The Devil is in the Details: Common trail design mistakes & how to avoid them

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General

Instead of This....

- Not enough of the details of trail design get considered during the planning and design stages of trail development
- This can lead to:
  - —Project delays
  - —Permitting problems
  - —Expensive re-designs
  - —Construction “surprises”
  - —Cost overruns
  - —Loss of grant funding due to long delays
  - —Trail condition problems
  - —Shorter trail lifespan
  - —Hazards for trail users, increased accidents
  - —Increased maintenance needs
  - —Lawsuits

Do This...

- Take the time to research and consider the design details during the planning stage of your trail project, when things can most easily be adjusted
- Walk your proposed alignments—more than once. You can’t plan trails from your computer or from a car (this is the fun part!)
- Designing hard surface trails is not the same as designing roads, or natural surface trails. Experts in these may not be experienced or knowledgeable about designing hard surface trails
- Consider the details especially during preliminary design, when preparing your cost estimate. It is easier to add items before your budget is approved than after
- If you use a contractor for trail design, check out not only the company’s experience & expertise with hard surface trails, but the individual’s who will work on your project.
- Give your design contractor the latest trail design standards from your DOT, AASHTO and others.
- Take advantage of the free advice and information provided by government natural resource and transportation staff
- Consult trail managers, maintenance staff, trail user groups, and police in your area for their advice on what design elements would make the trail easier to manage, maintain, use and monitor
- Don’t re-invent the wheel! Lots of advice is available at www.americantrails.org and other online sources

Planning—constraints first

Instead of This….

- Trails are often planned along the path of least resistance, such as a publicly owned right-of-way, or a traditional travel route, or a straight line between origins and destinations, without enough thought given to construction constraints and safety
- Especially troublesome are road crossings at places with high vehicular speeds, limited sight lines, and multiple lanes with no median
- It is much harder to retrofit a safer solution to a poor crossing location, than to plan your trail to cross at the safest place before construction. If you try to divert them to a safer crossing that is out of their way, trail users will tend to dash across where the trail is instead

Do This...

- If you are designing long distance trails and have a choice of alignments, consider the constraints to development and safety early in the planning process
- Design your trail to cross major highways at places with lower posted speeds, fewer vehicular lanes, shorter crossing distances, good sight lines, and preferably at an existing signalized intersection. Then design your trail to meet the crossing location
- Consult with the appropriate road management agency early in the planning process to assure permission to cross where you want before you finalize your trail alignment
- Consider river crossing locations early in the planning process as well. Rivers move over time. Straight sections tend to move less, so your bridge foundation will be less at risk of being undermined by water later than on fast moving river bends. Consult an experienced bridge engineer during your planning process

Environmental planning/permitting

Instead of This….

- The “we’ll handle that during Engineering” approach to environmental issues has caused countless cost overruns, project delays, and has even resulted in projects having to turn back their grant money.
- Don’t wait until you have your grant, and you’re submitting your design to permitting agencies to find out whether there are any environmental issues in your trail corridor
- Don’t buy any land for your trail corridor until you have determined whether there are any sensitive environmental areas on it that should be avoides
- Wetlands; floodplains; and rare, threatened or endangered species are common trail planning issues that should be dealt with early
- Your state or local government may have other environmental regulations, such as required buffers, protected habitat types, etc.
- Permitting agencies are sometimes reluctant to provide information until you submit a complete design. This may be due to habit, laziness or understaffing. The enlightened employees will welcome you consulting with them early in your planning process to avoid permitting issues later.

Do This...

- Much environmental data can be found online. Take the time to do this during your planning process
- Avoid permitting issues by selecting your trail alignment to AVOID sensitive environmental areas, whenever possible. If you research environmental issues early in your planning process, you can choose another alignment.
- If your corridor choices are limited and you must go near or through sensitive areas consult your permitting agencies. Be persistent. Tell them you are trying to avoid permitting problems later by consulting with them early. Assure them that you will consider their comments “preliminary” or “advisory”. They don’t want ot be held to what they say before they see a design, but their advice can be enlightening.
- Try to get the permitting staff to accompany you on a field visit. Many will appreciate getting g out of the office! In the end they will appreciate not having to deny permits and review plan changes.

Water pooling/Culverts

Instead of This....

Do This...

Trail is in between these road culverts and a wetland with no culvert under the trail

Water damage on trail over a natural drainage channel with no culvert

- Plan how you will get the water off of the trail during the planning or preliminary design stage of a project
- First, AVOID wet areas whenever possible
- Some engineers never think of culverts for trails., and don't include them in the cost estimate. Cost overruns occur if they are added during final design or construction. Frequent water pooling happens if ignored.
- Too small of culverts may cause water to pool on your trial
- Your culvert may collapse if it is not designed to handle the weight of the trail and the vehicles that use it, such as maintenance vehicles

- Consider the water flow in your trail corridor early in your planning process., BEFORE you submit a cost estimate with a grant application
- Size your culverts to meet expected water flow during storms to avoid water polling on the trail
- Consider whether maintenance and/or emergency vehicles will use your trail, and their weight, and design your culverts to handle it.
- Include culverts under the trail in your design, where necessary.

Wetlands

Instead of This....

- As you probably know, wetland regulations require that you first "avoid" wetlands if you can. If that is not possible, then you "minimize" disturbance to wetlands. As the last resort option, you "mitigate" for the wetland disturbance that your trail will cause
- Trail designers sometimes skip the "avoid" and "minimize" options, and go straight to "mitigate", planning to pay for wetland credits in a wetland "bank", which means that a wetland will be developed somewhere else in your area so that there is no net loss of wetland acres. This issue has delayed or even stopped many trail projects. This should not be the first option considered in trail projects, because:

—Permitting agencies do not as readily accept your plan to "mitigate" for trail projects as they do for road projects. Designers used to working on roads often try this and are refused.

—You must prove that you have tried to "avoid" and "minimize" first. If you are aware of wetland issues early enough in the project planning stage, this is possible.

—There may not be any wetland credits to purchase when you want them. Usually there is a defined region from which you can purchase. Most state laws don't let you purchase from across the state in a different habitat type. Check your local and state wetland banking regulations.

Do This...

- Before you have purchased your trail corridor, start by looking up the National Wetlandz Inventory: https://www.fws.gov/wetlands/ and your state for wetland maps. The locations and sizes identified online need to be confirmed on the ground, but it's a start.
- Check your state and local regulations for wetland buffer requirements. These may vary depending on location and habitat type. Check buffer regulations for trails to be located near rivers,, creeks and lakes as well. Some may not allow hard surface trails in buffers.
- Get someone knowledgeable about wetland characteristics to conduct a field visit with you. In many cases, someone will be able to tell where the wetland characteristics end, so that you can avoid a costly wetland "delineation" at the planning stage. When possible, reroute your trail to stay away from the wetland and buffer.
- If you have no other route options, a boardwalk over the wetland that is high enough to allow light and vegetation under it will sometimes be allowed, so that the trail does not disturb the function of the wetland. Providing wetland interpretative signs, and educational programming about wetlands make help convince permitting staff that the disturbance is acceptable.
- If you need to "mitigate" your wetland disturbance, make sure that there are wetland credits available for your project, and include the cost in your budget.

Trees

Instead of This....

Balm of Gilead tree (balsam poplar) causes extensive trail damage in northern US from root suckoring

- Trees add shade and beauty to the trail experience,, but also can damage trails with roots and root suckoring
- Trees can also be damaged and die if trails are constructed too close to them
- How close can you built a trail near existing trees before the tree will be damaged, or the trail will have endless root damage?

Do This...

- A rule of thumb is to stay outside of the “drip line”, or the extent of the tree’s canopy to minimize damage to trees. The distance to build away from trees that you want to save depends on the type of tree. Consult a forester before you finalize your design ; realign the trail if feasible
- Some trees proliferate through root suckoring, such as the Balm of Gilead tree in the northern US forests. During trail planning, stay away from groves of these types of trees to avoid endless maintenance problems
- Building in root barriers on the trail edge can limit root intrusion
- For existing trails, Some trail managers are cutting back root suckoring trees at least 15’ from the trail edges to minimize trail surface damage

Attracting tourists

Instead of This....

- One of the purposes of major trail development is often to attract tourists, yet some trails are difficult to find, and lack some of the features and amenities that welcome tourists
- Trailheads and parking are sometimes difficult to find by motor vehicle
- Connections to towns may be unsigned, require travel on facilities in poor condition, and/or unwelcoming. If a trail user cannot see a town from the main trail, they are less likely to stop
- Trailheads that don't offer information and encouragement for trail users to enter a town will get passed by

Do This...

Interactive computer map & info outside at trailhead

- Design your trail alignment to pass close enough by attractive parts of town to encourage trail users to stop, or align the trail directly through or on the edge of town
- Provide a well-marked, good quality connection (trail or on-road route) to direct people from the main trail into the town's commercial district
- Use multiple media, including signs to clearly direct motor vehicles to your trailhead from the highway(s)
- Provide current information about the town's features and commercial establishments, especially food, drink & lodging, at the trailhead, and keep it up to date

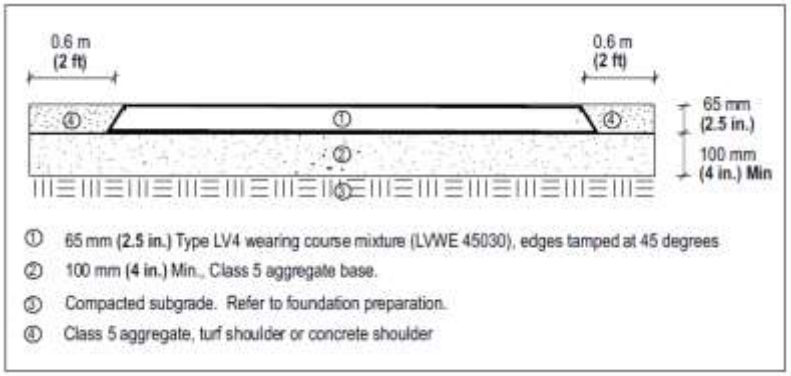
Subgrade/Grading

Instead of This....

Uneven surface on subdivision-built trail

Do This...

Minnesota Dept. of Transportation Bituminous Stuctural Section Bikeways Design Manual 2007



- Poor subgrade that is unstable or does not drain well can lead to uneven surfaces and cracks, or drainage problems when paved
- Soils are not often given consideration during the planning stage of projects, before a final trail alignment is chosen
- Too few soil borings in the design stage can lead to surprise additional depths of organic matter during construction, causing cost overruns if soil must be removed to a greater depth than anticipated
- Designing hard surface trails are not quite like designing roads or natural surface trails
- Uneven grades due to sloppy or imprecise subsurface grading happen too often
- Uneven surfaces may not be disturbing to walkers, but are very noticeable to bikers and people using wheelchairs

- Soil maps for the US are available from the USDA Natural Resources Conservation Service and state & county sources
- When planning long distance trails, check for hydric and highly erodible soil types, and avoid them, if possible
- In areas where unstable soils are suspected, conduct soil borings prior to construction to minimize cost overruns
- Prepare ground and subsurface to provide even surfaces
- Provide standard cross slopes on trail surface
- Watch especially If subdivision contractors are required to provide trails—they may have little experience with trails. Provide design standards and monitor construction.

Road crossing Design

Instead of This….

Do This…

- Many trail crossings of roads have the minimal amount of signing and warnings for motor vehicles
- The typical two line paint pattern for crossings are barely visible from a distance and get work off, making them less visible
- Some road managers believe that any crossing markings will give trail users a false sense of security, so believe that nothing is better. This attitude is changing. From a trail planner's perspective, motor vehicles need to be able to be made aware that there are trail crossings, and where they are.

- The ladder or zebra striping patterns are much more visible than standard the standard two line pattern; other more visible patterns are approved for use on some state or local roads as well.
- Bump outs (curb extensions) on city streets with on-street parking shortens the distance trail users must travel across the roadway, act as a traffic calming device for motor vehicles, and make trail users more visible to motor vehicle drivers
- On urban streets, signs in the middle of the street stating "vehicles must stop for pedestrians" have been effective

Road crossings, contd.

Instead of This….

Do This...

- Long distance trails must often cross major highways with high posted speeds, or urban multi lane streets with high traffic volumes
- Crossings can be long, and crossing locations do not all have good visibility due to curves and hills
- Standard pedestrian crossing signs are not visible for long distances, and can be easily missed among road sign clutter, or by distracted drivrs
- Road crossings are the most dangerous part of trails, where the most serious accidents happen
- The use of pedestrian crossing or bike crossing signs are misleading for mixed use trail crossings

- More research and guidance documents on at-grade crossings are available now from state DOT's than has been available in the past; the transportation climate is changing to be more accepting and approving of pedestrian– and bicycle-friendly improvements
- Flashing warning beacons, HAWK signals that stop traffic, and a variety of other safety improvements are approved for use in the US (check your state DOT), but are expensive; negotiate the treatment with the road manager and include in your trail construction budget. Some grant sources will pay for them
- Refuge islands in the middle of high traffic streets allow trail users to cross one direction of traffic at a time, and can add to the street's appeal with landscaping, while calming traffic

Road crossings—curb ramps

Instead of This….

- Many poorly designed curb cuts exist, even new ones, that do not meet the Americans with Disabilities Act guidelines, or trail best practices
- The curb cut width is often constructed at a standard size for pedestrian sidewalks (36” wide, not including the flared sides) forcing trail users to form a single line to use it, or causing bicyclists or people with wheelchairs to jump the curb, which can be a safety hazard
- Some curb cuts have flared sides that are too long, without a level ramp that is wide enough for a wheelchair
- The cross slopes on the flared sides of curb cuts are sometimes too steep, causing a tipping hazard for people using wheelchairs
- ADA guidelines now recommend “truncated domes”— warning panels with upside down bottle cap shapes—to signal to people with visual impairments that a road crossing is ahead. Many existing trails do not have these

Do This...

- The curb cut should ideally be as wide as the trail, especially at high use intersections
- The top of the curb ramp must have a level landing (recent requirement)
- The running slope of a curb ramp should be 8.33%., or up to 12% under certain circumstances
- Truncated dome warning panels should be added to existing trails as a best practice. They alert people with disabilities as well as other trail users of the road crossing.

Gravel road crossings

Instead of This....

Do This...

- Crossing gravel driveways or roads with a concrete or asphalt trail becomes a continual maintenance issue, with gravel scattered over the hard surface trail for a considerable distance on each side of the crossing
- The scattered gravel is a safety hazard, especially for rollerskaters, but bicyclists may also skid on the gravel
- Maintenance crews must continue to sweep the gravel back in place

- A simple solution that is not always included in design plans is a concrete or asphalt apron on the gravel driveway or road, extending at least 10 to 15 feet beyond each edge of the trail. This minimizes the amount of gravel spray that ends up on your trail, increasing safety and reducing maintenance
- These aprons are much less costly to include with your original construction budget than they are to add later
- Be aware of your right-of-way boundaries, and negotiate in advance with the driveway owner or road manager

Trail width

Instead of This....

- Trail widths are often decided by the minimum allowed by trail guidelines or grant requirements, to save money
- Trail managers have regretted past decisions to build 8 foot wide multi-use trails. Few regret building it too wide.
- National guidelines now recommend 10' minimum, or even 12' or 14' for heavily used, multi use trails.
- Trails are used not just by walkers and people with standard bicycles. In-line rollerskaters take up about 5' of width with full strokes. Bicycles with attached child carriers, recumbent bicycles, and people using wheelchairs take up more width than a standard bicycle.
- It doesn't work to estimate expected use for a trail by measuring existing use on the unimproved corridor, as some who usually measure motorized vehicle traffic would like to do (the "warrant" idea. Non-motorized trail users do not behave like motorized vehicle drivers . They are much more likely to use a good facility that they perceive as safe.
- Consider that vegetation along the trail shoulders can have the effect of narrowing the useable trail width, between trail maintenance trips.

Do This...

- Consider your expected trail volumes and user mix rather than automatically selecting the narrowest width that you can "get away with."
- Estimate expected volumes by comparing visitor counts on trails with similar tourist/local user mix, and consider proximity to origins and destinations, expected use by groups (running teams, school field trips, etc.), transportation and recreational use, alternative routes, etc.
- Narrower trails may be acceptable for a bikeway where a separate pedestrian path is provided, or where very low volumes are expected.
- Consider separating "wheels" from "heels" on parallel separate paths for heavily travelled trails.
- Wider trails allow two bicyclists to ride side-by-side, and also allow for vegetation growth in between trail clearing maintenance.

Sharp curves

Instead of This....

- 90 degree turns are difficult for bicyclists to make, requiring them to slow down or even stop. Accidents can happen if a bicyclists tires must leave the pavement then re-enter it to make the turn. You will see tire tracks and bare spots on the trail shoulder at sharp turns where bicyclists have been unable to stay on the pavement to make a turn
- Sharp turns are often found where an off-road trail parallel to a roadway turns to cross the roadway
- The other common occurrence of sharp turns is at trail intersections with other trails
- Recumbent bicycles (82" long), tricycle recumbents, bicycles with child carrier trailers (117" long), and the like have wider turning radii than standard bicycles (70" long) and have an especially difficult time with sharp turns
- Trail intersections that are designed like highway on-ramps are great for people travelling one direct, and worse for people going the other way, so are a poor design for two-way trails
- Keep in mind that flat, straight rail-trails are notorious for pedestrian complaints of speeding bicyclists, so eliminating all curves in your alignment, when you have a choice, is not good either

Do This...

- The AASHTO Guide for the Development of Bicycle Facilities lists recommends a minimum radius of 60' for a design speed of 18 mph. Any design speed less than 18 should have sharp curve warning signs.
- At trail intersections, flare the pavement out at each corner so that bicyclists do not have to leave the pavement to make the turn. The sharper the turn, the wider the flare should be
- If you do not have space to provide the minimum curve radius not at an intersection, such as on a switchback on a hill, you can widen the trail gradually so that the widest point is at the sharpest part of the curve. This is especially important on trails with high usage levels
- Consider adding a solid painted centerline at sharp curves, even if you don't stripe the rest of the trail
- Better design is better than more signs, but for existing trails, warning signs may help
- If you are designing a multi use trail and expect very high volumes and trail user conflicts, you can reduce the design speed and the actual speed of bicyclists by adding in gentle curves , retaining tree canopy, and reducing sight lines where safe to do so. Same concept as traffic calming for roads.

Boardwalks

Instead of This....

Floating boardwalk

- Low boardwalks block light from reaching the water underneath them, disrupting the vegetation below them
- Low boardwalks can also block the flow of water, insects, etc.
- Some materials can harm the environment: Preservatives in chemically treated lumber can leach into the water; rainforests are being depleted with demand for naturally rot-resistant lumber (which is also expensive)

Do This...

- Build your boardwalk high enough so that water and light can pass underneath, so that there is continuous vegetation and water flow.
- If your design does not disrupt the flow, then permitting agencies may consider just the area of your piers as your wetland impact instead of the entire area of the boardwalk
- Consider helical piers for quick installation (if conditions are right), and for minimal area of impact
- If solid ground is too far underwater for wooden or helical piers, such as in peat bogs, consider floating boardwalks, like the docks used at marinas.
- If using treated lumber make sure it is certified that is s treated at the proper levels to minimize leaching. Usiing creosote treated products in freshwater is restricted in some states & Canada. If choosing natural rot- & insect-resistant timber, choose sustainably harvested sources. Consider composite materials.
- Locate the boardwalk in less sensitive areas of the wetland (consider waterfowl nesting & feeding areas, etc.)
- Consider closing the boardwalk during nesting season; provide a detour if you do.

Boardwalks, contd.

Instead of This....

Do This...

Helical pier installation

No overlooks/stopping space provided; narrow boardwalk

- People congregate on boardwalks for the scenic views, wildlife watching, etc. This can be a bottleneck on your trail if you do not allow space for standing or sitting

- Design rest/viewing areas into the boardwalk away from trail traffc flow. Locate and size for expected activities.
- Locate overlooks to maximize the user's experience, not where it is most convenient to build. Consider scenic views, better fishing spots, etc.

Clear zone

Instead of This….

Do This...

- Obstructions sometimes found in the horizontal or vertical clear zone, or even in the trail Treadway, include:
  - —Retaining walls
  - —Benches & picnic tables
  - —Landscaping rocks & boulders
  - —Road and trail signs
  - —Parked cars
  - —Tree limbs & shrubs
  - —Light poles
  - —Utility poles
  - —Mailboxes
  - —Bus shelters
  - —Trash receptacles

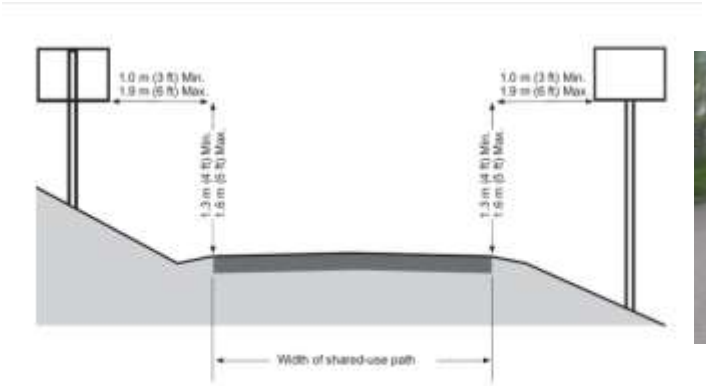


Figure 9B-1 Sign Placement on Shared-Use Paths

- The horizontal clear zone, 2—3 feet on either side of the trail, should be kept clear of anything that could be accidently hit
- The vertical clear zone should be at least 8 feet high over the trail and over the horizontal clear zones or trail shoulders
- Consider potential obstructions and the clear zone during the planning and design stages, and design the trail to avoid immovable obstructions
- For signs, ensure that the closest edge of the sign is outside of the clear zone, not just the post
- Add wheel stops for motor vehicles if a parking lot is adjacent to the trail to prevent cars from advancing into the clear zone or onto your trail
- For trails adjacent to roads, work with road managers to minimize obstructions and/or widen the trail to provide passing space around unavoidable obstructions
- Train your maintenance crew to avoid the clear zone when trimming vegetation, installing signs, etc.

Slippery Bridge Decks

Instead of This....

- Wooden bridge or boardwalk decks can get slippery when wet, which can cause accidents, especially for bicyclists with thin-tired road bicycles
- Treated lumber or wood with creosote seems to get especially slippery
- Curves and slopes on timber surfaces are especially hazardous, because of the need to change direction or brake, such as on a curved boardwalk or a bridge with a sloped deck

Do This...

- Many solutions have been tried to provide slip resistant surfaces, and all have pros and cons:
- During trail planning and design, avoid curves or slopes on timber surfaces that will be used by bicycles, when possible
- Concrete may provide the best slip resistance when wet, when sand cement is integrated, and it is set to a slightly rough “broom” finish, but requires additional substructure for support & is costly
- Metal surfaces, such as perforated aluminum or steel plates have been used for walking trails and some bike facilities. Additional slip resistant coating may be necessary
- A slip resistant coating, such as sandy compounds, or the old fashioned ground nutshells mixed with paint or varnish can improve conditions on wood surfaces, but need to be periodically reapplied
- An asphalt overlay to replace a timber deck adds slip resistance. Must take off timber deck boards. MN DNR uses 4”X6” timbers on end, bolted together into 10’ sections for additional support, and covered with rubber matting, then pavement.

Trail connections for accessiblity

Instead of This....

Do This...

- Trails sometimes pass by a destination or a starting location for trail users without connecting to it
- Pedestrians or bicyclists may make their own connector trails, but these informal trails are difficult for people with disabilities
- Small connector trails are much more expensive to build as separate projects, rather than including them with the trail construction project
- Small connections sometimes never get built, due to cost and time

- Think door-to-door when designing trails to be accessible for people with disabilities. If a major trail cannot be accessed, the entire trail is not useable for that sector of the population
- Plan for the minor connections when planning your trail, such as: to the parking lot, to the school sidewalk, to the door of the major employment center, etc.
- Work with adjacent landowners to include minor connections in your trail project, perhaps as a cost share item

ADA—vertical obstacles

Instead of This....

Do This...

- Bridge and boardwalk approaches often end up with drop-offs, a change in vertical alignment of 1 inch or more. This does not meet ADA guidelines, and can be a hazard for bicyclists, rollerskaters and pedestrians as well
- Even what seems like a minor vertical dropoff can make a trail impassable for people using wheelchairs, especially motorized ones, which are heavy. Some do not have enough power to overcome the height change.
- The drop off sometimes occurs because, during construction, the compaction rollers cannot get close enough to the bridge/ boardwalk to compact the end of the approach to the same degree as the rest of the trail. Settling then causes the vertical gap to lengthen over time.

- To avoid the compaction problem on a new asphalt trail, one solution is to construct a 10 foot long concrete approach panel on each side of the bridge, pin this to the bridge, then pave with asphalt over the concrete. It will look the same when finished, but eliminate the settling problem.
- For existing trails, be sure to monitor this vertical gap during regular trail inspections, and patch if possible.
- ADA guidelines recommend no more than a 1/2” high vertical obstactle

Tunnels/underpasses

Instead of This....

- Many trail managers find underpasses and tunnels troublesome to maintain in a safe condition
- New tunnels are often built at the minimum width, as wide as the trail treadway, or even narrower, to save money. People tend to move away from a wall, especially if the tunnel opening is curved—the "shy distance"—that is often not considered. This behavior effectively narrows your trail
- Tunnels are often left unlit due to installation or upkeep cost, or to avoid the design complication. But there may be users at dawn or dusk or light in the tunnel may be limited by vegetation at the openings. Also, how many bicyclists whom you know take off their sunglasses to enter a tunnel?
- Water pooling/sediment buildup
- Water undermining trail surface

Do This...

Trail tunnel with rail

- Consider the useable width of your tunnel design and size accordingly. On curved designs, consider the "shy distance" in height from the outside corners
- Whenever possible, continue the shoulder width that is provided on the trail through the tunnel (2' on each side of the treadway is recommended) The shoulders provide the horizontal "shy distance" from the tunnel sides.
- To determine lighting needs, consider: if vegetation limits light inside the tunnel, tunnel length & height, seasonal light variations and off-season use, commuter use at low-light hours,
- Add bright or reflective striping inside the tunnel to indicate the trail edges and centerline, even if you don't stripe the rest of your trail
- For high former railroad tunnels, consider the lumens at pedestrian level—you may need brighter or more lights than you think
- Solar panels may provide the energy source, depending on conditions.

Tunnels/underpasses, Contd.

Instead of This….

- Tunnel/underpass drainage problems are a common complaint among trail managers, and can be a safety hazard, especially in a dark tunnel
- Old railroad tunnels were often crowned, with the high point at the center and drainage channels at the sides. Old tunnels often drip, making the trail surface perpetually wet. This can be a safety hazard for trail users, especially if the cross slope is steeper than the trail outside the tunnel.
- Asphalt trails through tunnels/underpasses can crumble on the edges or wash due to water undermining the surface

Do This...

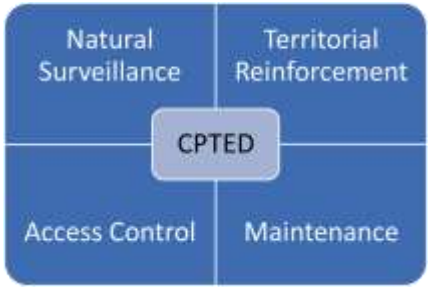
- Consider underpass/tunnel drainage early during the planning process, so that solutions can be included in your cost estimate
- If possible, retain the same cross slope within the tunnel as on the rest of the trail so that it is predictable for trail users
- Add advance warning signs for trail users if the cross slope changes, there are side drainage channels, it is regularly wet, etc.
- Lighting and striping inside the tunnel is especially important if water hazards are frequent
- One solution for underpasses subject ot flooding: use a cement slab surface under the underpass instead of asphalt, which will not get undermined with water and wash out as easily as asphalt

Cpted at trailheads

Instead of This....

- Don't design in hiding places for criminals, especially at trailheads
- Kiosks with solid walls, dense shrubs, etc. provide places where criminals can stand or crouch to surprise a trail user
- Even people in small towns and rural areas are afraid of attacks, and may deter people from using the trail.

Do This...



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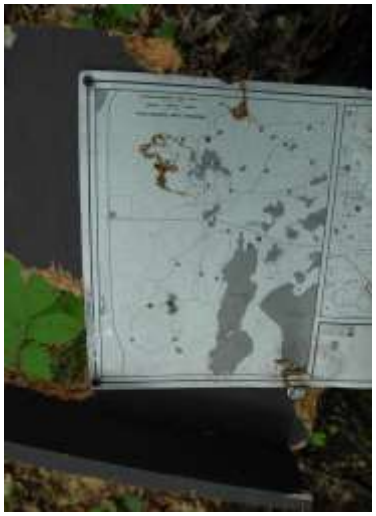
- The <u>perception</u> of safety for trail users is important, even if you are unconcerned about the danger of a trailhead, or if you have data indicating that few or no crimes have occurred at your trailhad
- Design trailheads to give the perception to criminals that this space is not friendly toward them
- For kiosks, include an opening between the base and information panels to allow people to see if someone is on the other side
- Avoid using tall, dense shrubs at trailheads. Keep vegetation under 3 feet height
- Consider pedestrian level lighting that lights people's faces if trail is used after dark, such as commuter trails
- Consult your local police department for tips on trouble spots and CPTED principles during the planning or design stage of your project

Trailside maps & system marking

Instead of This….



- Trail mapping and marking systems vary widely, but many are not user friendly, and do a poor job of providing information to trail users. This can lead to dangerous situations in bad weather or in case of injuries
- Many people, even experienced outdoorspeople, are directionally challenged and poor map readers.
- It doesn't matter if GIS technician or maintenance staff think that the trail system is adequately mapped and marked, if the trail users cannot find their way
- In the ground trail maps often do not point in the same direction as the trails do on the ground, causing confusion
- Maps often stop at the park boundaries, and do not include trails managed by other jurisdictions, causing confusion when an intersection is encountered that is not on the map

Do This…

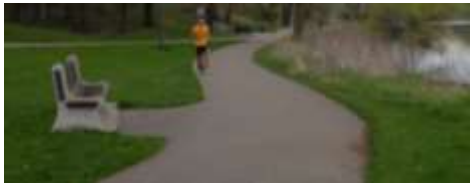
- Arguably, the purposes of maps are to give trail users a reasonable assurance that they will be able to identify interesting destinations, find them, and get back to their car within a reasonable time range, and with at least a rudimentary knowledge of conditions to expect.
- For linear trails, mile markers are most frequently requested, but don't install in the clear zone
- If North is on the top of your map, install the map in a location near the trail so that North is straight ahead (i.e. install the map on the opposite side of the trail) OR change the orientation of the map before manufacturing it so that the orientation matches the location where you intent to install it
- Include all trails or roads on the map, even ones outside of your jurisdiction, if they will be seen on the ground
- For complex trail systems, numbered intersections and "you are here" maps work well
- Identify the roads or rivers being crossed with signs near the trail; these are major indicators of location for trail users

Benches

Instead of This….

- Benches are often thought unessential, and not included in the original budget, thinking “we’ll add them later”, which sometimes doesn’t happen
- Many trails have too few benches, especially if frequented by pedestrians, including the elderly or people with disabilities
- Benches sometimes seem to be planned from a desk, and placed facing the trail or street while disregarding scenic views
- If benches are immediately adjacent to the trail and not enough legroom is provided, people’s feet are in the trail treadway when sitting
- Donated benches bought at the hardware store are not durable enough for public use
- Benches are not ADA accessible if there is no firm and stable surface leading from the trail to the bench
- Benches are subject to vandalism, sun, precipitation, and heavy use
- Bench maintenance is sometimes neglected

Do This...

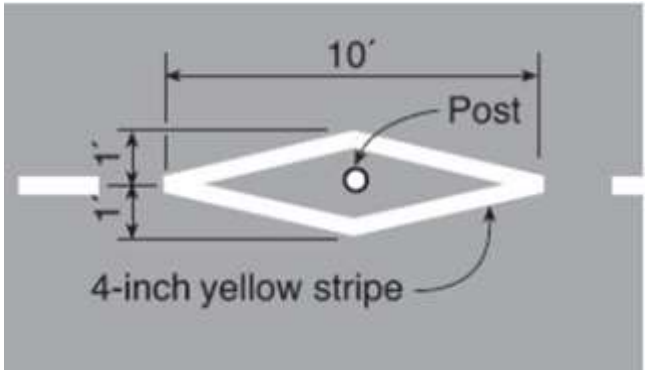


- Benches/rest areas should be considered an essential component of the trail system, and costs may be less if their installation is included in the trail construction project (however, some grant sources don’t allow this.)
- For trails with pedestrian trail use, a bench at least every 1/4 mile is best; every 1/2 mile is adequate
- Rest areas can be highlights of your trail. Plan bench locations & direction to face to take advantage of scenic views. Its okay if the bench faces away from the trail
- Make sure the bench and the legroom needed in front of the bench is all outside of the trail clear zone (feet should be at least 2’ from the trail edge)
- If your trail is ADA accessible, then a hard surface path and/or pad should lead from the trail to the bench. Include paved space for people using wheelchairs near the bench
- If you have a bench donation program, provide donors with specific bench standards to ensure durability, or have donors provide money, and purchase the bench yourself
- Benches of metal, concrete, wood, plastic, and composite materials are available. Composite materials are improving their resistance to warping and weather. Check for durability, weather– and vandal-resistance before purchasing

Bollards

Instead of This….

Do This...



- Bollards become hazardous obstacles that can cause accidents, especially on crowded trails
- Fast moving bicyclists or rollerskaters may not see a bollard if their vision of the trail is blocked by other trail users. People generally don't expect obstacles in the middle of the trail.

- Build the trail without bollards, monitor, then decide whether they are necessary to prevent motor vehicle use.
- Paint hazard warning marks on trail surface
- Paint and/or use reflective markers on bollard
- Removable bollards allow for maintenance equipment

Artistic elements

Do This...

- Add artistic elements to make your trail unique!