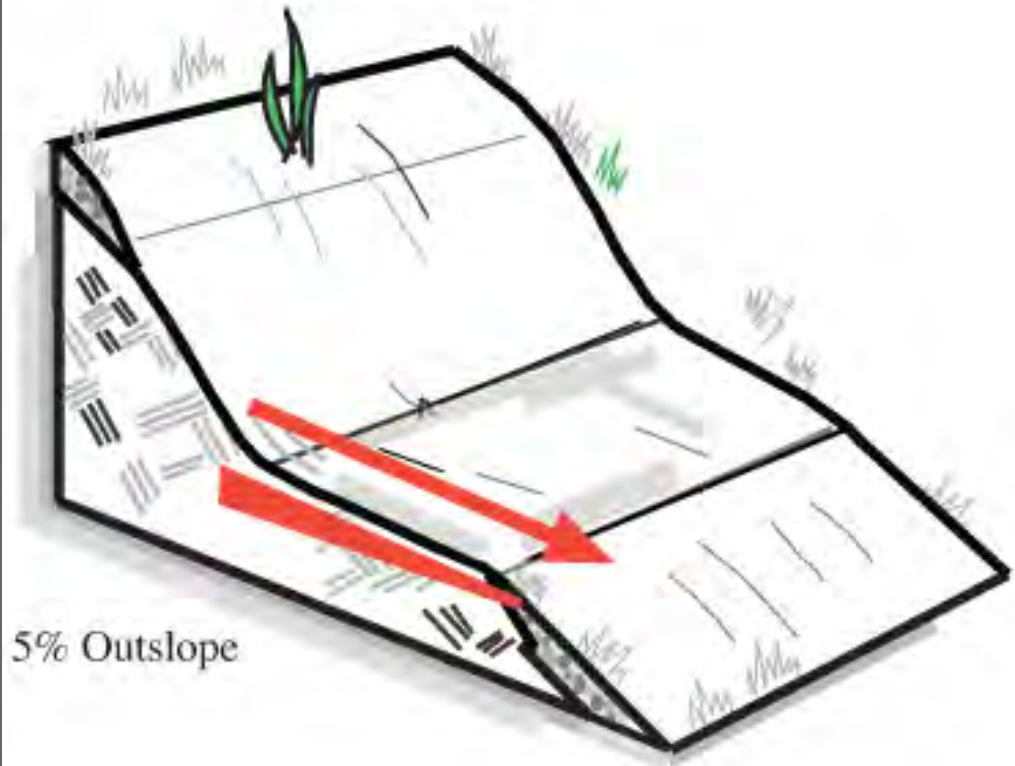


PARTIAL BENCH

Insloped Trail Tread



Outslope



5% Outslope



5% Outslope

WHY INSLOPE TREAD?

- Insloped tread focuses drainage, you can more precisely predict where runoff will flow, how it will effect your trail, and how to mitigate for those effects
- Insloping feels more secure on steeper sideslopes for many users
- Insloping is ideal for mountain bikers, wheeled vehicles roll along the trail, insloping can help riders maintain their momentum, thereby creating more flow in many instances
- All users displace trail tread soil, insloping helps reduce the soil displacement by transferring shear forces from users to force pushing directly into the tread
- Any displaced soil is more easily replaced, you can rake and move soil from the inside edge back up the insloped tread easier than soil which has washed downhill from outsloped trail tread
- On trails intended for beginners, especially mountain bikers, the above described characteristics of insloping helping create a friendly and inviting trail experience
- Insloping can be vital on bike-only descents such as gravity or jump trails, ensuring visitors maintain the intended speed for features and trail experience



TURNS



TURN BASICS

- Turns should be sited during design based upon the trail type, planned visitor experience, intended construction style, and terrain features.
- Turns are constructed features, generally defined as a change in direction of more than 90 degrees, although most turns are traditionally 180 degrees.
- Turn radius and elevation loss through the turn create stringent sideslope requirements
- By definition any turn on any slope will eventually go fall line, building the right turn for the trail will mitigate this issue in a variety of ways.
- Turns are generally described with a few key guidelines or specifications, including: radius, maximum grade cross the turn platform, and maximum camber (inslope) of the turning tread.
- Hikers can successfully navigate very tight (small radius) turns, mountain bikers generally need much larger radii turns (the tighter the turn the more advanced the feature is to a rider).
- Because turns can include steep (fall line) grades, drainage is important. The “omega” turn style is very common, ensuring good drainage with grade reversals directly before and after the turn.
- The grade of the turning platform should be the same or lower grade as the trail



TYPES OF TURNS

Climbing/At Grade Turn

- Require mellowest slopes of all turns (under 10%)
- Visitor goes along the fall line at some point
- Widest radii turns (for mountain bikes 10-15 feet minimum)
- Easiest for hand construction
- Require very careful design placement

Constructed Turns - General

- Can be on virtually any slope, at some point larger and larger retaining walls are required
- Generally easiest with mechanized equipment, especially if larger radii is required
- The turn platform will always be largely fill
- Grade reversals before and after will help protect the turn platform
- Generally redirecting the steepest part of the terrain to part of the turn through construction

Constructed Turns – Rolling Crown Switchback

- Generally not recommended, almost always require rock surface to last
- The best and worst feature is they have poor flow, especially for bikes
- Useful for situations on especially steep slopes or where you need to reduce riders speeds
- Mountain bikers generally do not enjoy these types of turns

Constructed Turns – Insloped Platform

- Best for shared-use and bike climbing trails
- Radii can vary depending on visitor and intended trail difficulty
- More often than not some insloping is used, even mellow 5% inslope on a switchback for hikers is helpful in managing visitors and runoff
- Steepest part of trail generally created as a “ramp” on the lower leg of trail

Constructed Turns - Berm

- Generally only on bike-only descents
- Berms are exaggerated insloping, they should have a radius themselves, going steeper as they near the top edge
- The top will be fragile, compacting the edge and outside will help ensure longevity
- Can be “falling away” style where turn goes fall line with some form of catching inslope on the lower leg



TURN TIPS

- Look for good natural turning platforms during design!
- Keep water out of the turn with grade reversals before and after
- Prevent shortcutting with anchoring inside
- Type of turn is dictated by the steepness of the sideslope, trail type, and difficulty level.

Keep turn
radius as wide
as possible.



Grade
Reversals

Outslope
5%

Sideslope
7% maximum.

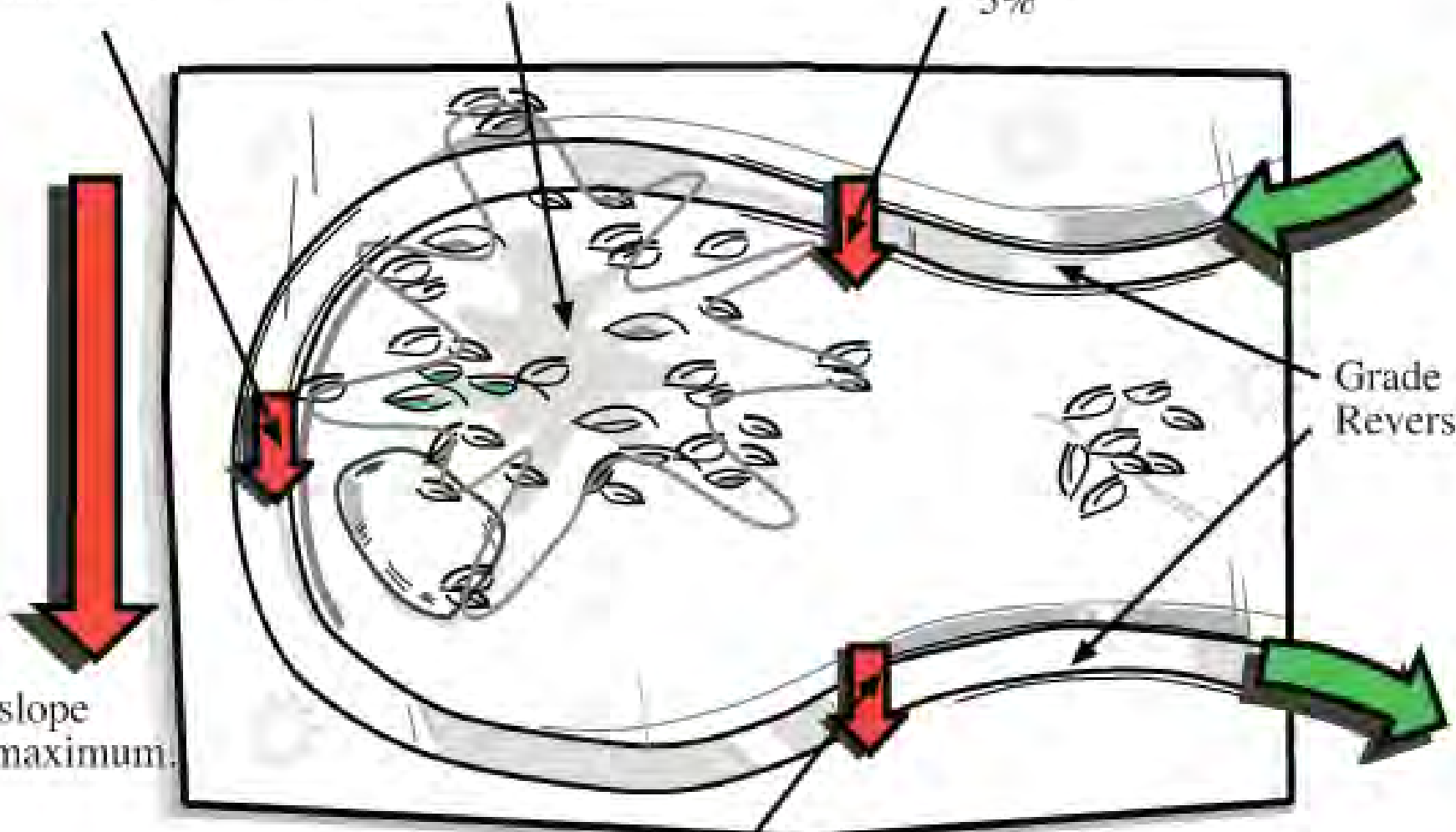
Short section of trail (the
apex of the turn) lies directly
in the fall line.

Climbing Turn

Trail passes briefly through fall line.

Natural or Placed Barrier

Outslope 5%



Sideslope 7% maximum.

Grade Reversals

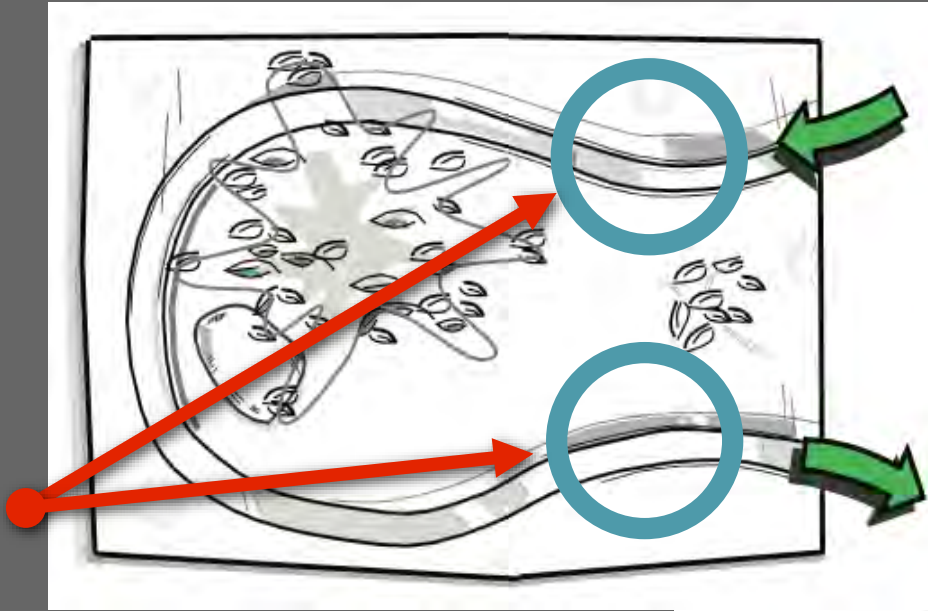
Outslope 5%

AT GRADE TURNS



AT GRADE TURNS

- Built on the existing slope
NOT on a constructed turning platform
- Sideslope <10% grade
- Grade reversal before and after
- Approximately 15 foot radius
- Well anchored inside



CONSTRUCTED TURNS

- Involves excavation and construction to create a turning platform
- Sideslope >10%, sideslopes >60% may require retaining ways
- Grade reversal before and after
- Hikers can navigate 2-3 foot radii turns, mountain bikers need between 4 and 12 feet generally
- Constructed turns can be platforms, have insloping, or be fully bermed (where insloping goes near vertical at the top)
- Soil should be excavated from the upper leg of trail or the backslope of the turn pad, do not excavate soil from borrow pits behind or below the turn
- If enough soil can be excavated and placed to create a 3:1 or shallower outer slope a retaining wall is not necessary
- The outer slope will buttress and protect the turn platform, if it is too steep it will erode faster and the turn platform will collapse and crumble
- To further protect the outer fill slope, natural and native organic material should be placed here (described more in the general naturalization notes)
- Advanced bike-only descending trails can have “fall away” turns, which resemble climbing turns on steeper slopes, these types of turns need a “catchers mitt” of insloping on the lower leg to help redirect riders



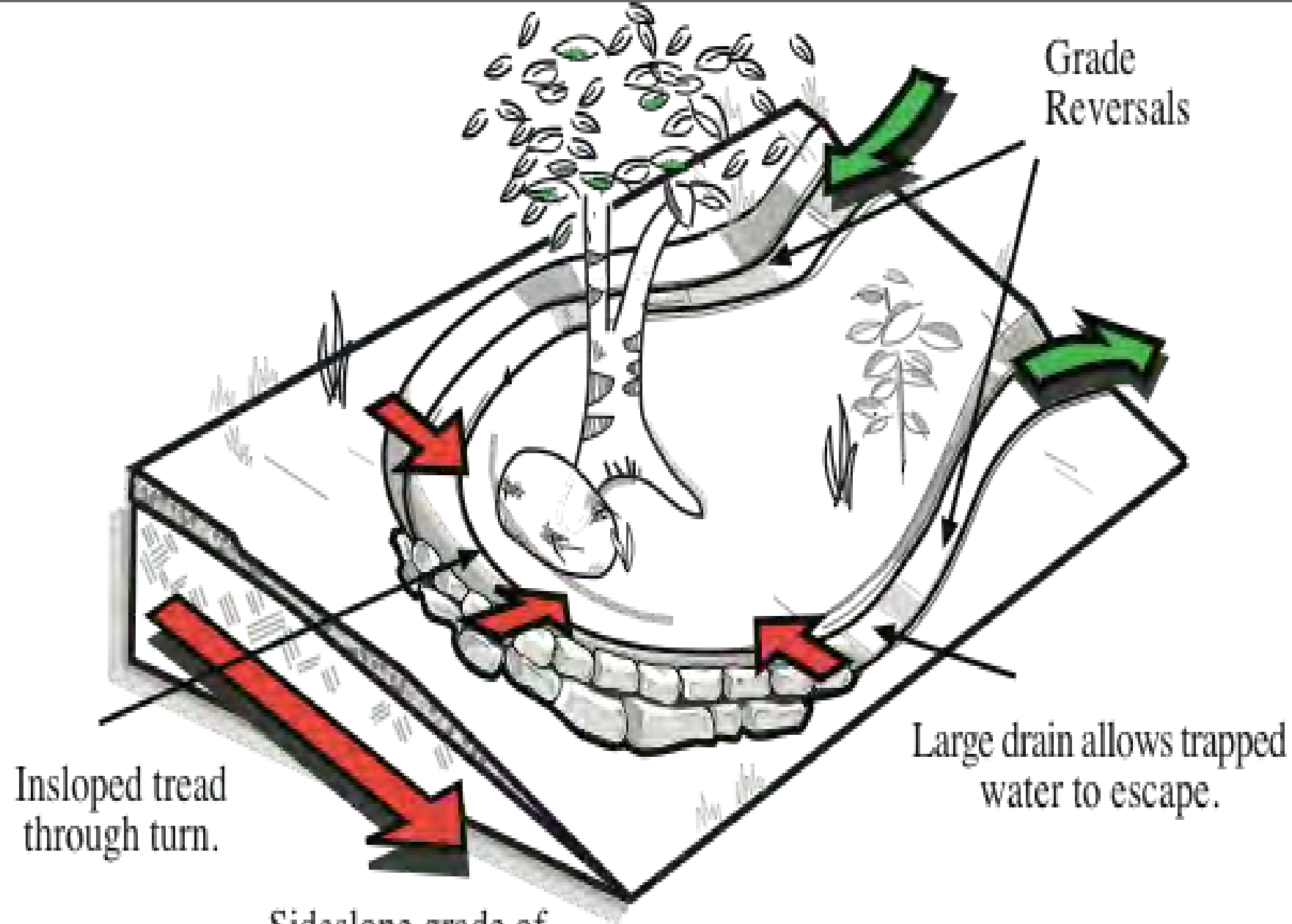
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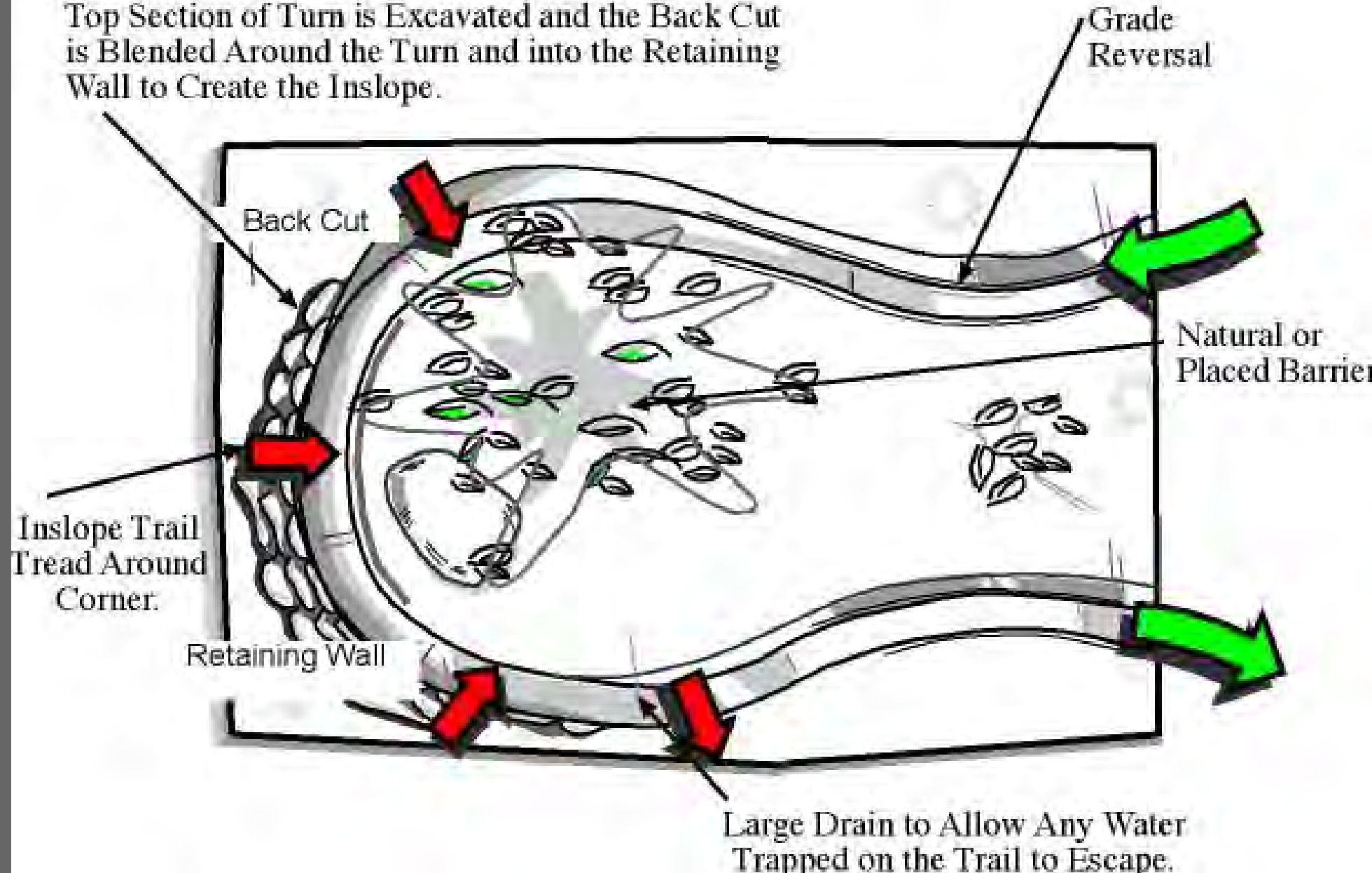
CONSTRUCTED TURNS





Insloped Turn

Top Section of Turn is Excavated and the Back Cut is Blended Around the Turn and into the Retaining Wall to Create the Inslope.



PLATFORM TURN

Grade reversal



Grade reversal



Turn Pad – build it up by excavating soil from the upper leg and building out the lower leg

PLATFORM TURN

PLATFORM TURN

- Built up lower leg “ramp”, in general the best place to put the steepest grades in a platform turn is the lower leg of trail
- The turn and lower leg are insloped, the grade of the lower leg “ramp” is steep so the “gutter line” is armored with riprap
- Grade reversal at the bottom is also armored with riprap



PLATFORM TURN

- Grade reversals at the top and bottom creates the classic “omega” shape, this chicane is also an ideal weight transfer for mountain bikers to optimize the turn
- The pad and lower leg have been built up with retaining walls. The slope did not necessitate a retaining wall, it was more likely a unique and aesthetically pleasing way to use rock found during construction
- Wide, flat turning pad. The turn is executed on the flattest grades, decoupling the typical steep grade and turn found in at grade or climbing turns



INSLOPED PLATFORM TURN

BERM TURNS



BERM TURNS

- Berms are better for mountain bike trails, best for downhill trails
- Berm holds riders in the turn
- Berms let the rider maintain momentum
- Berms need large grade reversals at the entrance and exit



SWITCHBACK

- Better for foot users (hikers)
- Should only be built on steep sideslopes
- More challenging to ride because the radius is tight
- May increase erosion because bikes must brake more
- Large grade reversals at the entrance and exit



TURNS



Platform/Inslope Turn



Berm turn



Platform Turn

NATURALIZATION

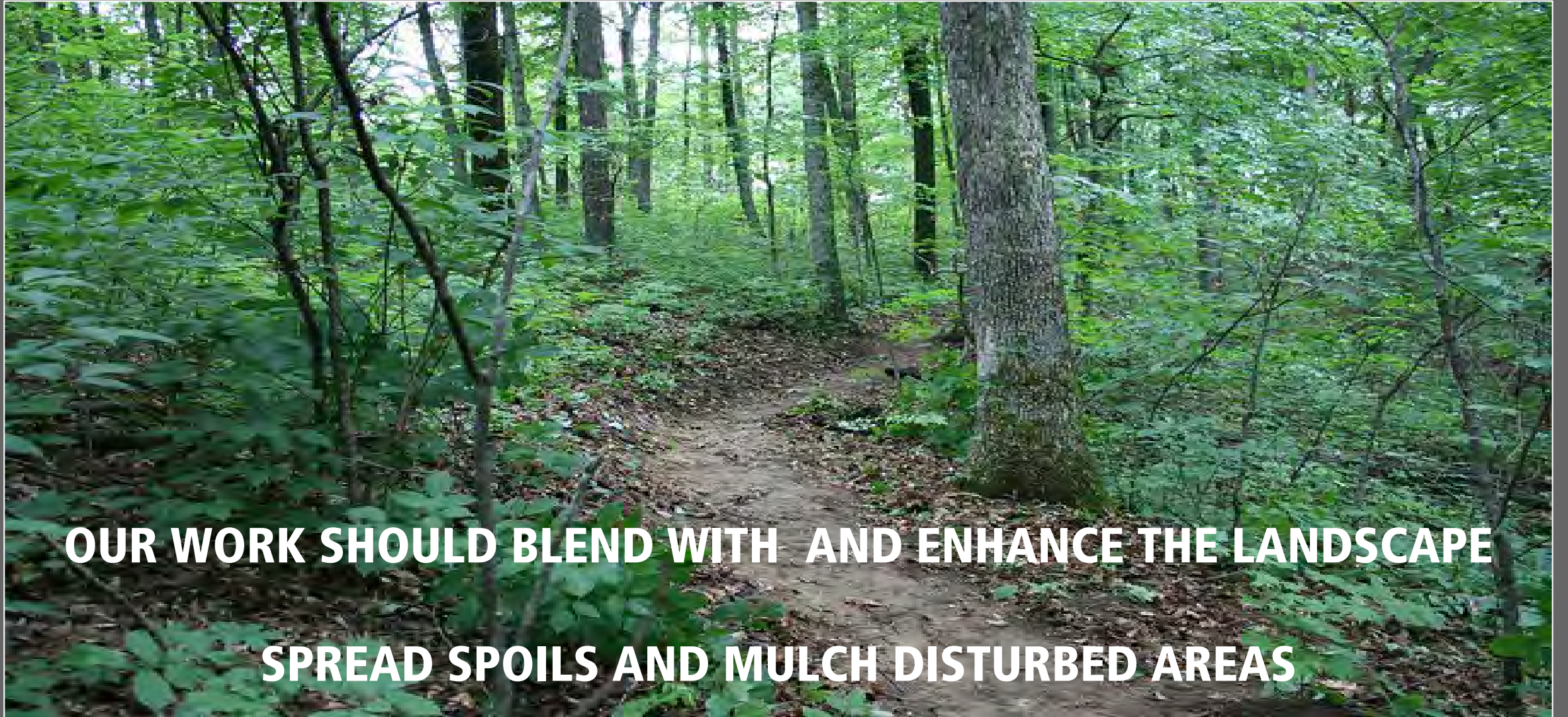
- We recreate to be in nature (most of the time), so it is very important to leave it as we found it
- Naturalization is the process by which we re-wild the trail after construction, this is the very last step prior to opening a trail for use
- In forested areas, leaves, pine needles, and debris are your friend
- What was removed during corridor clearing should be spread over trail edges and critical points to blend the tread back to the un-impacted areas outside the corridor
- If you have enough debris, a leaf blower can work wonders, blowing all organic material back onto the recently built trail and idling down the tread after leaves a nice ribbon of tread exposed
- Cover the backslope if its not a riding surface, make sure gutter lines are clean
- Do not fill your grade reversals or drains!
- The downside edge should always drain, it should not dam water on the trail, ensure the tread always drains
- Roots, trees, and other cut woody debris should be scattered away from the corridor, not piled or placed so its obvious



STABILIZATION

- Essentially the same step as naturalization, this is the process by which we as trailbuilders ensure our site is stable and can be opened for public use
- Generally, stabilization is ensuring loss soil material is minimal, the only expose soils should be the trail tread and it should be compacted (the best compaction is use)
- Insloped sections of trail, turns, and other built up dirt features should be heavily mulched on the outside to "buttress" the pile and help stabilize it
- Steep sideslopes below bench (especially partial benches) may benefit from parallel log or branch placement, these can help act as sediment barriers (especially useful above waterways)
- When naturalized properly, many trails will stabilize quickly
- The seed matter in the organic material will help vegetation take root, which will be the best stabilization possible for the trail





OUR WORK SHOULD BLEND WITH AND ENHANCE THE LANDSCAPE
SPREAD SPOILS AND MULCH DISTURBED AREAS



INTERNATIONAL MOUNTAIN BICYCLING ASSOCIATION

WATER CROSSINGS TIPS

- Identify water crossings as key control points
- Carefully design crossing approaches (both grade and alignment)
- Include grade reversals before and after (much like turns)
- Find stable location (especially important for larger streams/rivers)
- Don't constrict flow
- Crossing should be at the bottom of a grade reversal, the lowest point, if not water will flow down your trail



WATER CROSSINGS TIPS

- No corduroy! (Picture to the left) . If there is a wet spot properly mitigate it through armoring, relocation, or structure
- Much like turns, forcing water crossings into the wrong location will continue to cause issues
- Water crossings are one of the most likely to trigger compliance
- Water crossings are some of the biggest maintenance concerns, further reason to site them properly
- Crossing type depends largely on visitor and trail types



WATER CROSSINGS TYPES

Natural Ford (at-grade)

- Easiest to build (its natural! But likely requires good approach and exits)
- Can be hardest to find/locate during planning/design
- Only feasible in certain situations, both terrain/landscape and compliance/regulatory
- May only be feasible for certain visitor types on specific trail types

Constructed/Armored Ford (at-grade)

- Simpler than bridges in most instances
- Generally need similar landscape situations as natural fords
- May require regulatory compliance (401/404)
- Typically the best option for ephemeral or seasonal drainages
- May only be feasible for certain visitor types on specific trail types

Bridge

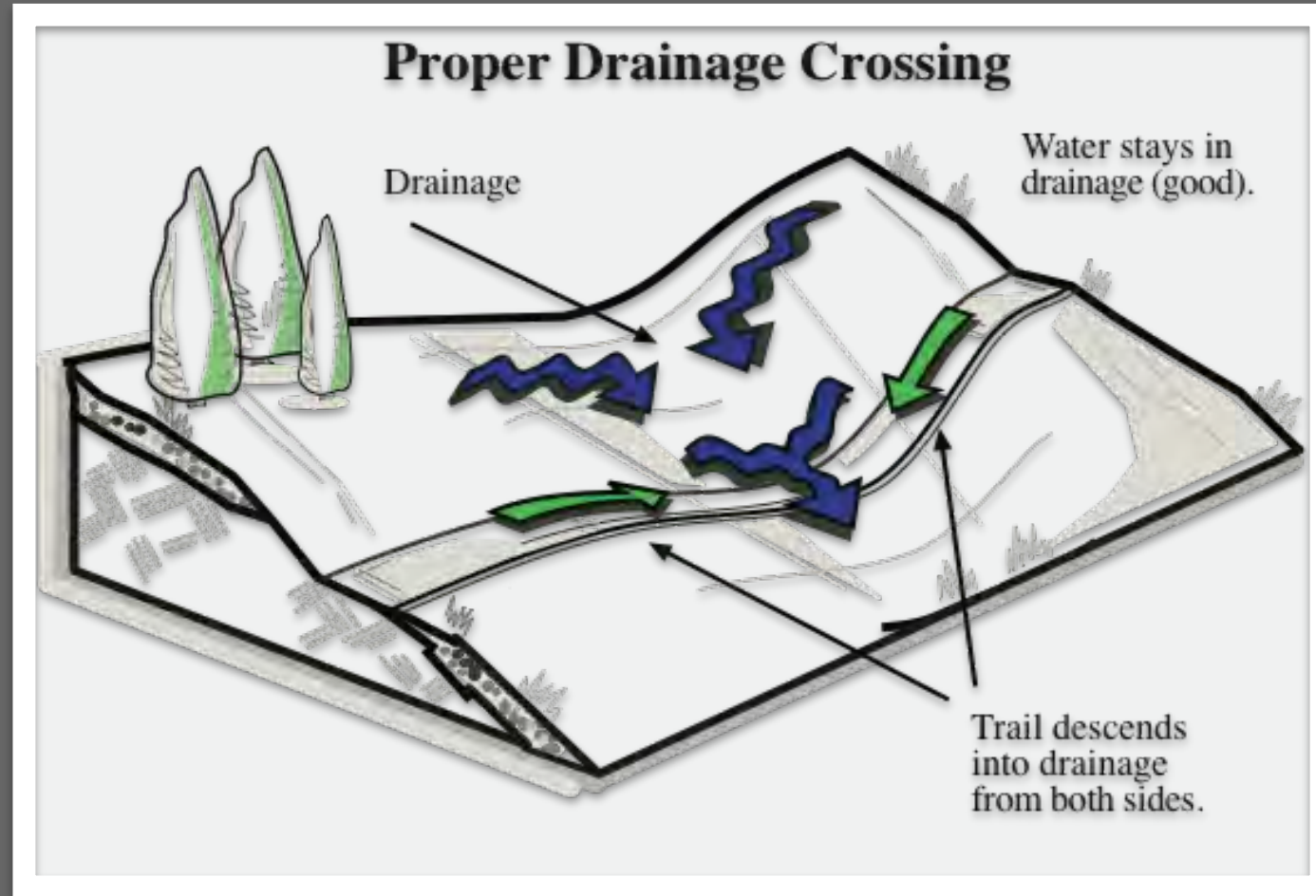
- Typically requires the most design, regulatory compliance, and cost
- Typically used to cross wide or deep streams, rivers, and channels

Boardwalk

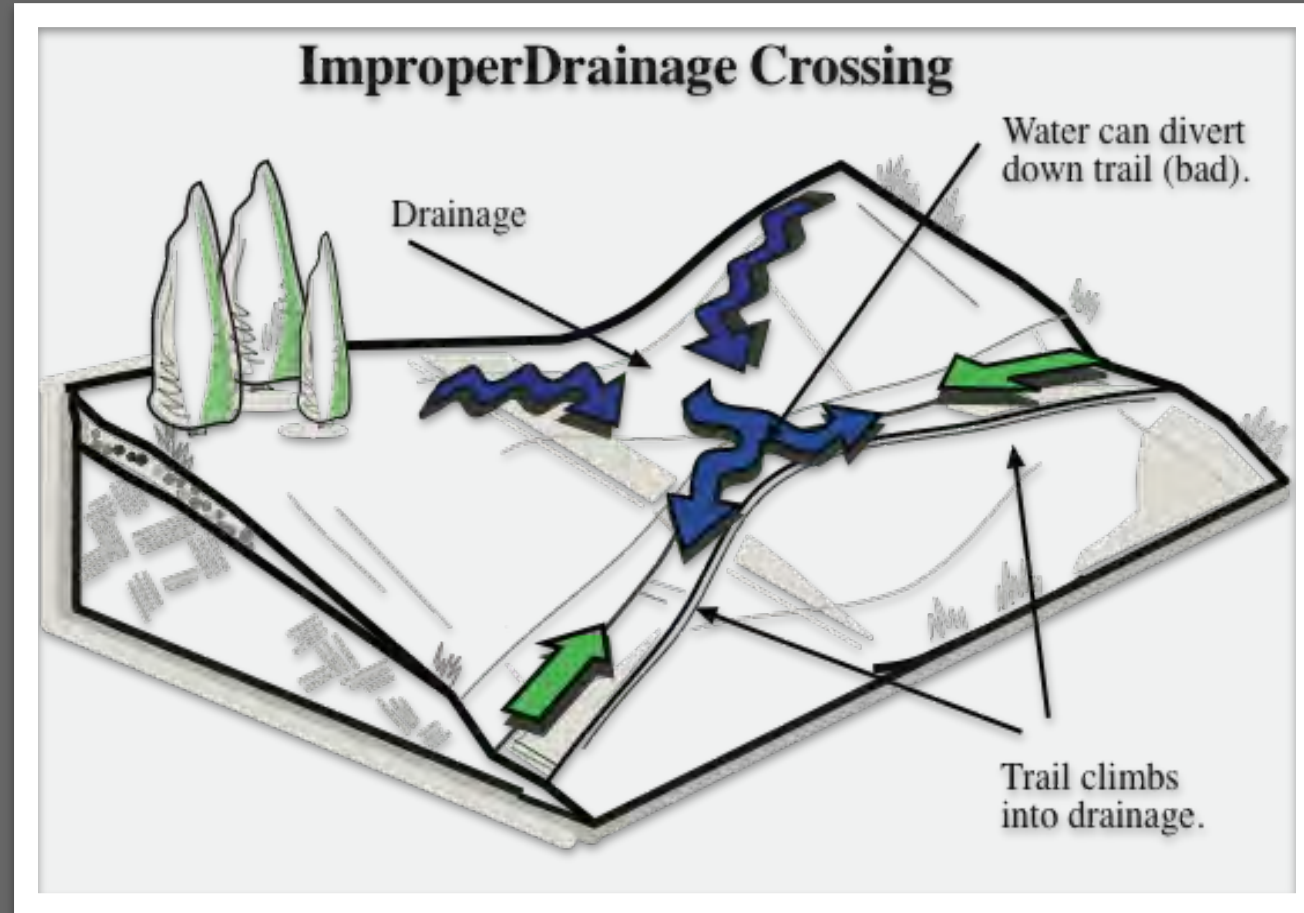
- Similar to bridges, these built structures can require expensive engineering, design, permitting, installation, and maintenance
- Typically used to cross wetlands or marshy areas.



WATER CROSSINGS



WATER CROSSINGS



CROSSINGS FOCUSED WATER



NATURAL FORDS

- Natural crossings (pictured) are rare both in terrain and compliance
- Generally these crossings will involve visitors getting wet at some point during the year
- These may provide useful options for equestrian crossings on shared-use trails that utilize another method (armored ford, bridge, etc.) for pedestrians and mountain bikers
- While the stream or channel bottom may be left intact, armored approach and exits will increase crossing lifespan and reduce nearby trail maintenance
- These crossing types are most appropriate in backcountry and remote settings, where crossing a water feature fits nicely with the aesthetic and experience



ARMORED FORDS/CROSSINGS

- Armored fords and crossings (pictured) are generally some of the most prolific water crossing types
- These crossings may or may not be wet
- When armoring a drainage crossing it is important to ensure the armoring will not dam or constrict flow
- The lowest point should always match up the original channel and be on the downside edge of the trail tread
- Generally anchoring is recommended at the approach and exits to guide visitors over the armoring
- Approaches and exits much also be armored to increase lifespan and reduce nearby trail maintenance
- Largest rocks should anchor the entire armoring (more on this in rock armoring)



ARMORED FORDS/CROSSINGS



ARMORED FORDS/CROSSINGS



ARMORED FORDS/CROSSINGS

- Grade reversal prior to crossing
- Lowest point in the channel/downside edge of trail tread
- Armored approach/exits
- Riprap below armoring to protect rocks/dissipate water energy



SEEPS

- Seeps should be treated like armored fords and crossings
- Identifying seeps may be difficult during planning/design, in fact seeps may form over time due to trail construction and use
- Seeps should be armored to increase trail lifespan and reduce maintenance needs, while also increasing positive experiences for visitors



ROCK ARMORING

WHY ROCK ARMORING?

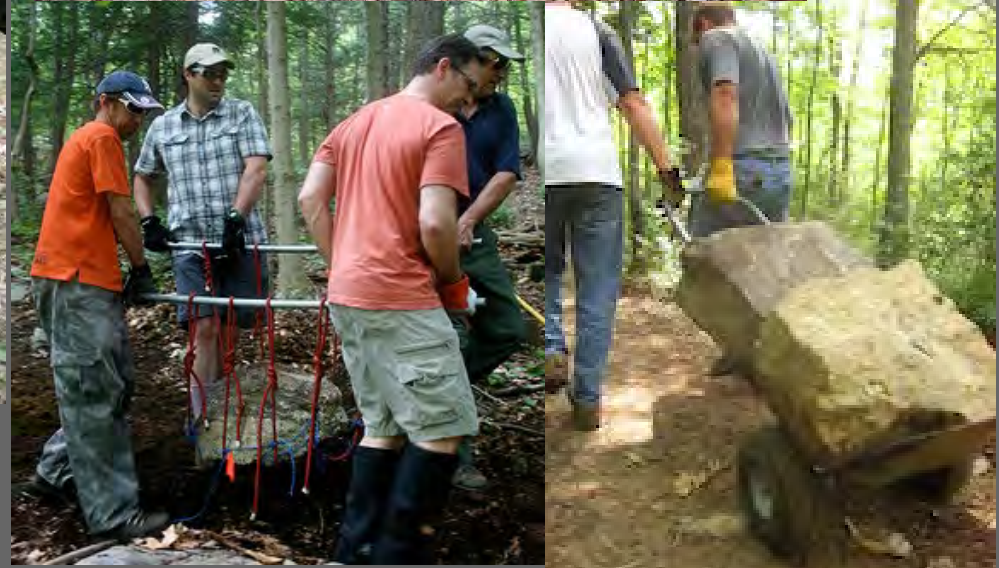
- Fortify Wet Areas
- Stop User-Based Erosion
- More Durable
- Add Technical Challenge
- Increase Difficulty Level
- Optional Lines/Skills Progression
- Visitor Management
- Diversify Trail Experiences
- Create a Natural Feel

MOVING ROCKS SAFELY

- Lift smart
- Share the load
- Use the right tools
- Slow down



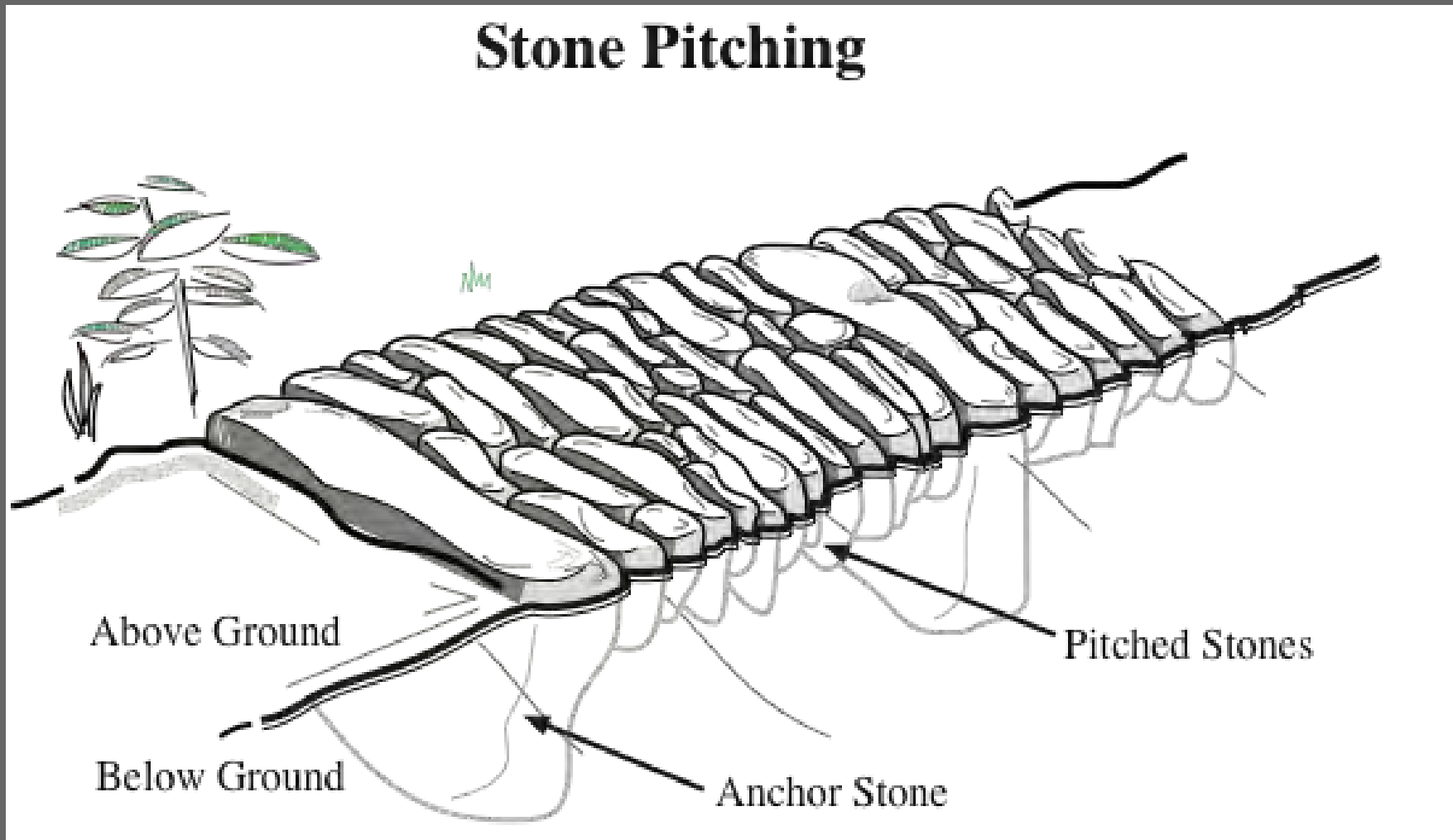
MOVING ROCKS SAFELY



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ROCK ARMORING

Stone Pitching



ROCK ARMORING

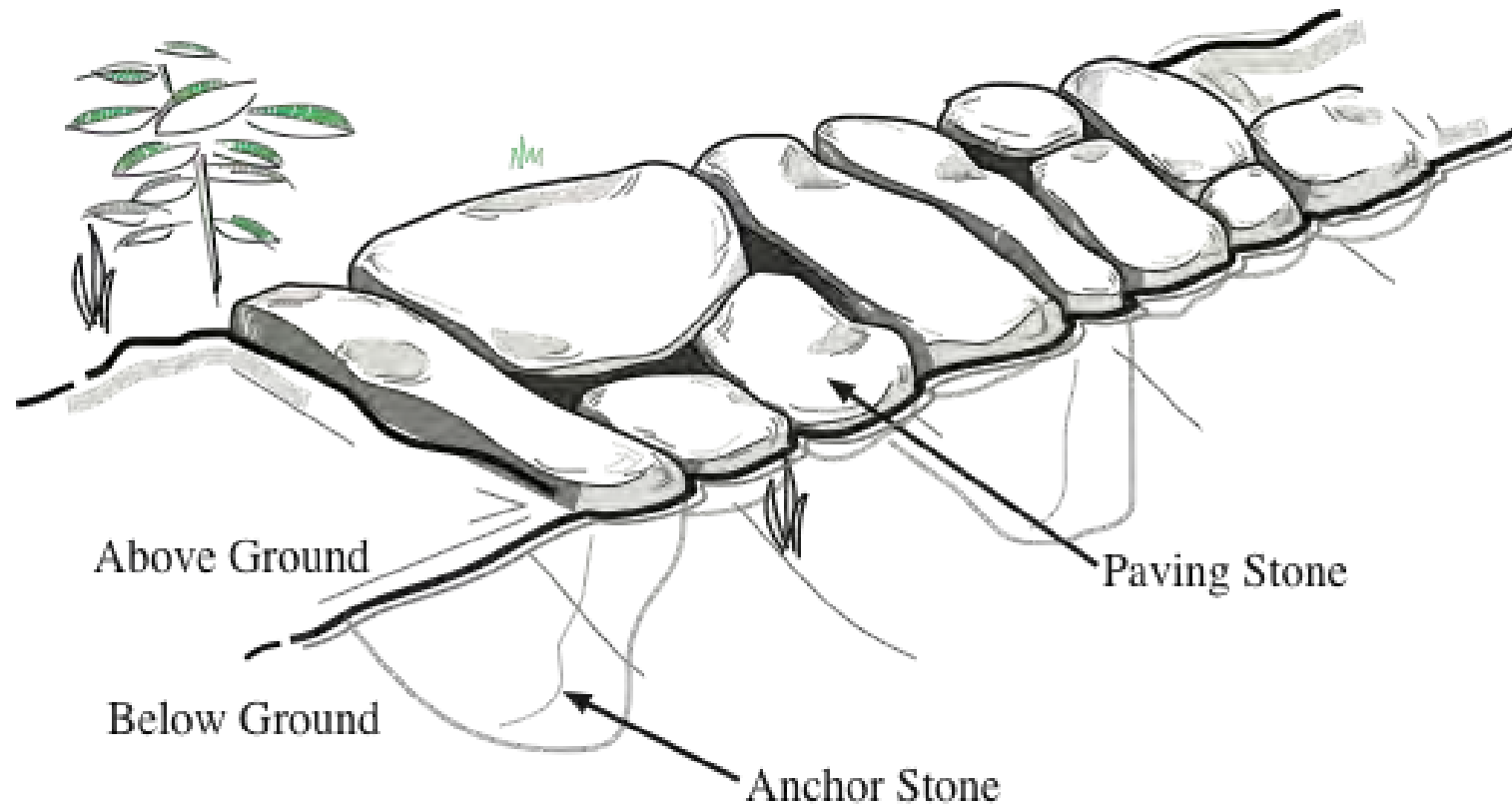


STONE PITCHING



ROCK ARMORING

Flagstone Paving



FLAGSTONE PAVING



FLAGSTONE PAVING



FLAGSTONE PAVING



FLAGSTONE PAVING

FOUNDATION ARMORING

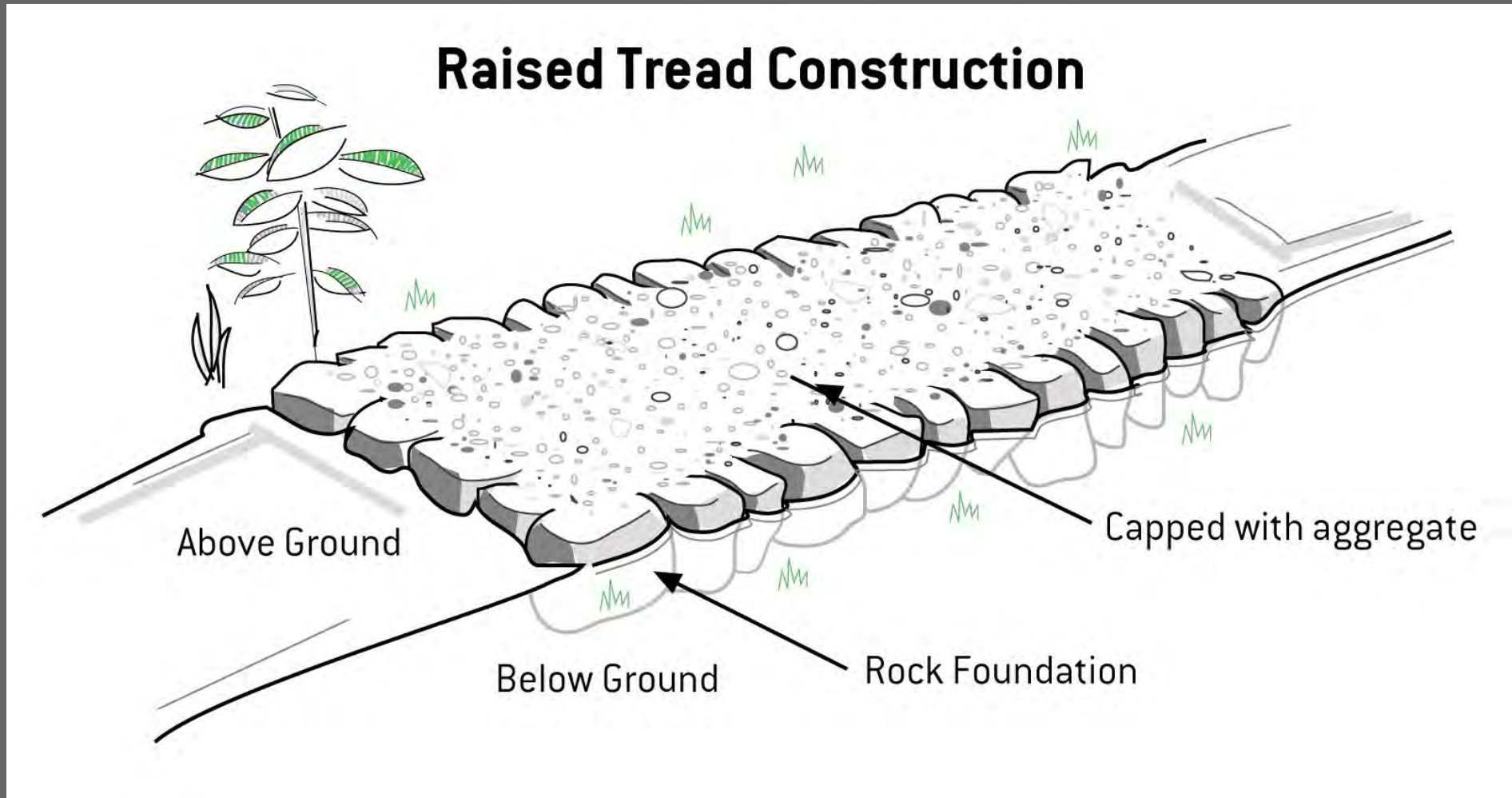


FOUNDATION ARMORING

- Used in wet areas
- Natural construction is typically better than wooden features
- Rocks will wear through, depending on goals may require heavy maintenance
- Substrate can be gravel up to large stones



RAISED TREAD



RAISED TREAD

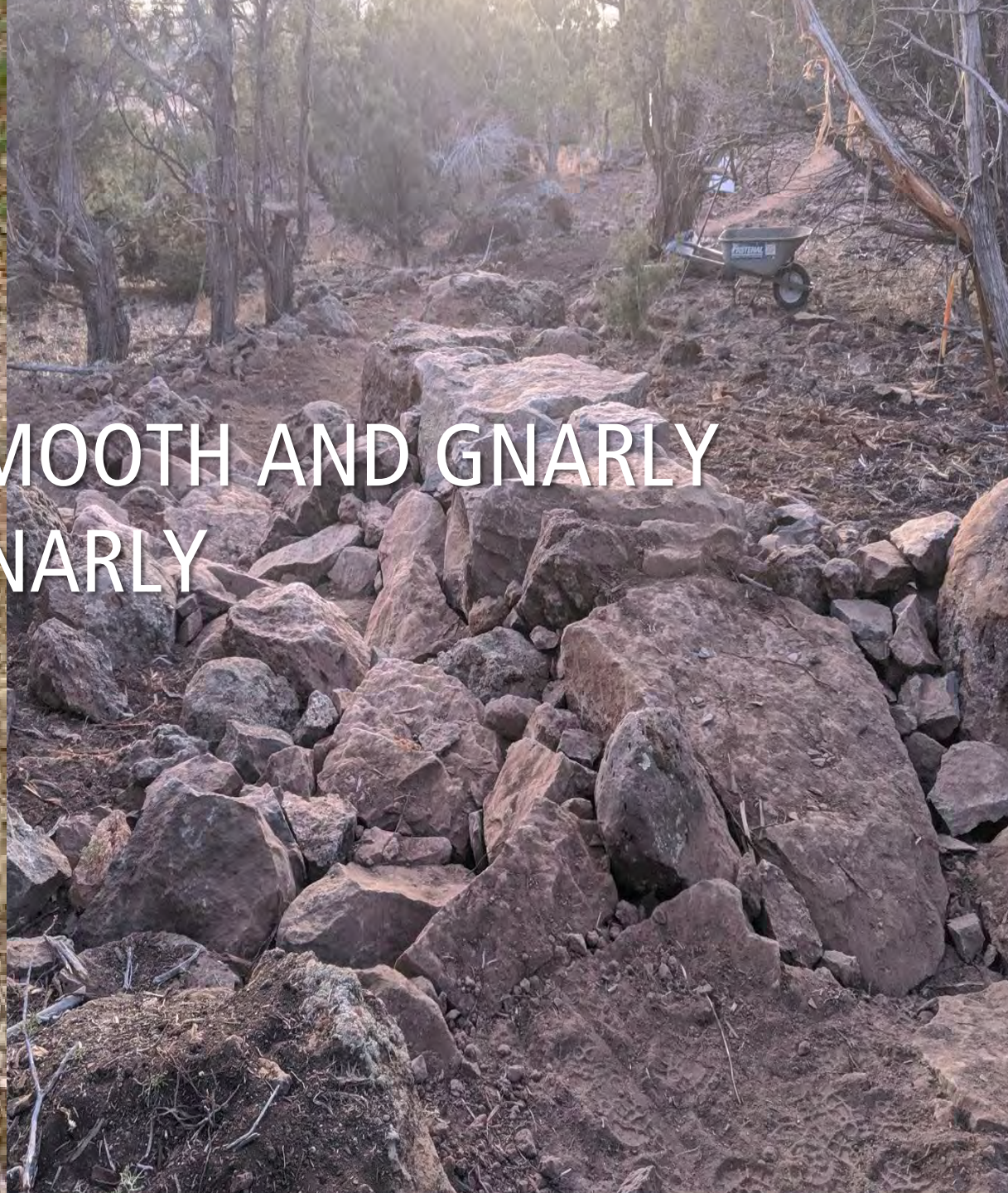


RAISED TREAD



RAISED TREAD



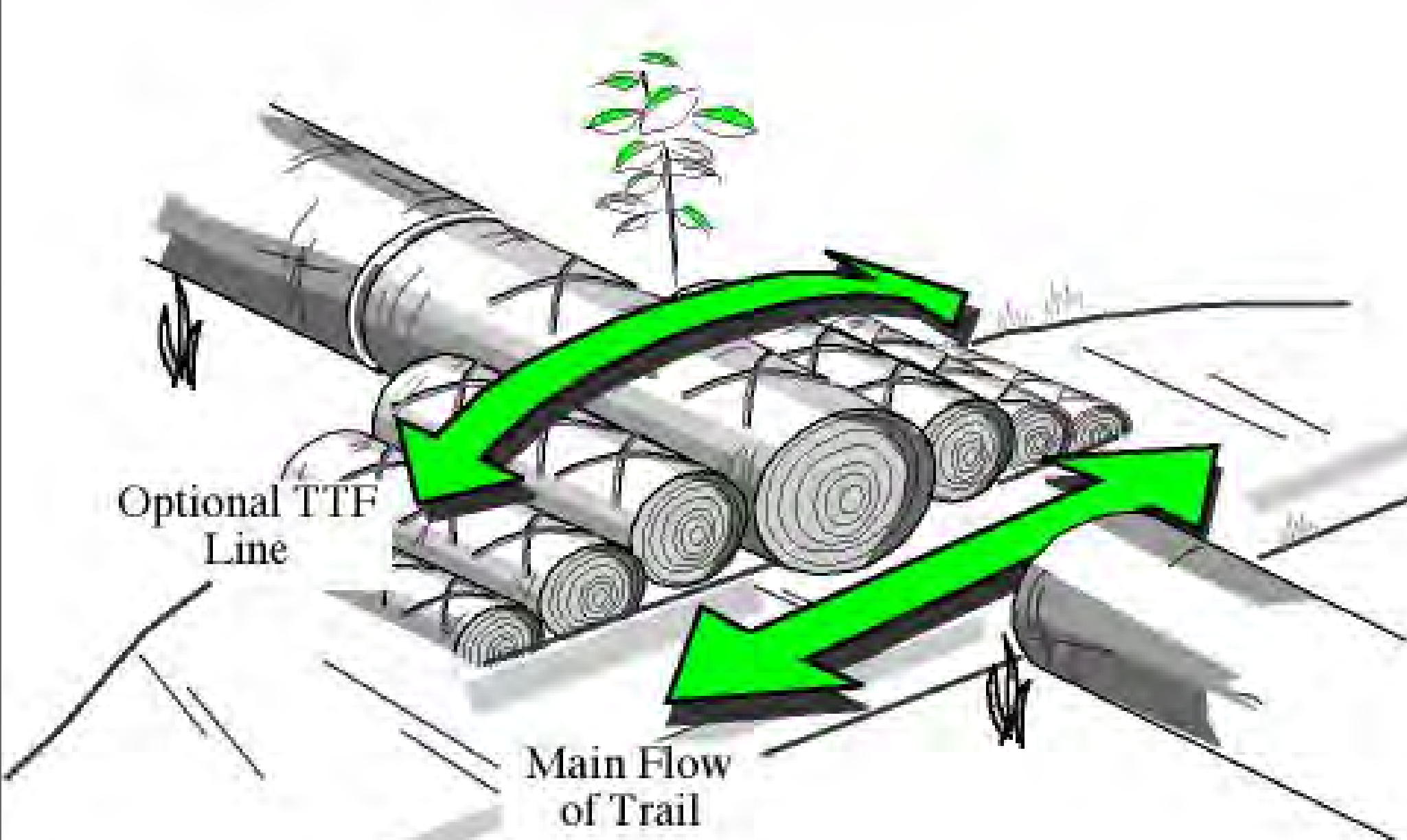


KEEP SMOOTH TRAILS SMOOTH AND GNARLY
TRAILS GNARLY

OPTIONAL FEATURES

- Optional features (A-line/B-line, alternate lines, etc.) are features or very short segments of optional trail that provide a different difficulty level challenge than the actual trail
- They provide a wide variety of visitor management potential and add tremendously to trail systems
- Providing on trail opportunities for riders to challenge themselves and “level up” is a great way to provide risk management and progression
- Often humans learn best by watching, and see its possible, others – optional features in trails create chances for riders to see others accomplish the feature and realize they too can do it!
- For best results, optional features or alternate lines should reward to visitor – generally this means providing a faster way to travel the trail
- I.E. a rock garden on the inside of a slight chicane will be more likely to be ridden because it rewards riders who want to tackle the chunky texture with a faster more direct line
- Feature placement can be very subtle, blend with nature, and provide alternate benefits
- I.E. an anchor stone can be place on the outside edge such that walkers, runners, and beginner mountain bikers avoid it (it pushes them inside, as an anchor is intended to do) – but the skilled rider may see that stone as a side hit, something to grab air off of, especially if it sets them up nicely into a roller/landing
- Alternate lines should be very visible, if they are hidden from sight its unlikely they will be regularly used
- Signage can be very important, if the A-line is a large drop that is out of place for the trail, a sign denoting its advanced skill may be advised
- Signage can also point out alternate lines that may not be obvious, if they veer from the trail significantly
- Good sightlines on alternate lines are important, especially if the line requires more speed the user may carry as they merge back onto the trail





Optional TTF
Line

Main Flow
of Trail

FEATURES



AG
Arkansas
Outside.com



FEATURES



FEATURES



OPTIONAL LINES





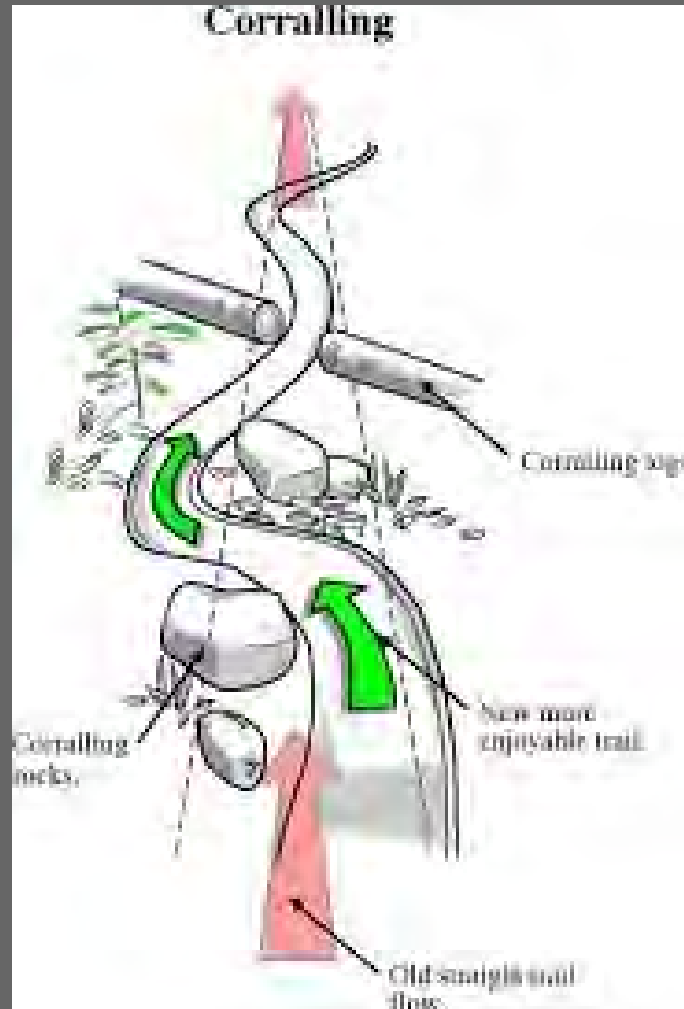
PROGRESSION

SHARED-USE VISITOR MANAGEMENT

- Shared-use trails are typically the most prone to negative social interactions
- The leading cause of a negative experience between visitors is surprise – generally due to speed differentials in their rate of travel
- Reducing visitors speed, especially before places where interaction between visitors is highest, is the key to successful shared-use trails
- Corraling, gateways, and anchoring – using natural features like trees, downed logs, or rocks to pinch the trail down
- Generally, anchoring the downside edge is advised as the uphill side is anchored by the backslope
- Steep sideslopes mean narrow benches and steep backslopes, these will be more difficult for passing, can you leave room in some places for people to get off tread?
- Humans generally avoid large steps, rocks, awkward footing, roots, anything that resembles a harder path – they look for the easiest way!
- To keep visitors on your trail tread, especially if its rough, uneven, etc. – anchor your trail!
- Uphills are the best way to slow visitor speeds – but tight gateways and rocky rumble strips are also useful techniques
- Sightlines are vital to good shared-use trails, ensure your sightlines are regularly opened up and meet the speed differential of the visitors using the trail



VISITOR MANAGEMENT



VISITOR MANAGEMENT



MAINTENANCE AND COMMON DRAINAGE SOLUTIONS

TRAIL MAINTENANCE

Develop a work Plan

Identify problems and solutions that:

- Improve The Trail
- Don't cause new problems
- Are achievable with the tools and team available

Not everything will be fixable, so don't try.

- Choose successful locations
- Skip hopeless sections and document for trail manager



TRAIL MAINTENANCE

Develop a work Plan

Three common maintenance types

1. Tread erosion from running water and visitors
2. Soft or muddy tread from puddling and seeps
3. Trail corridor brushing and sightline clearing



TRAIL MAINTENANCE

Develop a work Plan

Problem: Erosion by moving water and/or visitors

Symptoms: Rills, gullies, headcutting, deposition, skid marks

Solutions: Drains, Grade reversals & armoring

Important questions:

- Can we get the water off the trail and keep it off?
- Does the trail break the half rule ? (falline)
- Can WE place the drain in place where it won't be awkward
- How steep is it
- Is there any rock and will riders be happy we used it?



TRAIL MAINTENANCE

Develop a work Plan

Problem: Soft or Muddy tread from puddling or seeps

Symptoms: Wet and soft when rest of tread is dry

Solutions: Outslope, Elevate, foundation, armor

Important questions:

- Can we get the water off the trail to dry it out?
- Can we move the trail just a little to get it to a higher location?
- Why is it wet? Is it a low spot or groundwater?
- Is there rock or stone available and will riders be happy we used it?



TRAIL MAINTENANCE

Develop a work Plan

Problem: Trail or sightlines are obscured and causing visitor unhappiness

Symptoms: overgrown trail, logs down, short sightlines

Solutions: Pruning and swamping (cutting & dragging)

Important questions:

- Water is the expected corridor limits?
- What tools can we use?
- What is the preferred sightline distance?
- Any limits on what we can prune?
- Is there poison ivy or oak?



TRAIL MAINTENANCE

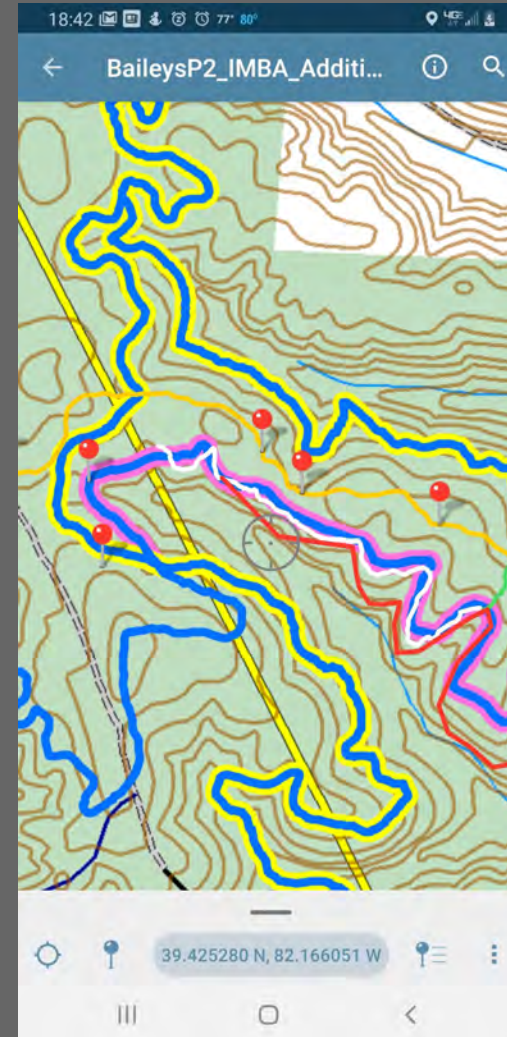
Monitor your trail

Document trail conditions

- Geo- referenced photos
- Videos (360)
- Maps
- Inspection logs
- Avenza Pro Map app

Informed decisions

- Help plan the next work days
- Provide information to land manger on conditions
- Identify sections that require additional help



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TRAIL MAINTENANCE

Safety First!

Personal Protective Equipment

Head – hard hat

Feet – solid shoes or boots

Eyes – glasses or goggles

Hands – Gloves

Legs - pants

Other – first aid kit and bug spray

Proper Clothing and Protection

Tool and Safety talk before work

Emergency action plan



PUDDLES AND MUDHOLES

Why is it wet - seep or puddle?

Puddles are filled with surface collected stormwater with no subsurface flow

Seeps are places where groundwater comes to the surface.

Puddle Solutions:

- Drain downslope if cupped on slope
- Regrade trail so it drains to somewhere lower than it.
- Elevate trail tread with compacted soil fill.
- improve material to handle being wet if grading can't keep it dry



PUDDLES AND MUDHOLES



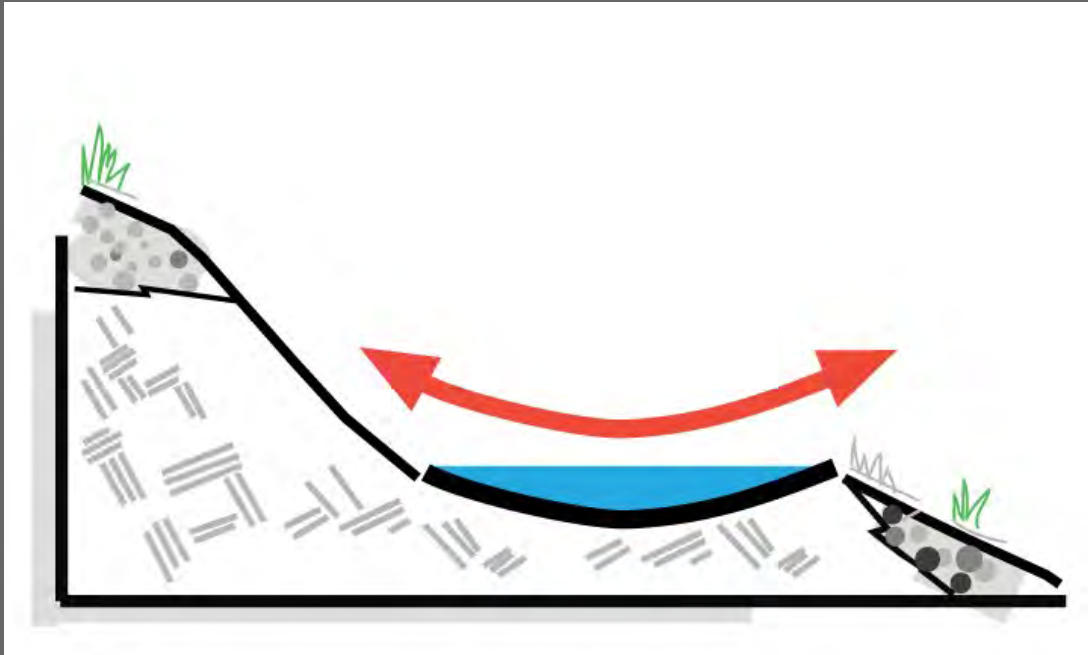
Seeps and places that stay wet

- Fed by subsurface flow
- Porous solutions such as pitching and foundation all less likely to create a dam

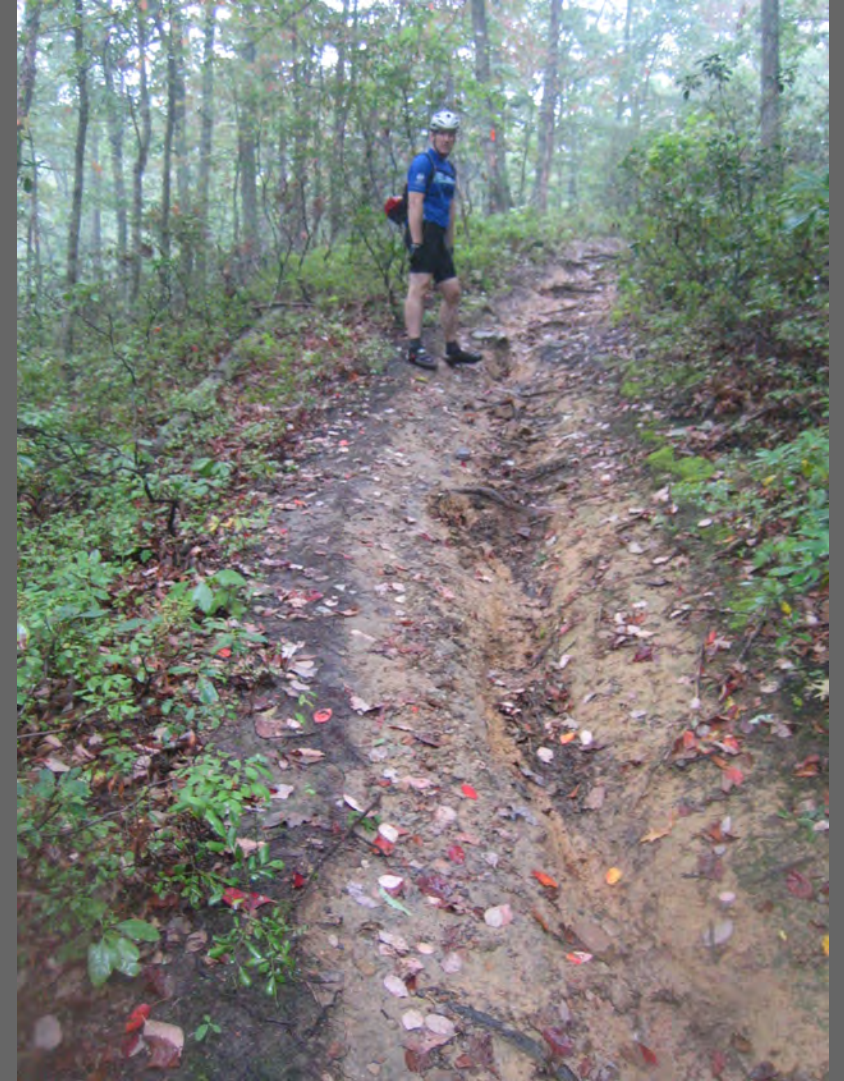
Works when wet:

- Raised tread (rock or stone fill above grade)
- Foundation (rock or gravel fill below grade)
- Flagstones and/or pitched stones

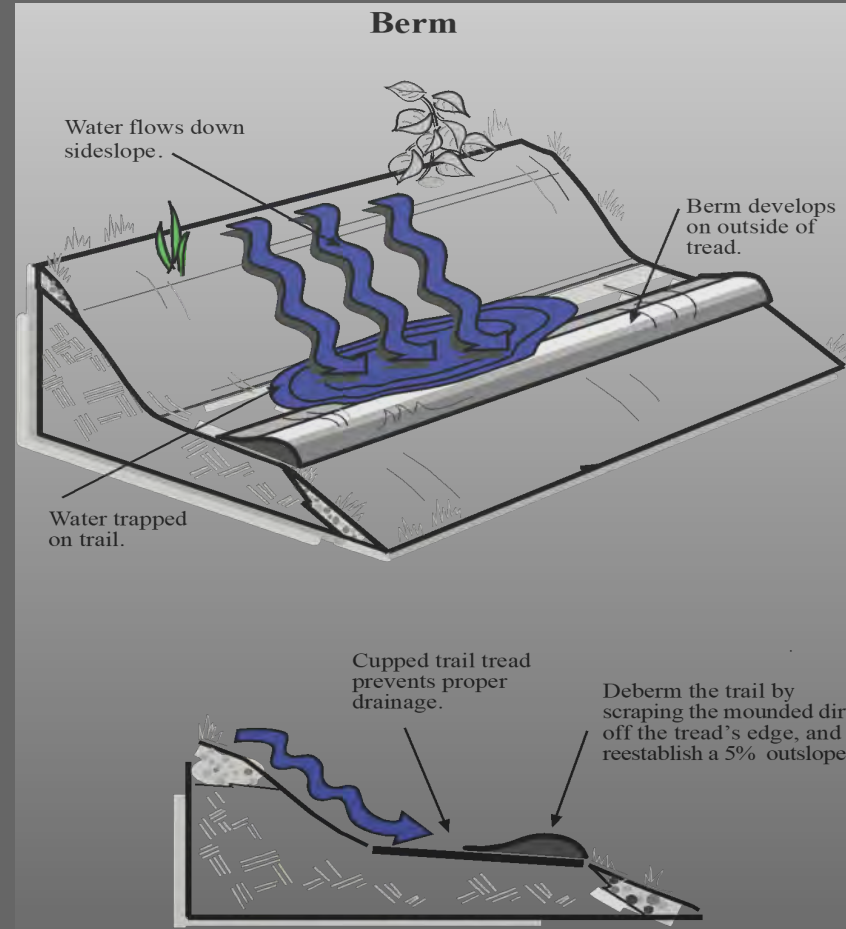
TRAIL CUPPING



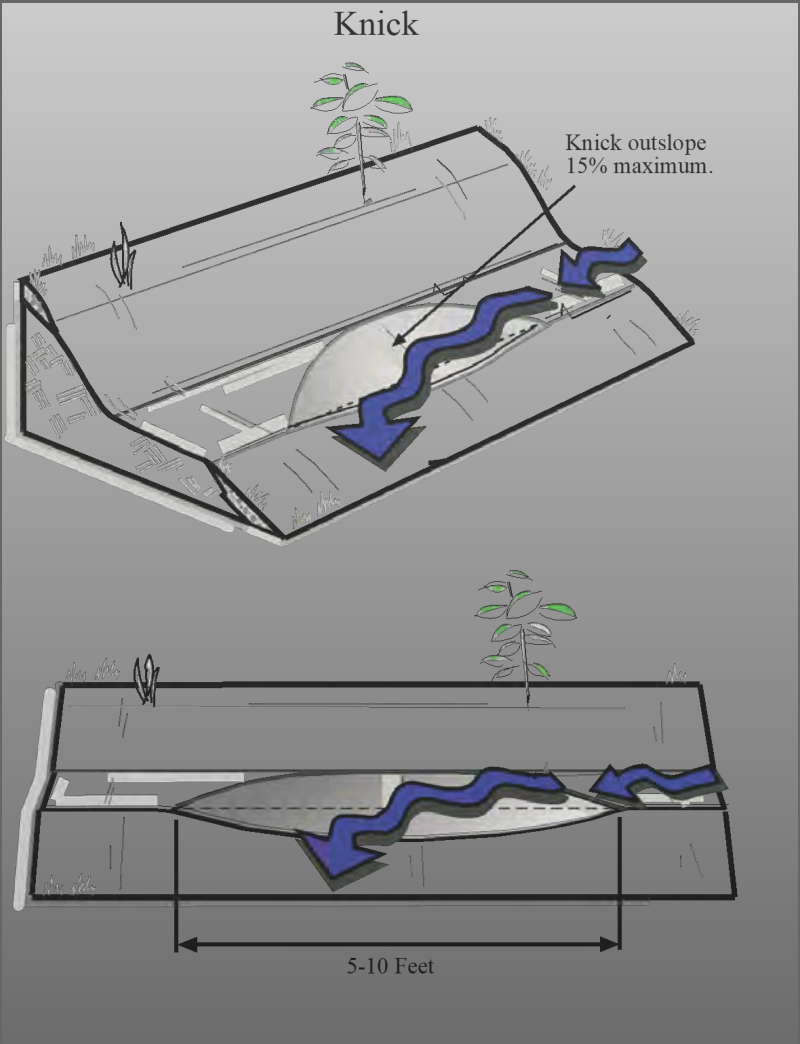
TRAIL TRENCHING



TRAIL TRENCHING



KNICK



KNICK

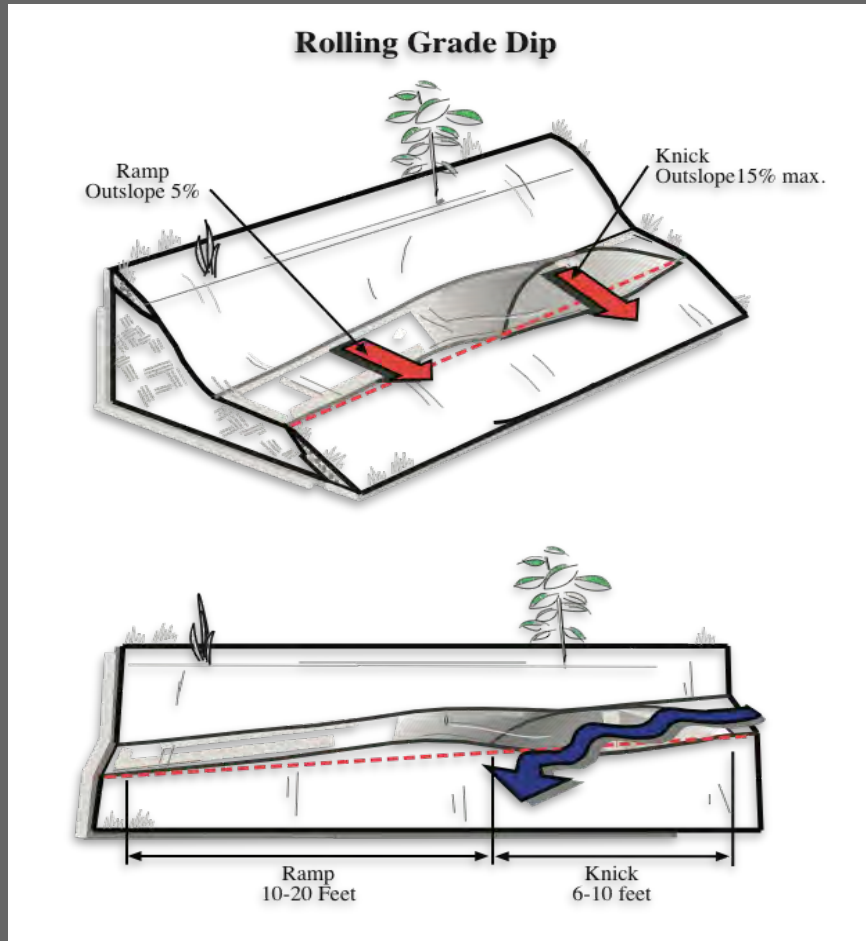




CAN THE TREAD BE MOVED TO ADJACENT HIGH GROUND?



ROLLING GRADE DIP



Drain needs to be steeper than trail grade.

Dip and rise need to be longer than the wheelbase of a bike (6+ feet).

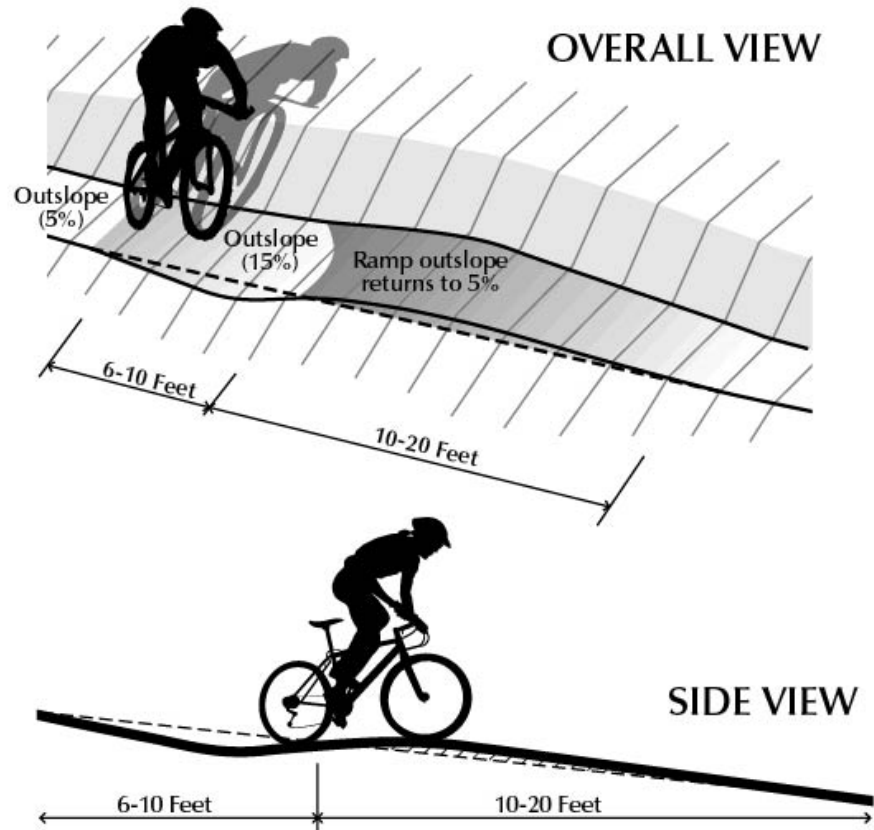
Compaction; expect settling.

You may need to armor the drain.

You can build core of ramp out of small rocks, then cover with soil.

Frequency and placement.

ROLLING GRADE DIP



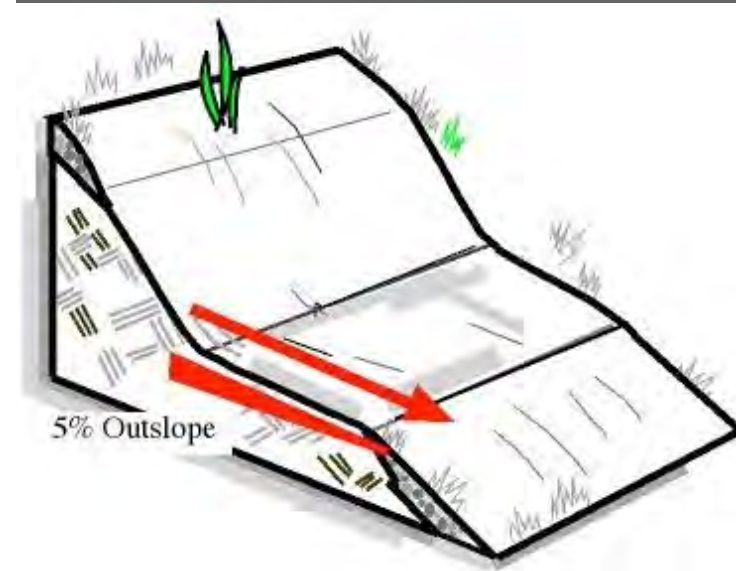
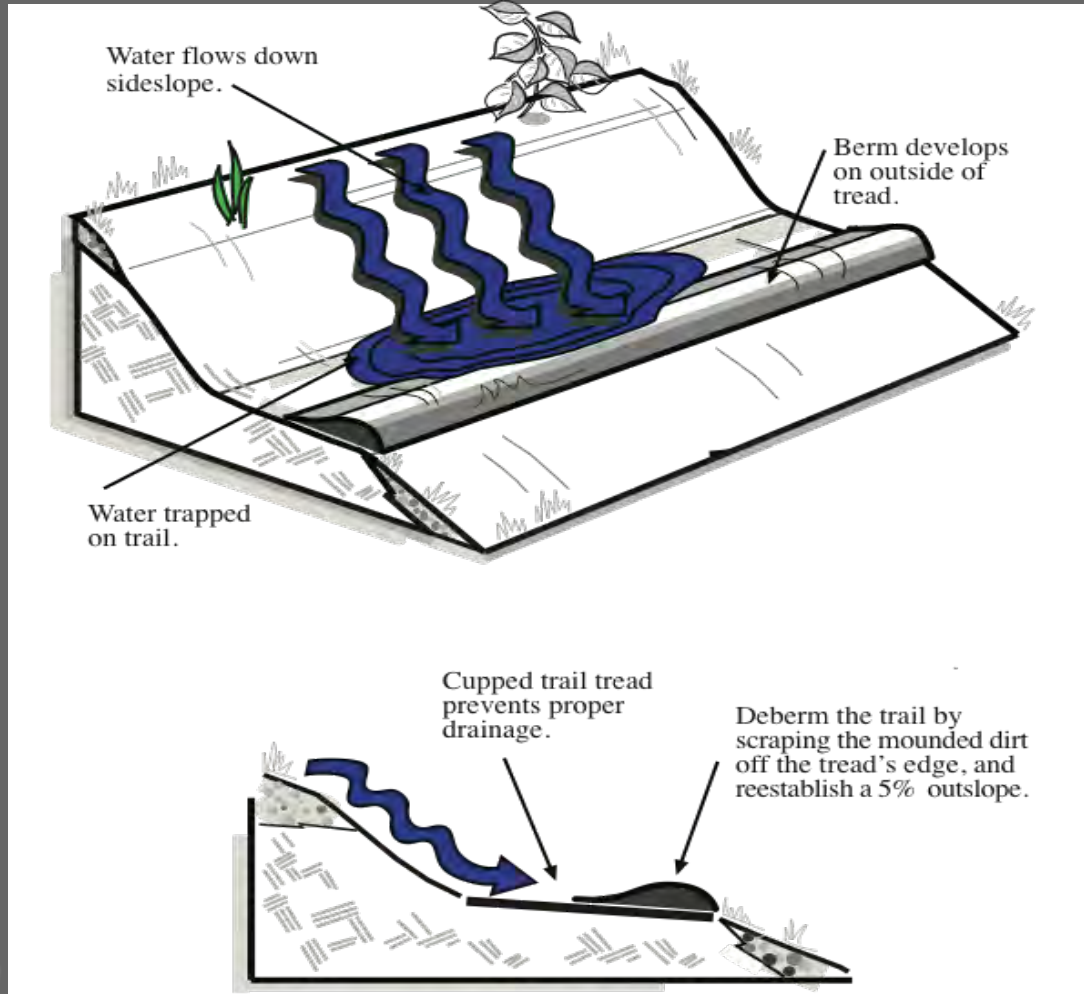
The most sustainable alternative to water bars. Rolling grade dips are large enough to be self-cleaning and subtle enough that users do not go around them. Dip itself is longer than a bicycle and shaped like a knick. Bondable soil from dip is used to build a long gentle ramp downtrail from dip. Ramp is nearly twice as long as

KTGA



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DEBERMING



CORRIDOR CLEARING



- Ensure the trail corridor is passable until the next maintenance interval.
- Make sure sightlines are sufficient.
- Note and document material to big to safely handle. (Geotagged photo with scale item)



WATER BARS

WATER BARS

Water starts to channelize, gaining volume/velocity and picking up sediment

An obstacle abruptly changes the direction of the water, causing it to dump sediment behind the object

The water continues to erode soil on the down hill side of the obstacle



USING MACHINES



Photo courtesy of IMBA, www.imba.com



Photo courtesy of IMBA, www.imba.com



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USING MACHINES



USING MACHINES



photo courtesy of - IMBA - www.imba.com



photo courtesy of - IMBA - www.imba.com

MACHINES

- Very useful!
- Very powerful!
- May trigger more scrutiny!
- Should only be operated by someone familiar with that machine in that landscape!
- Trailbuilding involves taking machines to places they really shouldn't be in many cases.
- Can you get the machine out? Know how to extract and rescue a machine before you take it in the woods.
- Machines add risk – do you have the proper PPE? Always be aware of your surroundings!
- While skilled operators can do a lot of things, hand building will almost always result in a lower impact, more intimate/natural, trail experience.



KEY IDEAS

What is the intended experience of this trail?

Progression and diversity.

Riders look for difficulty level and styles.

Grade reversals, grade reversals, grade reversals.

Long and shallow.

Rocks help with a lot!

Machines can make a larger disturbance.

Naturalization is very important



RECAP

- Plan, plan, plan
- Experiences not activities
- Build on the contour
- Grade reversals for drainage
- Use a clinometer
- Half rule, 10% average, outslope
- Turns and intersections require careful design
- Rock armoring solves lots of problems





THANK YOU!



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