City of Fort Collins

STRATEGIC TRAILS PLAN

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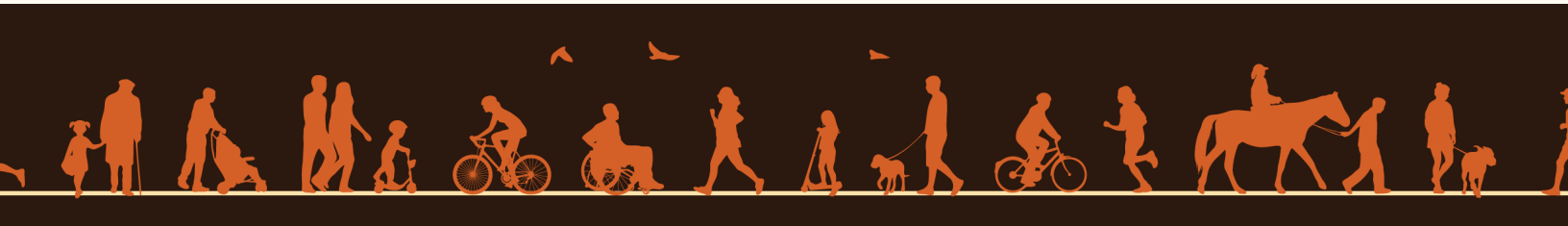
APPENDIX F:

Trail Design & Construction Standards



Trail Design and Construction Standards

Prepared for:
City of Fort Collins

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DN24-0814

FEHR PEERS

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Introduction

This document summarizes the review of the City of Fort Collins existing standard details and provides recommendations for updating typical trail sections to advance future trail projects. The content and recommendations in this memorandum are intended to accompany the Strategic Trails Plan and to serve as a reference document City staff and trail development partners in the Fort Collins community. The following elements are included:

- **Previous Plan and Standards Review and Incorporation**– Review and summary of Paved Pedestrian Plan (2011), Recreational Trail Master Plan Trail Standards (2013), Bicycle Wayfinding Master Plan (2015), and Grade Separated Crossing Prioritization Tool (2018). The review includes an assessment of what elements are carried forward into the Strategic Trails Plan Design Standards and Guidelines.
- **Strategic Trails Plan Trail Standard Design Guidelines –** Revised trail types and descriptions of trail standard details included in the Strategic Trails Plan.
- **At-Grade Crossing Standards** – Provides a comprehensive assessment of at-grade improvement design alternatives.
- **Grade Separated Crossings Standards** – Provides design considerations, including desired minimum heights and widths depending on crossing type (road, water feature, railroad), and a process for choosing an underpass or overpass for varying locations.

This memorandum summarizes and recommends fundamental components included in the updated Design and Construction Standards included with the Strategic Trails Plan.

Previous Plan and Standards Review and Incorporation

Pedestrian Plan (2011)

The Pedestrian Plan addresses citywide pedestrian needs, proposes solutions to problems for pedestrians, and guides and prioritizes pedestrian improvements.

Pedestrian needs, such as gaps in the sidewalk network and noncompliant ramps, were identified using a new Pedestrian Level of Service (LOS) scoring methodology, which considered:

- Directness
- Continuity
- Signalized Street Crossings
- Visual Interest and Amenity
- Security

Priority areas include the following:

- Pedestrian districts, such as downtown and university areas
- Activity centers/commercial corridors, such as College Avenue and East Mulberry Street
- Areas within a one-mile radius of public schools
- Areas within a one-quarter-mile radius of transit routes

The Pedestrian Plan also includes a crossing policy to guide decisions regarding crossing treatments and created a list of recommended pedestrian projects throughout the City. The Strategic Trails Plan includes a simplified trail-specific crossing guide that is intended to supplement the existing pedestrian crossing guidelines and be incorporated into a future update.

Paved Recreational Trail Master Plan Trail Standards (2013)

Design standards were included in the 2013 Paved Recreational Trail Master Plan to provide trail planners and designers guidance to develop an enjoyable, safe trail system for all users. These standards were the starting point for revising and refining to meet the needs of the updated Strategic Trails Plan. A summary chart showing how these recommendations were integrated into updated recommendations for the Strategic Trails Plan is included at the end of this document in Table 2.

Grade Separated Crossing Prioritization Plan (2018)

The Bicycle and Pedestrian Grade Separated Crossing Prioritization Study was conducted to establish an approach to prioritize candidate bicycle and pedestrian grade separation locations to prioritize investment using a data driven approach. The process included identifying crossing opportunities, establishing criteria for evaluation, and screening according to benefits generated for the bicycle network and the community.

Many of the identified grade separated crossings are trail locations to access trails and provide through trail connections. The following prioritization categories were developed and scored for each crossing:

- **Demand Category** (Bicycle Demand, Pedestrian Demand, Population Density, Youth Density, Student Density, Senior Density)
- **Connectivity Category** (Transit, Enhanced Travel Corridor, Regional Trail, Connects to Trail, Alternate Crossing Location, Existing Streets and Sidewalks, Natural Resources, Destinations)
- **Safety Category** (Low-Stress Network, Crash Reduction Potential, Quality of Existing Crossing)
- **Public Support Category** (included in previous plan)
- **Social Equity Category** (low- and moderate-income populations served)
- **Cost and Constructability Category** (Cost, Partnership or funding opportunities)

All locations were scored using the set criteria and prioritized according to individual category priorities. Concept design options were established for top-scoring locations. As part of the Strategic Trail Plan process, an updated list of desired future grade separated crossings was generated, and each location was scored following the prioritization process which included a few updates due to updates in data availability. The documentation of the new prioritization process and summary of prioritized locations is included in a separate memorandum.

Bicycle Wayfinding Plan (2015)

The 2015 Bicycle Wayfinding Plan created a uniquely branded, consistent, and integrated bicycle wayfinding system to reliably and intuitively guide bicyclists of all abilities to key destinations throughout Fort Collins along the bicycle network. The goals of the plan include:

- Create a custom designed set of wayfinding signs that reflect the spirit of Fort Collins.
- Program system of routes that builds on the Low Stress Bicycle Route network identified in the 2014 Bicycle Master Plan and seamlessly connects to the multi-use trail network.
- Sign local and regional bicycle routes consistently within the City of Fort Collins.
- Integrate the wayfinding system with existing park and trail system.
- Design the bicycle wayfinding system so that it is comprehendible to a broad user group.

High quality wayfinding helps users safely and efficiently navigate the bicycle network and improves overall comfort and usability.

Trail Corridor Standard Design Guidelines

Trail design guidelines, consistent with previously defined guidelines and national trail design best practices, standards, and guidelines are integrated into proposed trail standards. These are intended to provide the City of Fort Collins with a resource for implementing the recommendations in the Strategic Trails Plan. They are intended to provide engineering guidance for trail design and implementation.

Trail Standard Guidance

Trail design standards for Fort Collins are developed based on existing City standards as well as other relevant design guidelines including those listed below. Should any design standards not be included in this document following, the guidelines below shall be used in supplement:

- **AASHTO Guide for the Development of Bicycle Facilities, 5th Edition** provides guidance on the dimensions, use, and layout of specific bicycle facilities including streets, roads, highways, and off-street paths.
- **Manual on Uniform Traffic Control Devices (MUTCD), 11th Edition** effective on January 18, 2024, defines the standards used by road managers nationwide to install and maintain traffic control devices on all streets, highways, pedestrian and bicycle facilities open to public travel. It is the primary source for guidance on pavement markings, signal warrants, and signage.
- **Public Right-of-Way Accessibility Guidelines (PROWAG)** addresses access to sidewalks and streets, crosswalks, curb ramps, pedestrian signals, and other components of public right-of-way. It includes guidelines for shared-use paths, which are designed primarily for use by bicyclists and pedestrians for transportation and recreation purposes.
- **FHWA, Evaluation of Safety, Design, and Operation of Shared-Use Paths** provides guidance on how to design shared-use paths and how to manage users based on the FHWA Shared-Use Path Level of Service Calculator.
- **National Association of City Transportation Officials (NACTO) Urban Bikeway Design Guide, Second Edition** provides nationally recognized bikeway design standards and guidance on the current state of the practice designs. An updated edition was published on January 14, 2025 but updated guidance has not yet been integrated into this trail standard guidance.

Proposed Trail Types

A network of trails can consist of a variety of trail types and contexts. When designing and constructing new trails and connections, determining an appropriate trail type that serves the specific purpose and context of the trail can help to create a predictable user experience. This section outlines proposed trail types, each included to serve specific purposes and contexts along trails.

Major Trail: a trail that connects Fort Collins to neighboring communities, promoting long-distance travel and regional connectivity. They tend to be suitable for higher volumes of users and often have a higher mode share of bicyclists than other trail types.

a. Oftentimes, major trails feature an adjacent crusher fines trail, which is preferred whenever possible.
b. If a major trail runs immediately adjacent and parallel to a roadway, it is considered a sidepath and it should follow the same or better design guidelines as a standard major trail and should be separated from the edge of the traveled roadway by a minimum of five feet. Other requirements for sidepaths are available in the AASHTO Guide for the Development of Bicycle Facilities.

Minor Trail: a trail that connects Fort Collins to local destinations and primarily promotes short-distance trips. They often support a lower mode share of long-range bicyclists and serve higher shares of runners and walkers. Minor trails may not always connect to the larger trail network but tend to serve significant volumes of users with a highly varied mode share.

Spur/Connector Trail: a shorter trail that links to major or minor trails to establish and maintain connections to local destinations such as parks, schools, and neighborhoods. They enhance trail connectivity and provide comfortable access for more people. Spur and connector trails tend to serve fewer users, often with a higher mode share of pedestrians. Spur/connectors are typically constructed as a part of another project such as park construction or neighborhood development.

Trail Section Standard Details

Fort Collins has three existing trail section standard details that were developed more recently than the 2013 Paved Recreational Trail Master Plan. These sections were developed to standardize design assumptions and have provided an improvement over previous design guidelines. Based on feedback obtained from coordination with City of Fort Collins staff and best practices for inclusion, proposed changes to each detail are documented below. Updated sections are included in the appendices of this document.

Typical Trail Section Detail with Detached Gravel Path

a. This standard detail shall be considered for use on major trails and minor trails, depending on local context.
b. The recommended and minimum width for the paved trail is 10 feet. Increasing the width along sections of trail to 12 feet may be preferred, particularly at trail junctions, near parks or activity centers, and other concentrated areas that experience a high volume of users.
c. Specify the type of material to be used for crusher fines.
d. Specify that fiber mesh in concrete shall be applied at a rate of 1.5 pounds per cubic yard of concrete.
e. Specify that the trail shall have an expansion joint every 100 feet instead of 400 feet and specify that joints shall be caulked with self-leveling caulk approved by the City. Expansion joints should be used at cold joints as well.

f. Change the specified depth of crusher fines to four inches and specify that it shall be installed in two-inch lifts with a vibratory plate compactor with water on each lift.
g. Specify that the color of crusher fines shall be grey.
h. Specify that concrete forms (metal or wood) shall be used to delineate the edge of crusher fines and that the outside edge of crusher fines should be shored up with compacted topsoil prior to the installation and compaction of crusher fines.
i. Specify a maximum shoulder slope of 1:6.
j. Specify a recommended shoulder width of 5 feet and a minimum shoulder width of 2 feet for short distances.
k. Specify a minimum overhead clearance of 10 feet.

Typical Trail Section Detail with Attached Gravel Path

a. This standard detail shall be considered for use on major trails and minor trails depending on local context, especially in natural areas.
b. The recommended and minimum width for the paved trail is 10 feet. Increasing the width along sections of trail to 12 feet may be preferred, particularly at trail junctions, near parks or activity centers, and other concentrated areas that experience a high volume of users.
c. Specify the type of material to be used for crusher fines.
d. Specify that fiber mesh in concrete shall be applied at a rate of 1.5 pounds per cubic yard of concrete.
e. Specify that the trail shall have an expansion joint every 100 feet instead of 400 feet and specify that joints shall be caulked with self-leveling caulk approved by the City. Expansion joints should be used at cold joints as well.
f. Change the specified depth of crusher fines to five inches and specify that it shall be installed in 2.5 inch lifts with a vibratory plate compactor with water on each lift.
g. Specify that the color of crusher fines shall be grey.
h. Specify that concrete forms (metal or wood) shall be used to delineate the edge of crusher fines and that the outside edge of crusher fines should be shored up with compacted topsoil prior to the installation and compaction of crusher fines.
i. Specify a maximum shoulder slope of 1:6.
j. Specify a recommended shoulder width of 5 feet and a minimum shoulder width of 2 feet for short distances.
k. Specify a minimum overhead clearance of 10 feet.

Typical Trail Section Detail

a. This standard detail shall be noted as the preferred typical section for spur/connector trails.
b. Recommended trail width is 10 feet and minimum trail width is 8 feet in constrained locations or for short distances.
c. Specify that fiber mesh in concrete shall be applied at a rate of 1.5 pounds per cubic yard of concrete.
d. Specify that the trail shall have an expansion joint every 100 feet instead of 400 feet and specify that joints shall be caulked with self-leveling caulk approved by the City. Expansion joints should be used at cold joints as well.

e. Specify a maximum shoulder slope of 1:6.
f. Specify a recommended shoulder width of 5 feet and a minimum shoulder width of 2 feet for short distances.
g. Specify a minimum overhead clearance of 10 feet.

Width

The recommended trail width for all trail types is ten feet. The minimum trail width for major and minor trails is ten feet and for spurs/connectors is eight feet. Increasing the width along sections of trail to 12 feet may be preferred, particularly at trail junctions, near parks or activity centers, and other concentrated areas that experience a high volume of users. Trails that separate users by mode should be a minimum of 15 feet wide with a minimum of ten feet for bicycling and five feet for walking.

In locations where horizontal curves equal to or less than 90 degrees cannot be avoided, the trail can be widened to improve comfort for users navigating the curve. The maximum constructable radius of the path within the available space should be provided on both sides of the trail. Widening on the corner of the curve should be supplemented by a widening taper on the approach to the curve. The taper should be calculated using the formula shown in Figure 1 below.

Shifting Taper Equation		
$L = \frac{WS^2}{60}$		
Where:		
L	=	longitudinal lane shift (ft), minimum 20 ft
W	=	lateral width of offset (ft)
S	=	target bicyclist operating speed (mph)

Figure 1: Shifting Taper Equation

In cases where it is not possible to achieve the recommended trail width, the following considerations should be taken:

- Potentially hazardous fixed objects should be properly marked.
- Advance warning signs should be installed where sight distance is limited.
- Consider installing a "path narrows" sign (W5-4a).
- Consider using a centerline to help organize traffic.

If intersection queuing on a trail results in crowding near the roadway, the trail approach to the intersection can be widened to help increase crossing capacity and reduce conflicts. Crosswalk width should match the width of the trail at the roadway edge.

Shared-Use Path Level of Service (SUP LOS)

The AASTHO Guide for the Development of Bicycle Facilities recommends agencies use a minimum SUP LOS of C in order to meet current demand and have some ability to handle future capacity. Given the high importance of trails in the City of Fort Collins, it is recommended that the City aim for a minimum SUP LOS of B on all trails. The peak operating condition of a LOS B shared-use path is described as having "a moderate ability to absorb more users across all modes". The ten-foot minimum trail width shown in the Trail Section Details should be increased as needed to achieve a SUP LOS of B at a minimum. Figure 2 below identifies the SUP LOS Score associated with various trail volumes and widths, given a typical mode split. SUP LOS can be calculated more accurately using the FHWA SUP LOS Calculator (2006) if the actual mode share of a trail is known.

Shared Use Path Level of Service Look-Up Table, Typical Mode Split*										
Shared Use Path Peak Hour Volume	Shared Use Path Width (ft)									
	8	10	11	12	14	15	16	18	20	≤ 25
50	B	B	B	B	B	A	A	A	A	A
100	D	C	B	B	B	A	A	A	A	A
150	D	C	B	B	B	A	B	A	A	A
200	D	D	C	B	B	A	B	A	A	A
300	E	D	C	C	C	B	B	B	B	A
400	F	E	D	D	C	C	C	B	B	A
500	F	F	D	D	D	C	C	C	C	A
600	F	F	E	E	E	D	D	C	C	A
800	F	F	F	F	F	E	E	E	E	A
1,000	F	F	F	F	F	E	F	F	F	A
≥ 1,200	F	F	F	F	F	F	F	F	F	A

*Assumptions:

1. Mode split is 55 percent adult bicyclists, 20 percent pedestrians, 10 percent runners, 10 percent in-line skaters, and 5 percent child bicyclists.
2. An equal number of trail users travel in each direction (the model uses a 50 percent–50 percent directional split).
3. Trail volume represents the actual number of users counted in the field (the model adjusts this volume based on a peak hour factor of 0.85).
4. Trail has a centerline.

Figure 2: FHWA SUP LOS Look-Up Table for Typical Mode Split

Design Speed

15 MPH is the minimum recommended design speed for bicycles and is appropriate for up to 2% running slope in urban settings. 30 MPH is generally the maximum recommended design speed for bicycles and is appropriate for major trail segments with sustained steeper grades. The City of Fort Collins advised against sustained steep grades in the 2013 Paved Recreational Trail Master Plan, so a 30 MPH design speed should generally be avoided. Due to the need to accommodate maintenance vehicles on trails, bicycle design speed is generally not the constraining factor in trail design.

Horizontal Alignment

The horizontal alignment for the trail is controlled by many factors including the topography, natural and man-made obstacles, and the amount of right-of-way that can be obtained. An alignment that allows for a pleasant horizontal flow to the trail should be the goal. Sharp horizontal corners should be avoided. Trails in Fort Collins are serviced by vehicles that have significantly less maneuverability than a bicycle, such as plows, forestry grapple trucks, and utility vacuum trucks, which should determine the minimum horizontal radius on trails. To accommodate these vehicles, the minimum interior horizontal radius on

trails should be 40 feet generally and 45 feet for curves within 50 feet of a bridge or other grade-separated structure, whenever these allowances can be achieved within reason given local context and environmental impacts.

Vertical Alignment

Trail grades should be less than 5% where possible to provide an enjoyable experience for the trail user and to minimize cuts and fills. When grades reach more than 5% and up to 8% for a sustained distance, the trail should have rest areas of 2% grade for a distance of 10 feet for every 2.5 feet of rise/fall along the trail center line. Grades over 8% to 10% should only be used for very short distances (less than 50 feet) and have ADA handrails. Grades over 10% should not be used on the trail.

Vertical curves should adhere to the stopping sight distance required by a typical adult bicyclist. The minimum length of a crest vertical curve based on grade difference and stopping sight distance is shown in Figure 3.

Minimum Length of Crest Vertical Curve (ft) Based on Stopping Sight Distance														
A	S = Stopping Sight Distance for flat grade (ft)*													
(%)	40	60	80	100	120	140	160	180	200	220	240	260	280	300
2									17	57	97	137	177	217
3						25	65	105	145	185	225	265	307	352
4				9	49	89	129	169	209	253	301	353	409	470
5			7	47	87	127	167	211	261	316	376	441	512	587
6			32	72	112	154	201	254	313	379	451	530	614	705
7		11	51	91	132	179	234	296	366	442	526	618	716	822
8		24	64	104	150	205	267	338	418	505	602	706	819	940
9		35	75	117	169	230	301	381	470	569	677	794	921	1057
10	3	43	84	131	188	256	334	423	522	632	752	883	1023	1175
11	10	50	92	144	207	281	368	465	574	695	827	971	1126	1292
12	16	56	100	157	226	307	401	508	627	758	902	1059	1228	1410
13	21	61	109	170	244	333	434	550	679	821	978	1147	1331	1527
14	25	66	117	183	263	358	468	592	731	885	1053	1236	1433	1645
15	29	70	125	196	282	384	501	634	783	948	1128	1324	1535	1762
16	32	75	134	209	301	409	535	677	836	1011	1203	1412	1638	1880
17	35	80	142	222	320	435	568	719	888	1074	1278	1500	1740	1997
18	37	85	150	235	338	461	602	761	940	1137	1354	1589	1842	2115
19	40	89	159	248	357	486	635	804	992	1201	1429	1677	1945	2232
20	42	94	167	261	376	512	668	846	1044	1264	1504	1765	2047	2350
Shaded area represents S = L. Minimum length of vertical curve = 5 ft														

Figure 3: Minimum Length of Crest Vertical Curve

Centerline Standards

It is recommended to stripe a centerline at specific locations where conflicts with objects or other trail users are likely to arise. Standard details for each location type are described below.

When a bollard or similar device is present on a trail, a centerline should be striped to clearly divide trail users in opposing directions. MUTCD provides a standard detail, shown in Figure 4, that should be applied to trails in Fort Collins.

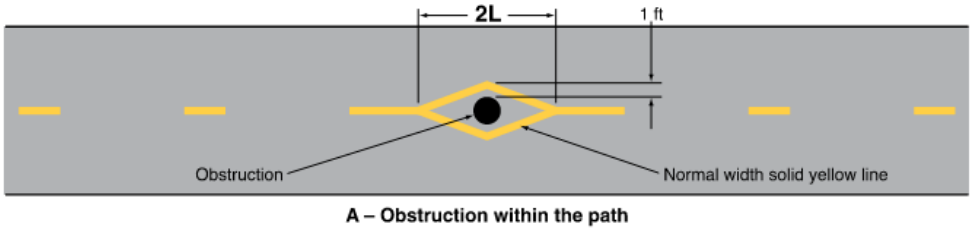


Figure 4: Obstruction Pavement Markings

When a trail approaches an intersection with a roadway that is designated as a collector or arterial, a solid centerline should be striped for the length of the stopping sight distance on either side of the intersection.
When a trail approaches a sharp curve or an area where sight distance is limited for any reason, a solid centerline should be striped throughout the curve as well as for the length of the stopping sight distance in each direction.

Painting a continuous centerline on a trail can positively impact safety for users by separating opposing traffic but can also negatively impact user perception of trail comfort due to the nature of restricting users' freedom to maneuver. As a result, it is not always appropriate to stripe a centerline in otherwise unobstructed sections of a trail. It is recommended to consider striping a continuous centerline on trails with a peak one-way volume greater than 100 users per hour. Broken centerlines should only be used where passing is permitted. MUTCD provides a standard detail for a 4-6 inch" continuous centerline stripe, shown in Figure 5.

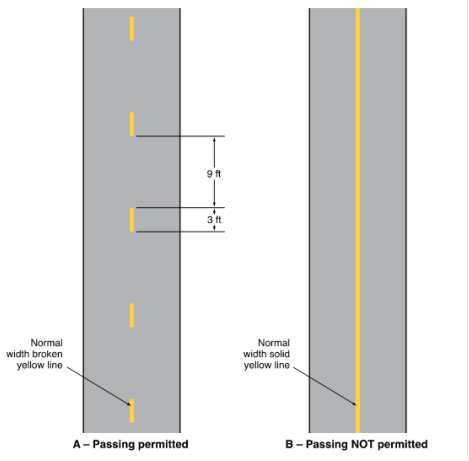


Figure 5: Centerline Markings

Striping on trails shall be painted using thermoplastic pavement markings. Although thermoplastic materials cost more initially, they are more effective than standard pavement marking paint and require less frequent reapplication, especially given typical weather conditions in Fort Collins.

Separation of Modes

Separating bicyclists and pedestrians can be an efficient and safe way of managing trail users when there is sufficient width. Separating users should be considered when peak volume is greater than 300 users or when pedestrians make up 30% or more of the total users. Trails that separate by mode should be at least 15 feet wide. Separation of modes may also be warranted by high user volumes, proximity to destinations, limited sight distance, and/or approaches to intersections and trailheads.

Figure 6: Example of a Mode-Separated Trail

Right of Way

The recommended right-of-way width is 50 feet. The minimum trail right-of-way width is 30 feet for short distances (less than 500 feet minimized right of way width including tapers to recommended width). There should be no more than 1,500 feet in total (including tapers) of minimized right of way width per trail mile. These distances allow for the trail to meander and allow for the placement of the adjacent gravel path in certain standard trail sections.

Trail Placement and Environmental Sensitivity

Within the urban context of the Fort Collins trail system there is a spectrum from disturbed to less disturbed habitat areas. Waterways are generally considered a critical habitat element and function as movement corridors for a variety of species within Fort Collins. Many of the stream corridors are already highly altered habitats due to the history of agriculture and the urban setting. This, however, does not diminish the importance of streams, rivers and even ditches serving as movement corridors, and critical habitat and refuge areas for wildlife.

Trail placement should avoid high quality and/or sensitive habitat areas. Trail alignments should avoid fragmenting high quality habitat and be aligned along habitat edges to minimize impact. Trails with a wide buffer from the built environment can function as corridors for wildlife between good habitat patches. The number of river, stream and wetland crossings by the trail should be minimized. Also, efforts should be made to minimize disturbances to and find opportunities to restore floodplain function (e.g., allowing the river or stream to periodically over-top its banks). Trail alignment should avoid or minimize or mitigate removing native trees or shrubs, especially in riparian areas. All setbacks and seasonal closures for rare, sensitive, threatened or endangered plants and wildlife should be respected with regard to trail placement. When possible and appropriate, trails should be aligned where there is already an existing

disturbance, such as a utility right-of-way or crossing streams at existing roads and bridges. The vertical alignment of trails should minimize grade inconsistencies and alterations from that of existing natural areas as much as is reasonable. Also, careful placement of the trails should be considered to discourage off-trail use in sensitive habitat areas.

As new trails are developed along or extending past the urban core of Fort Collins, more sensitive habitats will be found. Trail planners should work with Natural Areas Department staff and Colorado Parks and Wildlife as necessary to assess potential sensitive habitats and to ensure best or next-best case trail placement options.

Trail Placement in Riparian Buffer Areas & Natural Habitat Buffer Areas

Many existing trails follow natural habitat areas and river and stream corridors, which as mentioned above are considered sensitive and important habitat. The condition of this habitat varies greatly throughout the city. Trails are permitted within the development buffers of these waterways and habitats. However, to alleviate the added pressure on wildlife in these corridors and to help create wildlife refuge areas, the trail should not remain in the buffers for the entire stretch of the corridor. Along river and stream corridors and natural habitat buffers, the trail should periodically be pulled toward the edge of the buffer to create areas without constant disturbance from trail users. The trail can then meander back into the buffer areas to provide a balance of good stewardship and visitor experience. It is difficult to set a determined length to how often and for how far these meanders should occur. When opportunities exist to pull the trail further from a waterway or closer to the edge of a habitat, for example when the trail runs through a natural area, the opportunity should be considered while balancing the environmental value with the recreational trail value. Trail Planners and Natural Areas staff will continue to work in collaboration toward this end.

Opportunities for Restoration

Construction of new efforts to widen or realign trails create opportunities for restoration of native vegetation especially within riparian and stream corridors. The City's Stormwater Department previously assessed the habitat along several stream reaches with the goal of restoring many of these reaches. It is imperative that all future trail work within the City's stream corridors include consultation with the Stormwater and the Natural Areas Departments to assess restoration opportunities.

Horizontal Clearance

The edges of the paved trails should have a minimum three feet of horizontal clearance from vertical obstructions. The gravel path should also have three feet of horizontal clearance on both sides. The edges of paved trails should have a minimum of ten feet of horizontal clearance to trees, if present, unless otherwise approved by the Parks Department.

When a trail is running parallel and immediately adjacent to a wall, fence, or other vertical structure, a one-foot buffer between the structure and the edge of the trail shall be given at a minimum. Two feet is recommended.

Vertical Clearance

Paved trails and gravel paths should have a minimum vertical clearance of ten feet.

Sight Distance

Efforts should be made to provide ample sight distances at intersections and at junctions with streets, underpasses, etc. Curves along the trail alignment should not be greater than a 90 degree angle. More pronounced curves require the trail to be placed to avoid any sight distance obstruction being within 30 feet of the trail centerline at the midpoint of the curve. Trail underpasses and bridges should have a straight section of at least 20 feet approaching the structure.

Trail Lighting

The trail system is not lit except at underpasses where "dark sky" friendly light fixtures are used to help trail users enter, travel through, and exit these facilities. All lighting shall comply with current exterior lighting standards in the City of Fort Collins Land Use Code. When dark sky fixtures are available, lighting shall be scaled appropriately for pedestrians and can be limited to expected trail use hours only if desired, such as until 11pm and starting at 6am. All trail intersections with roads should always be lit to improve safety of nighttime users.

Signage

Trail signage should comply with the most current Manual on Uniform Traffic Control Devices and the 2015 Bicycle Wayfinding Master Plan.

Fencing

The standard fence along the trail should be the western two-rail. A non-climb horse fabric can be installed on the fence for animal control. Other types of fencing may be needed depending upon the situation and should be determined site-by-site.

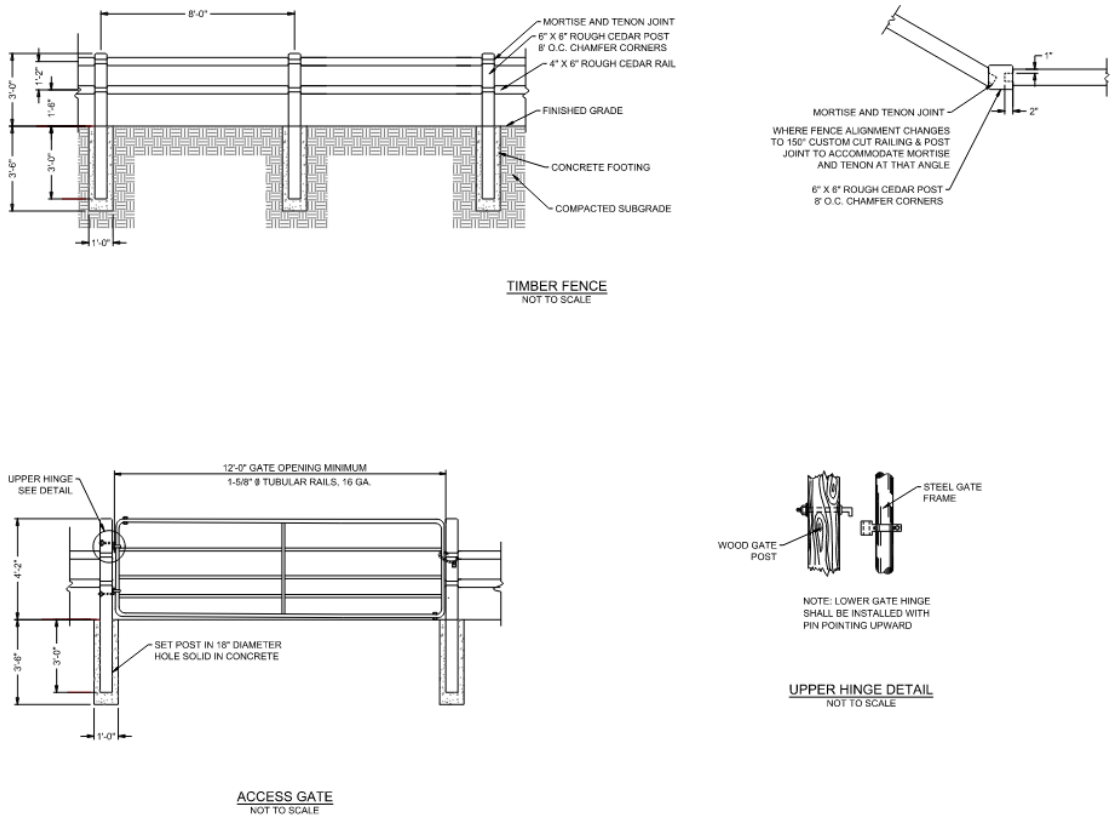


Figure 7: Standard Fence Detail

Fencing along the trail should be wildlife friendly and passable. This includes considering height of the fence as well as analysis with Natural Areas Department staff as to where considerations for wildlife should be made. Colorado Parks and Wildlife (CPW) has guidelines that should be followed for appropriate wildlife fencing for the specific wildlife species found in the area.

Mesh fabric can greatly impede movement of smaller animals along riparian corridors and has been a problem for snapping turtles. Tall privacy fences have created barriers to deer, forcing them to cross busy streets. CPW guidelines for wildlife-friendly fencing is ideally 16 inches off the ground and a maximum height of 42 inches on level ground. When mesh is needed in key wildlife movement areas, periodic openings can alleviate problems. Elevating the mesh above the ground, where possible, helps create passages for small wildlife. Keeping the fencing height to a minimum allows safe passage for young deer.

Seeding

The required seed mix for when the trail is not bisecting irrigated turf areas should be a blend of buffalo grass, blue gramma, and little blue stem. These short growing warm season grasses require less water and mowing. The short grasses should be planted in the three-foot shoulder area of the paved trail and/or the gravel sidepath. Any additionally disturbed areas beyond the trail and shoulder width (including staging areas) should be planted with the native seed mixes recommended by the City's Natural Areas

Department. In any of the non-turf areas, no exotic species will be allowed to be planted, specifically no smooth brome (Bromus inermis) or crested wheatgrass (Agropyron cristatum).

Trail Safety

Paved trails will have an Emergency Locator System for communicating trail location during emergency response situations. Accurate location reporting by trail users helps police dispatchers guide the appropriate responders to the emergency site. Safety signage identifies such conditions as slow zones, sharp corners, road crossing, etc. and are installed after careful review of conditions. Park and Natural Area Rangers patrol trails and can issue misdemeanor citations for riding in a careless manner and warn users who are not abiding by trail courtesy. Rangers also patrol for unleashed dogs who pose a safety hazard to other trail users.

Recreational Value

Maintaining and enhancing the recreational value of the paved trail system is equally important to planning for utilitarian connections. The future of the trail system shall be designed in such a manner that preserves the recreational experience by planning a system that provides the following features:

- Cascading or stacked recreational loops
- Trail design that emulates the shape of the natural landscape and provides variety
- Prioritization of trails to access parks, natural areas, and open spaces.

Other Trail Applications for Consideration

Some additional design standards have not been detailed or documented as part of this process but could be useful to define in future documents. For consideration, these include:

- Trails in Active Rail Corridors – document any railroad requirements or easements
- Trails in Ditch & Utility Corridors – define best practice on easements and coordination
- Trails along Roads – additional guidance on minimum and desired trail configurations to minimize pedestrian and bicycle level of traffic stress

At-Grade Crossings Standard Design Guidelines

The most appropriate at-grade crossing treatment in the City of Fort Collins varies and must be determined at each location where a trail intersects with a roadway. This is impacted by volume of vehicular traffic, vehicle speeds, road width, and adjacent land uses and destinations. Guidance on selecting appropriate at-grade crossing standards is drawn from previously documented national guidelines, Colorado standards, and City of Fort Collins standards including:

- CDOT Pedestrian Crossing Installation Guide (2021)
- Fort Collins Pedestrian Plan (2011)
- Fort Collins Intersection Guidelines for Pedestrian and Bicycles (2022)

Existing At-Grade Crossing Locations

The paved trails evaluated in the Fort Collins Strategic Trails Plan have 58 at-grade roadway crossings. This includes ten arterial crossings, twelve collector crossings, one guideway crossing, and 35 local crossings. Of the arterial crossings, six are fully signalized, one has a HAWK , two have RRFBs, , and one is uncontrolled. Of the collector crossings, one has an RRFB, three are stop-controlled at a three-leg intersection, and eight are uncontrolled. The number of at-grade crossings along each trail, summarized by roadway functional classification, is shown in Table *1*.

Table 1: Number of Existing At-Grade Crossings by Trail

Trail	Total At-Grade Crossings	Arterial Crossings	Collector Crossings	Guideway Crossings	Local Crossings
Colorado Front Range Trail	3	1			2
Dovetail Spur	1				1
East Poudre Trail	3	1	2		
East Spring Creek Trail	3		3		
Fossil Creek Trail	14		2		12
Hickory Trail	1				1
Mail Creek Trail	2				2
Mason Trail	5	3	1	1	
Pleasant Valley Trail (often considered to be part of the West Poudre Trail)	4				4
Poudre River Trail	3	1			2
Power Trail	3	2	1		
Rendezvous Trail	3		2		1
West Poudre Trail	1	1			
West Spring Creek Trail	2				2
Unnamed (Radiant Park area)	6		1		5

At-Grade Treatment Identification and Selection

Crossing treatment process was defined in the Fort Collins Pedestrian Plan (2011) and confirmed again in the Fort Collins Active Modes Plan (2022) and shown in Figure 8. A new trail crossing specific process has been drafted in Figure 9. At identified locations, an appropriate crossing treatment for any given trail and roadway intersection should be determined using the uncontrolled crossing evaluation table found in the Fort Collins Intersection Guidelines for Pedestrian and Bicycles within the Fort Collins Active Modes Plan (2022), which was created based on FHWA guidelines. The uncontrolled crossing evaluation table identifies appropriate crossing treatments based on roadway type, vehicle volumes, and speed limit. Decisions regarding at-grade crossing treatments must ultimately be approved by the City Traffic Engineer.

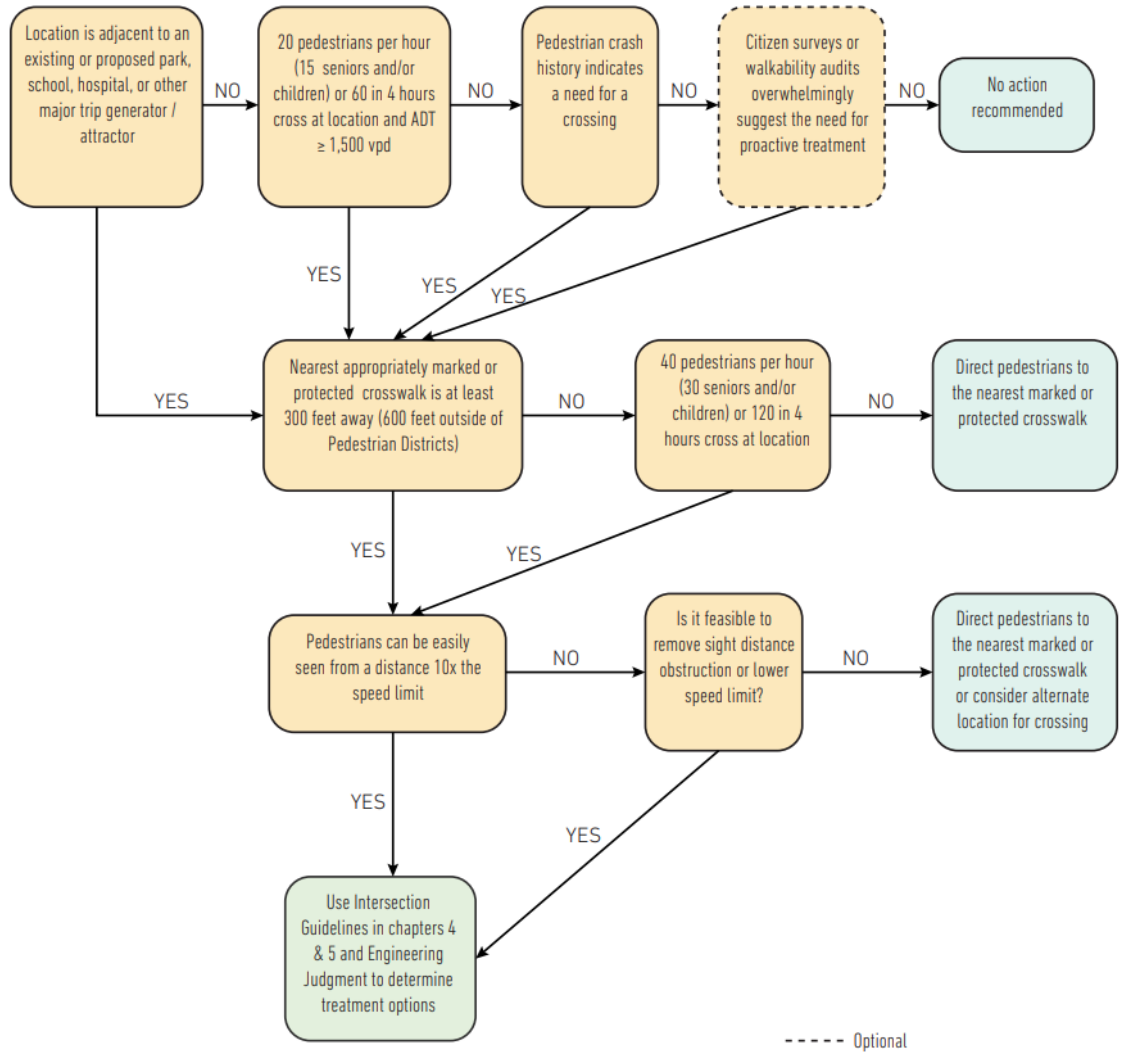


Figure 8: Pedestrian Plan (2011) Crossing Policy

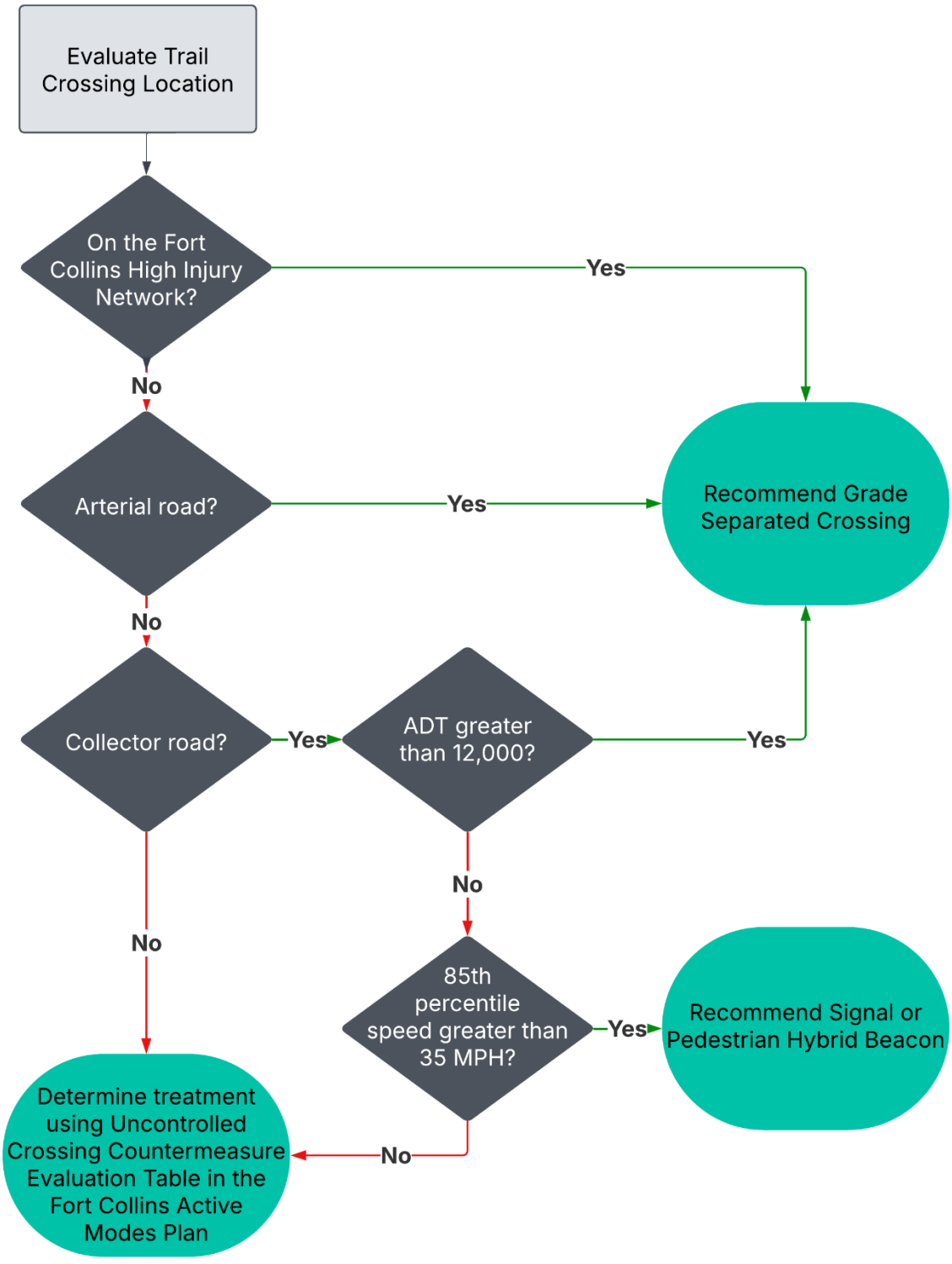


Figure 9: Updated Trail Crossing Policy

At-Grade Crossing Treatments

At locations where existing or proposed trails intersect roads at grade, identified appropriate treatments can be implemented. Potential at-grade crossing treatments are described in subsequent sections.

Uncontrolled Marked Crossing

Pavement markings are recommended as a minimum treatment at all at-grade trail crossings. Crossing markings for two-way trails should be delineated with high visibility (diagonal or ladder style) marked crosswalks. They delineate the crossing location and can help alert roadway users to the potential conflict ahead.

Raised Crossing

At appropriate locations, raised crossings improve safety by increasing visibility and encouraging vehicles to yield to trail users. A speed table, recommended to be 22 feet in length, includes a marked crosswalk on top of it. The MUTCD provides a standard design for raised crossings, shown in Figure 10 below.

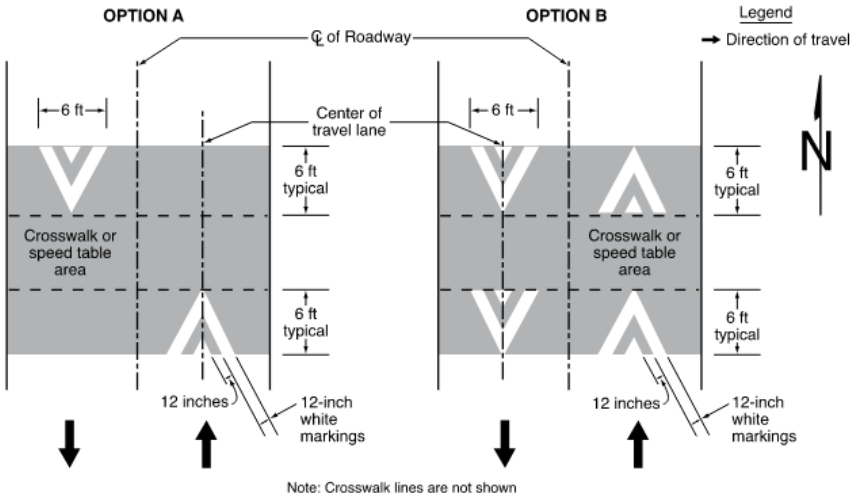


Figure 10: Pavement Markings for Raised Crosswalks

Rectangular Rapid Flashing Beacon (RRFB)

A pedestrian push button activates flashing lights on a pedestrian warning sign to increase visibility of pedestrians and trail users and increase driver yielding behavior. NACTO provides a concept drawing of an RRFB, shown in Figure 11, and refers to MUTCD for additional design guidance.

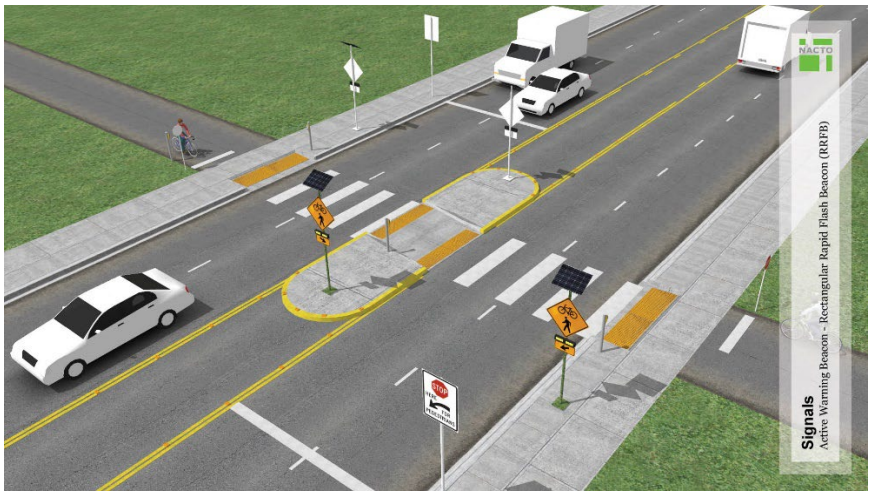


Figure 11: RRFB Concept Drawing

Pedestrian Hybrid Beacon (HAWK)

An overhead signal that is activated by a pedestrian push button and requires vehicles to come to a complete stop. NACTO provides a concept design of a HAWK, shown in Figure 12, and references the MUTCD for HAWK signal warrant requirements.

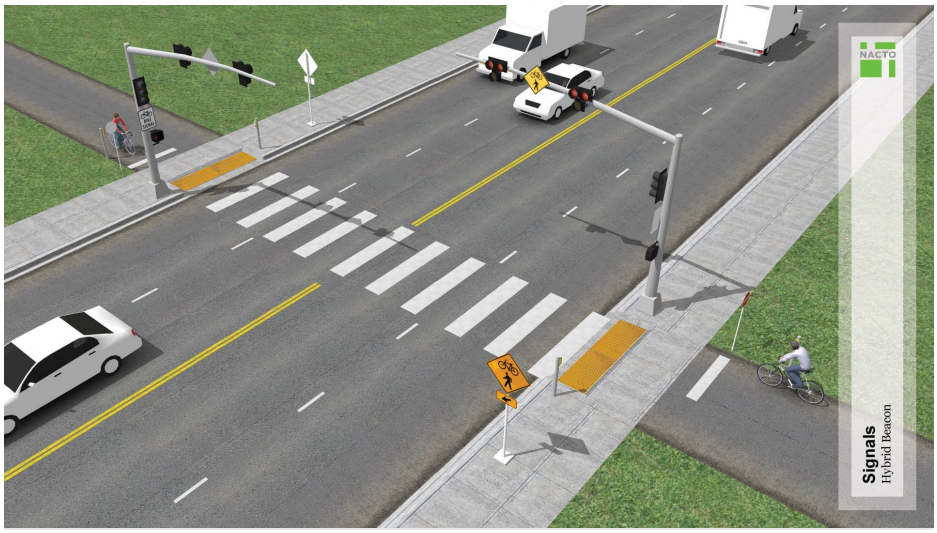


Figure 12: HAWK Concept Drawing

Signalized Crossing

These trail crossing locations have an existing full traffic signal or meet MUTCD warrant for a new signal. In Fort Collins, signals must be located more than 300 feet from other signalized intersections. The signals may operate for the trail using push button activation for trail users or may be activated with pedestrian recall to automatically include a trail crossing signal phase in every cycle. Trails can be directly aligned with the traffic signal or can be routed to a nearby signal along a perpendicular sidepath to cross at the signalized location. A fully signalized trail crossing would look very similar to the HAWK signal shown in Figure 13, and further design guidance from the Fort Collins Active Modes Plan Intersection Guidelines for Pedestrian and Bicycles should be consulted.

Landing Area at Trail Crossings

When a trail approaches a road at grade, it is recommended to maintain a consistent width rather than narrowing the trail. However, narrowing a trail can be a strategy to help to manage trail user speeds. If a trail changes direction at an intersection, a landing area with a minimum width of the trail and a minimum length of 10 feet is recommended to provide additional comfort and allow a variety of users to maneuver at the location.

Grade-Separated Crossings Standard Design Guidelines

The three main barriers in the trail system are roadways, railroads, and water crossings. These barriers may result in a significant amount of out-of-direction travel for trail users or undesired and potentially unsafe social trails that are more direct. Grade-separated crossings provide critical trail links by joining areas separated by these barriers.

Previous work documented all potential new grade-separated crossing locations within the City and established a prioritization methodology to implement new structures. Grade-separated crossings are a significant investment, so it is important to prioritize the most needed structures first.

Roadway Crossings

Grade-separated crossings of roads provide a lower-stress trail experience and lower the operational impacts of trail use on traffic. There are not any minimum roadway characteristics to consider a grade separated crossing, but they do require significant investment and may often not be feasible due to site constraints. The following roadway crossings can be evaluated for potential grade separation:

- **Arterial Crossings:** In all locations where a trail crosses an arterial roadway, a grade-separated crossing is preferred and feasibility should be evaluated, especially during redevelopment. The number of travel lanes on an arterial roadway should be considered in prioritization of grade separated crossing locations. If a grade-separated crossing at an arterial is not selected during the redevelopment process, this decision must be approved by the City. Even if a grade-separated crossing is not selected during the redevelopment process, the proposed development should not preclude the future construction of a grade-separated crossing.
- **Collector Crossings:** Locations where a trail crosses a collector roadway should also be evaluated for grade-separated crossing feasibility, especially during redevelopment. Even if a grade-separated crossing is not selected during the redevelopment process, the proposed development should not preclude the future construction of a grade-separated crossing.

Grade-separated crossings can be an overpass or underpass depending upon site constraints and desired user experience. The following general design features apply:

- **Overpass**: 14-foot width preferred; 12-foot minimum. Depending upon grades, an overpass generally requires more ramp distance due to a higher minimum elevation difference from the road. Ten-foot height is recommended for bicyclists and pedestrians, 12-foot height is recommended for equestrian activity, and 13-foot-6 inches height is required for emergency vehicles, if applicable. Trail bridges should be rated for a 10,000-pound vehicle and have a 52” inch high railing.

- **Underpass**: 14-foot minimum width; greater width for longer lengths. Ten-foot height recommended for bicyclists and pedestrians, 12-foot height recommended for equestrian activity, 13-foot-6 inches height required for emergency vehicles.

Railroad Crossings

Railroad crossings should always be evaluated for a grade-separated crossing facility. If a railroad must be crossed at grade, designers should refer to NACTO for design guidance.

- Clear and visible signage indicating the presence of the railroad crossing well in advance per MUTCD standards
- Smooth crossing surface level with the trail to accommodate all users
- Angle of intersection no less than 60 degrees but ideally 90 degrees, as shown in Figure 13

Figure 13: Achieving an Appropriate Angle of Intersection at a Railroad Crossing

Water Crossings

Trail bridges should be rated for a 10,000-pound vehicle, be a minimum of ten feet wide, have a railing height of 52 inches, utilize weathering steel and iron wood or concrete deck, have a rub rail, and be break-a-way if required for City Stormwater approval. Trail width on all bridges shall be a minimum of twelve feet. All trail crossing and drainage structures will be constructed and placed in a way that does not impede fish passage. Trail designers will work with the City's Stormwater Department, Natural Resource Department, and if needed Colorado Parks and Wildlife for guidance on this item.

Low water crossings may be permitted for shallow water and ditch crossings. Low water crossings should have a minimum twelve-foot width and are not required to have a railing but shall have concrete edges (minimum one-foot width) on both sides that are poured in a contrasting color such as red. Drainage pipes, box culverts, etc. shall be engineered to support the needed construction equipment and the trail loading. Drainage improvements will meet the City's Stormwater Department regulations, design, and construction standards. The CDOT standard details listed below should be referenced for water crossing design guidance.

- CDOT M-206-1 Excavation and backfill for structures (for box culverts)
- CDOT M-601-1, 2, 3 Concrete box culvert (cast-in-place)
- CDOT M-601-20 Wingwalls for pipe or box culverts

Wildlife Crossings

Trail underpasses of busy roads often serve to help wildlife get across the roads. Wildlife use of underpasses should be considered when underpasses are planned and designed.

Groundwater Quality Monitoring and Mitigation

When grade-separated crossings are installed in locations where groundwater levels are high, it is required that water quality be monitored when it is pumped out of the underpass, as it may contain heavy metals. Groundwater monitoring and mitigation is very costly. Therefore, groundwater levels should be verified and considered when choosing and prioritizing locations for grade-separated crossings.

Summary of Standards Changes

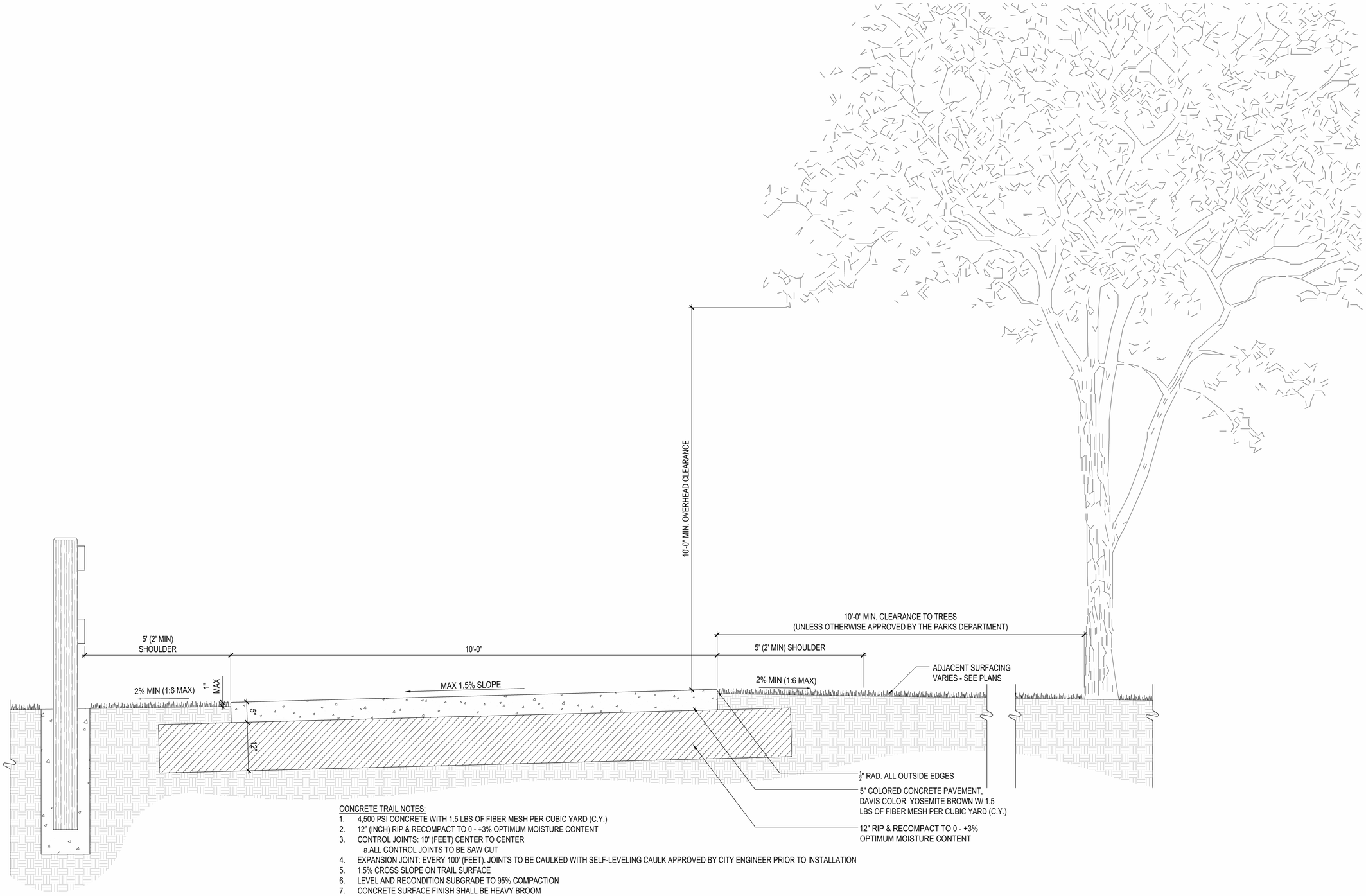
The table below summarizes updates made since the 2013 Paved Recreational Trail Master Plan Trail Standards.

Table 2: Summary of Standards Changes

Category	Previous Standard	New STP Standard
Right of Way	Recommend 50 feet with a minimum trail ROW of 30 feet for short distances	Defined limit on short distances of minimized ROW to clarify plan review standards
Horizontal Alignment	Goal is to have pleasant horizontal flow to the trail that avoids sharp corners. For unavoidable sharp corners, ROW should allow for a minimum 40 feet centerline radius to accommodate construction and maintenance vehicles	Added standard of 45-foot centerline radius within 50 feet of a bridge or other grade-separated structure to better accommodate City maintenance vehicles
Vertical Alignment	Trail grades less than 5% recommended where possible. For steeper grades up to 8%, trail should have rest areas of 2% grade for a distance of over 10 feet for every 2.5 feet of rise/fall along trail centerline. Grade of 8-10% only used for distances 50 feet and have ADA handrails. Grades > 10% should not be used.	Unchanged
Trail Placement and Environmental Sensitivity	Trail placement should avoid impacting high quality and/or sensitive habitat areas such as streams, rivers, and wetlands by following habitat edges and minimizing crossings.	Unchanged
Trail Placement in Riparian Buffer Areas	Opportunities to occasionally pull trail alignments away from waterways should be considered in order to balance environmental value with recreational value.	Unchanged, and added Trail Placement in Natural Habitat Buffer Areas to the discussion
Opportunities for Restoration	All future trail work within stream corridors shall include consultation with the Fort Collins Stormwater and Natural Areas Departments to assess restoration opportunities.	Unchanged

Category	Previous Standard	New STP Standard
Width	Paved trail width is recommended to be ten feet except in high congestion areas where it can be twelve feet and can be widened at other critical areas. Paved trail thickness is recommended to be 5-6 inches. Trails should have a three-foot-wide shoulder and an adjacent 5–6-foot gravel path, separated from the trail by 3-5 feet, that is 2-3 inches thick.	Changed to 10-foot minimum standard width and incorporated into Trail Section Details to better accommodate trail volumes and user comfort
Cross Slope	Cross slope should be between 1 and 2%.	Unchanged, but incorporated into Trail Section Details
Horizontal Clearance	Paved trails and gravel paths should have three feet of horizontal clearance at minimum.	Added 10-foot minimum clearance to trees to ensure consistency with Trail Section Details
Vertical Clearance	Paved trails and gravel paths should have a minimum vertical clearance of 8 feet.	Unchanged
Design Speed	Trails do not have a design speed, but City Code requires users to ride at a controlled speed for safety reasons.	Combined with Horizontal Alignment guidance, and changed to include a recommended minimum bicycle design speed of 18 MPH to reflect relevant standard guidelines.
Sight Distances	Curves should not be greater than 90 degrees but if they are there should be no sight obstructions within 30 feet of the trail centerline, and trails should have a straight section for 20 feet approaching an underpass.	Unchanged
Trail Lighting	The only lighting at underpasses and should be “dark sky” friendly	Added requirement of compliance with Fort Collins lighting standards to integrate trails with citywide regulations
Underpasses	Underpasses should comply with the Fort Collins Design Guidelines for Grade-Separated Pedestrian, Bicyclist, and Equestrian Structures	Unchanged, but incorporated into Grade-Separated Roadway Crossings

Category	Previous Standard	New STP Standard
Grade Separated Structures	Use of underpasses by wildlife should be considered when trail underpasses are planned and designed	Unchanged, but renamed to Wildlife Crossings
Drainage Structures	Trail bridges should be rated for 10,000 pounds, have a minimum width of ten feet, and have a 52 inch high railing. Structures must meet Stormwater Department regulations and standards. All water crossings and structures must not impede fish passage.	Unchanged, but incorporated into Water Crossings
Street Connections	Should be determined by City Traffic regulations and standards.	Unchanged, but incorporated into At-grade Crossing Treatment Guidance
Signage	Should comply with MUTCD.	Unchanged
Fencing	Standard fencing type along trails is Western two-rail. Fences should be wildlife friendly and passable.	Added fence standard detail
Seeding	Required seed mix for the three-foot shoulders and other disturbed areas is a blend of buffalo grass, blue gramma, and little blue stem. No exotic species are allowed.	Unchanged
Trail Safety	Trails should have Emergency Locator Systems and warning signage. Park and Natural Area Rangers on patrol can issue misdemeanor citations for unsafe trail use and unleashed dogs who are posing a hazard to other trail users.	Unchanged



CONCRETE TRAIL NOTES:

1. 4,500 PSI CONCRETE WITH 1.5 LBS OF FIBER MESH PER CUBIC YARD (C.Y.)
2. 12" (INCH) RIP & RECOMPACT TO 0 - +3% OPTIMUM MOISTURE CONTENT
3. CONTROL JOINTS: 10' (FEET) CENTER TO CENTER
   a. ALL CONTROL JOINTS TO BE SAW CUT
4. EXPANSION JOINT: EVERY 100' (FEET). JOINTS TO BE CAULKED WITH SELF-LEVELING CAULK APPROVED BY CITY ENGINEER PRIOR TO INSTALLATION
5. 1.5% CROSS SLOPE ON TRAIL SURFACE
6. LEVEL AND RECONDITION SUBGRADE TO 95% COMPACTION
7. CONCRETE SURFACE FINISH SHALL BE HEAVY BROOM
8. 5" (INCH) COLORED CONCRETE: DAVIS COLOR 'YOSEMITE BROWN", 2 LBS PER SACK OR APPROVED EQUAL
9. FORM WORK TO BE APPROVED BY ENGINEER OR INSPECTOR PRIOR TO POUR
10. CRUSHER FINES (3/8" MINUS AGGREGATE) FROM COLORADO LIEN CO. OR APPROVED EQUAL PER PARK PLANNING AND DEVELOPMENT, COLOR GREY SUBMIT SAMPLE FOR APPROVAL
11. 3' (FOOT) FLAT SHOULDER (SLOPED AWAY FROM TRAIL FOR DRAINAGE ~2%)
12. ALL DISTURBED AREAS SHALL BE REVEGETATED WITH THE SPECIFIED SEED MIX

A 5" CONCRETE TRAIL SECTION

SCALE: NOT TO SCALE

City of Fort Collins
Park Planning & Development

Park Planning & Development
215 North Mason Street
Fort Collins, Colorado 80521
tel: 970.221.6360
www.fcgov.com/parkplanning/

CALL UTILITY NOTIFICATION
CENTER OF COLORADO
1-800-922-1987
OR 534-6700 IN METRO DENVER

CALL 2 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES

TYPICAL TRAIL SECTIONS

CITY OF FORT COLLINS
FORT COLLINS, COLORADO

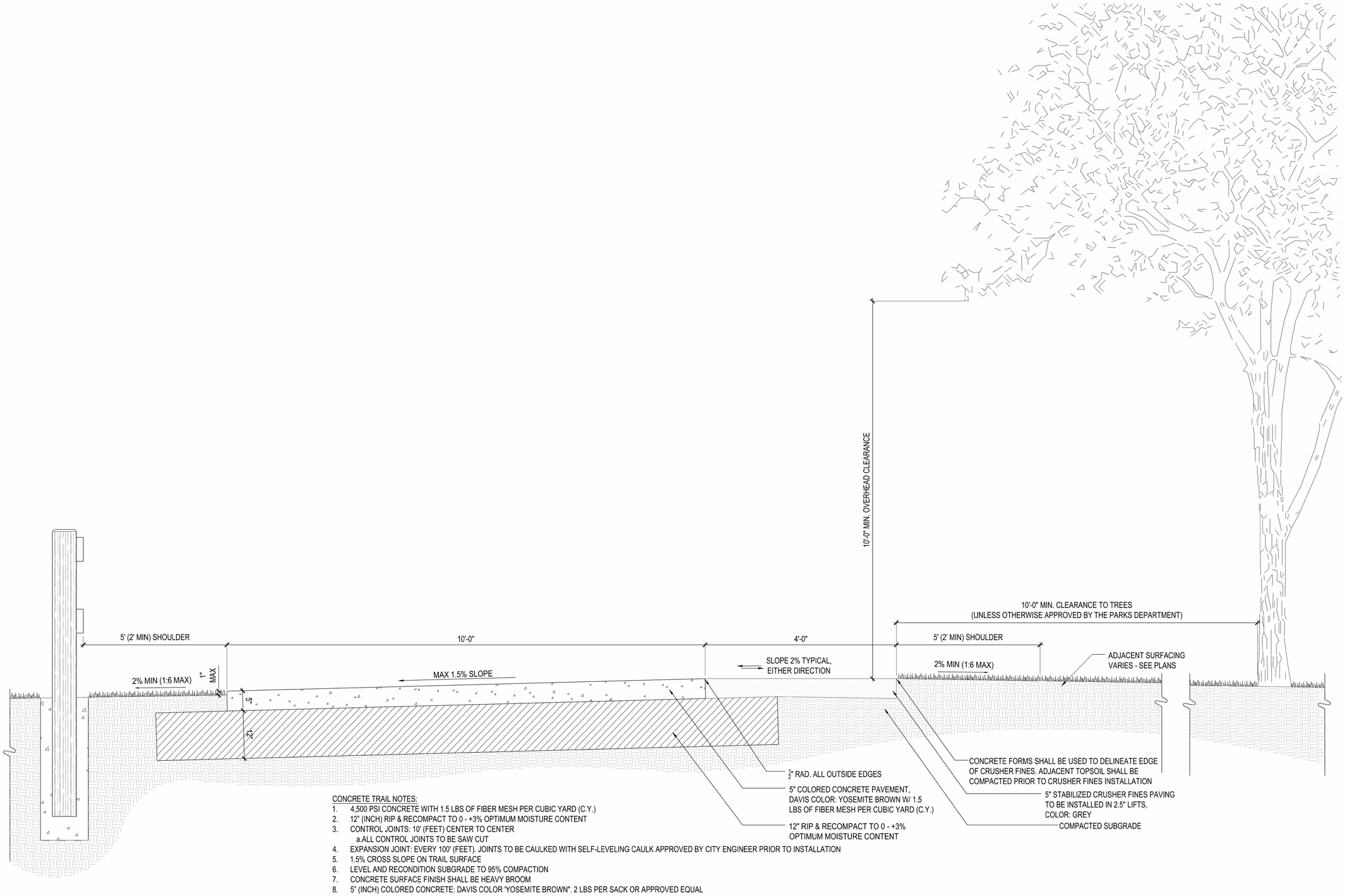
PROJ. NO. ...
DRAWN: MN
CHECKED: MN
APPROVED: MN
DATE: JANUARY 2024
REVISIONS :

TYPICAL TRAIL SECTIONS

ISSUED FOR:
-

SHEET TITLE:
TYPICAL TRAIL SECTION DETAIL

SCALE:
SHEET NUMBER
LS501



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PROJ. NO. ...
DRAWN: MN
CHECKED: MN
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DATE: JANUARY 2024
REVISIONS :

TYPICAL TRAIL SECTIONS

ISSUED FOR:
-

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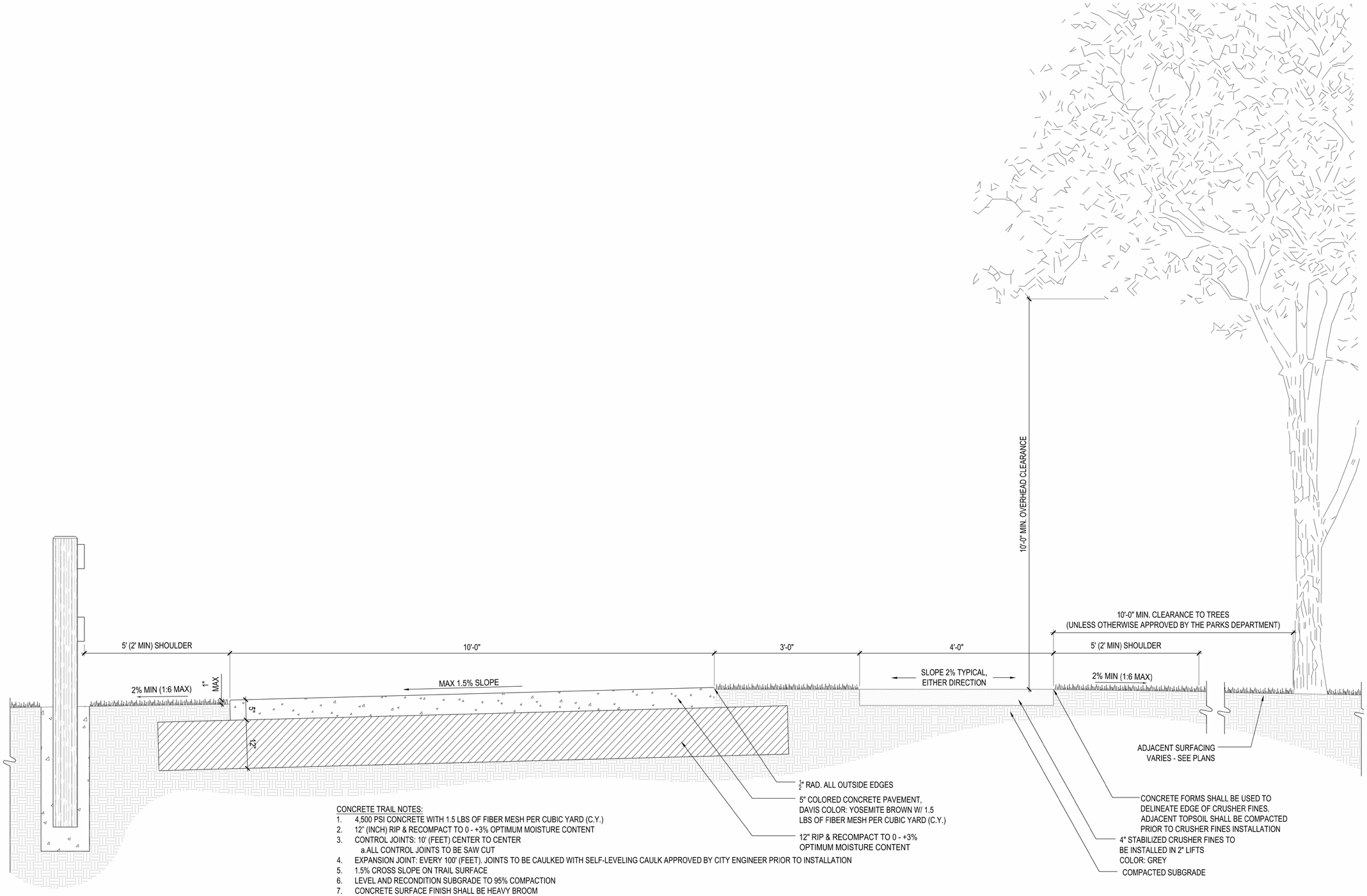
TYPICAL TRAIL SECTION DETAIL W/ ATTACHED GRAVEL PATH
SCALE: .
SHEET NUMBER
LS502



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SCALE: .
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