CO 119 Bikeway

Concept Design Validation Memo

Draft

Submitted to:

Boulder County
Transportation Department

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Project No. 19670

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Section 1. Introduction

Project Background

In 2018 CDOT hired Muller Engineering Company to provide a Connectivity Study and Concept Plan (15% Design) for a Bicycle and Pedestrian Path in the CO 119 Corridor between Boulder and Longmont (The Bikeway Project). This effort was completed at the direction of CDOT. The primary purpose of this study was to determine the feasibility of constructing a shared-use path in the corridor and plan for compatibility of this project with a future BRT project in the same corridor (The Safety and Mobility Project).

Boulder County Transportation Department (BOCO) used the Connectivity Study and Concept Plan to secure funding for the design of the Bikeway Project. BOCO is now the lead agency in finalizing the design of the Bikeway Project. It is BOCO's intention to use the Concept Plan as the basis for the final design. However, prior to proceeding to final design, BOCO has requested that a Design Validation be performed to consider areas of possible refinement in the Concept Plan.

Purpose of the Design Validation

The purpose of the Design Validation is to review, evaluate, and refine the design presented in the Concept Plans with more refined project goals and design criteria. These goals and design criteria include the following:

- Use design criteria for higher speed users, considering bike commuters, athletic riders and e-bikes.
- Maximize efficient connectivity to the corridor to attract use.
- Consider a wider tread or other treatments in areas of higher use.
- Minimize impacts to existing vegetation, waterways, and wetlands where possible.

The Concept Plan will be reviewed in detail. Suggestions to refine the Concept Plan to better meet these project goals and design criteria will be identified.

Section 2. Project Considerations

Expected User Groups

The majority of this project will be in the median of CO 119, in close proximity to high-speed and high-volume vehicular traffic. Also, most of this project is NOT directly adjacent to housing or businesses. For these reasons, this corridor is less likely to appeal to recreational users making short trips or looking for an enjoyable passive recreational experience. It is expected that most users will use this for longer trips at higher than typical speeds (bike commuters and athletic riders). Use of e-bikes is also expected. This project should also be designed to appeal to cyclist that currently use the shoulders of CO 119 **while also** safely accommodating all user groups.

Geometric Design Criteria

Design Standards

Bikeway design criteria has been established for this project (See Appendix A). The established design criteria is generally consistent with CDOT's Roadway Design Guide – Chapter 14 (2018) (RDG) and the AASHTO Guide for the Development of Bicycle Facilities (2012). Additionally, the CROW Design Manual

for Bicycle Traffic (2016) (CROW) was referenced for supplementary guidance regarding the design of the bikeway and potential at-grade crossing treatments.

Design Speed

The RDG suggests a design speed of 18 MPH to be used for most paths on relatively flat terrain. For this project to best accommodate the expected user groups outlined above, a design speed of 25 MPH will be used to better accommodate our expected user groups. This is consistent with the CROW design guidance for bicycle highways, which are defined as regional main cycle routes geared towards facilitating journeys by bicycle over longer distances ranging from 3 – 18.5 miles. The CROW suggests an 18 MPH design speed in built-up areas and 25 MPH outside of built-up areas. At the approaches to at-grade roadway crossings (see Type 2 and Type 3 Crossings below), the geometric design should encourage lower speeds. In these areas, a design speed of 12 MPH will be used.

Geometric Criteria

The above design speeds will be used to determine appropriate geometric design parameters provided by the CDOT RDG. Significant geometric parameters include the following:

Table 1 Geometric Design Criteria

Design Speed	12 MPH	25 MPH
Horizontal Curve Radius	27 Ft	115 Ft
Stopping Sight Distance (5% Accent)	67 Ft	190 Ft
Stopping Sight Distance (flat)	74 Ft	220 Ft
Stopping Sight Distance (5% Decent)	88 Ft	280 Ft

The geometric design/layout of underpass approaches, at-grade roadway crossing approaches, and BRT station areas will be closely reviewed for conformance with these design criteria.

Longitudinal Grades

A maximum longitudinal grade of 5% will be used on the project. This is expected to be technically feasible throughout the project. This meets AASHTO and ADA requirements and is consistent with the RDG.

Bikeway Width

The RDG suggests a minimum pavement width of 10’ for a two-directional shared use path. For this project, the typical bikeway width will be 12’ to accommodate higher speeds and passing / speed differentials anticipated with the expected user mix. As funding allows, the width will be increased to 16’ adjacent to BRT station areas when a greater volume of pedestrians is expected and at underpass approaches with grades exceeding 4%, where greater speed differentials are expected. The CROW design guidance supports these widths, stipulating a starting width of 13’ for a bicycle highway and adjusting based on volumes and speed differentials. The CROW states that bicycle highways along low-volume areas with no significant speed differentials can be decreased to 10 – 12 feet in width and those along high-volume areas and/or areas with high-speed differences should be increased to 15 – 16 feet in width.

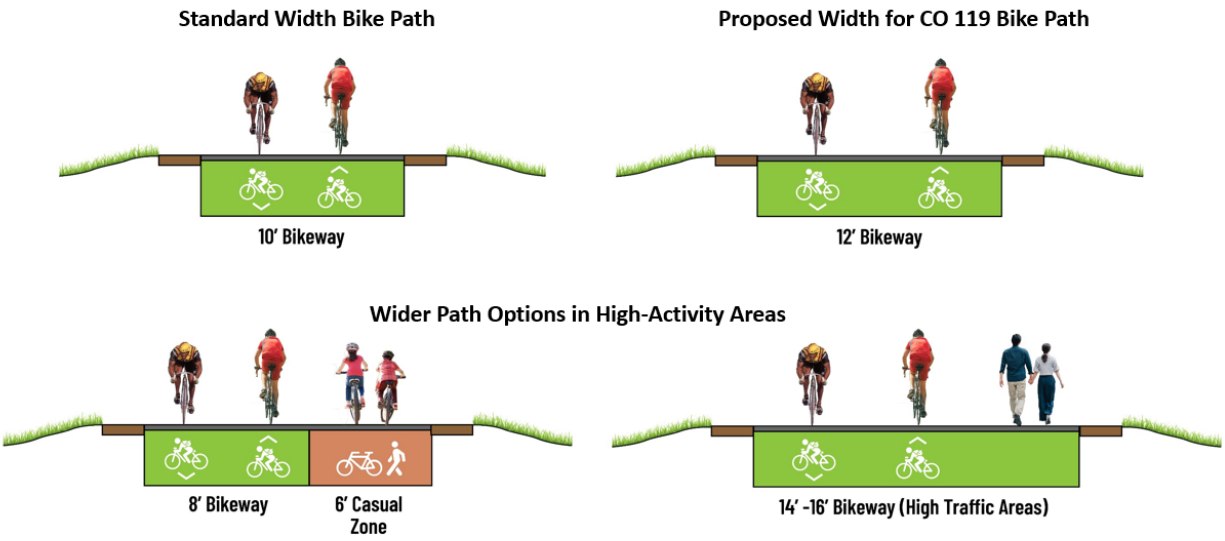


Figure 1 Proposed Bikeway Typical Sections

Shoulder Width

Shoulders are intended to provide a flat, traversable and obstruction free recovery area adjacent to the bikeway. The RDG suggests a minimum shoulder width of 3' graded at 6:1 maximum with a reduction to 2' in constrained locations. For this project, we propose typical shoulder width of 5' graded at 12:1. The 12:1 cross slope is proposed to promote positive drainage away from the bikeway while still providing a comfortable and easily traversable recovery area. A shy distance (distance between the edge of bikeway and vertical obstructions) of 5' typical and 2' in constrained situations should also be provided.

Underpass Width and Treatments

The RDG recommends that the clear width of bridges and tunnels be the width of the approaching path plus 2' at each side. Clear underpass width of 16' will be used at underpasses located away from BRT station areas and 20' at underpasses located adjacent to BRT station areas. (*Note: the 20' underpasses are 4' wider than those proposed in CDOT's concept design, so the extra cost for these underpasses will need to be considered against construction budget constraints*). A vertical clearance of 10' should be provided wherever possible. A reduction to 8.5' will be considered if needed for drainage or connectivity to the adjacent features such as a BRT station. The minimum cover / pavement thickness over the structures must be established in coordination with CDOT. Reduction in the needed depth from roadway profile to bikeway profile will be vital to provide drainage at the underpasses and avoid the need for a pump system.

Other Considerations

Clearance from Roadway

Protecting bikeway users from vehicles is a significant safety concern. Due to high vehicle speeds (55 to 65 MPH posted speed limit) and high vehicle volumes (30,000 to 59,000 ADT), providing a crash-worthy physical barrier (guardrail) should be considered where the bikeway must be located within close-proximity of the roadway. The RDG acknowledges that a crashworthy barrier should be provided between a roadway and bikeway when roadway speeds exceed 45 MPH. However, no guidance is provided regarding the minimum separation between roadway and bikeway without a crashworthy barrier.

We suggest that the AASHTO roadway clear-zone distance be used as the minimum distance without a crashworthy barrier.

The existing posted speed limit of CO 119 is 55 MPH south of Niwot Road and 65 MPH north of Niwot Road. The AASHTO Roadside Design Guide establishes the roadway clear-zone distance to be 30'-36' for a design speed of 60 MPH and ADT > 6000. In locations where the bikeway is located within 30' of the roadway traveled way (edge of adjacent thru lane), a guardrail or concrete barrier will be considered. The use of barriers should be minimized because they present a fixed-object hazard to both bicycles and vehicles. As such, the bikeway should be located more than 30' from the roadway wherever possible.

At-Grade Crossing Treatments

At-grade crossing treatments will be selected based on location specific characteristics; however, to provide a high-level overview of the treatments that will be applied to several locations throughout the corridor, the crossing improvements have been categorized into four typical crossing layouts. These include emergency vehicle access crossings, low-volume roadway crossings, moderate-volume roadway crossings, and channelized pedestrian crossings at station areas.

The uncontrolled at-grade roadway crossings will be located near the center of the CO 119 median and designed as mid-block crossings. This separates the bikeway crossing from vehicle turning movements at the adjacent roadway intersections and provides greater stopping sight distances between trail users and motorists, allowing them to more easily identify potential crossing conflicts.

Type 1: Emergency Vehicle Access Crossings – The study corridor includes a total of five emergency vehicle turnarounds that cross the alignment of the proposed bikeway as it runs along the median of CO 119. The turnarounds include R11-50 “Emergency and Authorized Vehicles Only” signage and are expected to carry a very low volume of vehicles. Therefore, the proposed treatments at the bikeway crossings of these turnarounds include the provision of crosswalk signing and striping improvements, implementation of yield-control on the vehicular approaches, and the use of continuous concrete across the asphalt turnaround as shown in the figure below.

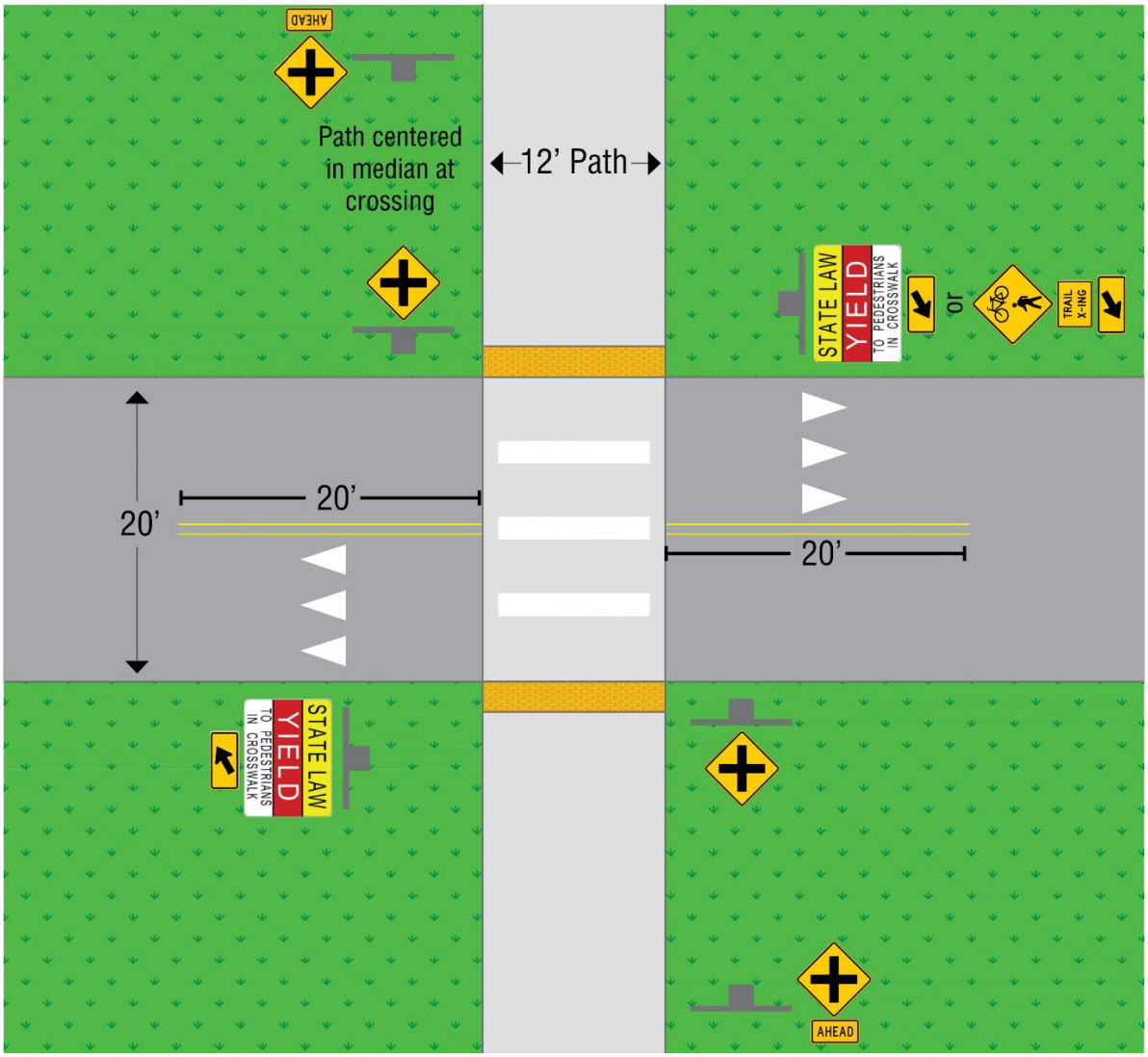


Figure 2 Type 1 – Emergency Vehicle Access Crossings

Type 2: Low-Volume Roadway Crossings – Along the corridor, there are four locations where the bikeway corridor crosses low-volume roadways. These include the crossings of 55th Street, Monarch Road, Oxford Road, and North 83rd Street. Proposed crossing treatments at these locations can include signing and striping improvements of the crosswalk, a median refuge island for path users, yield control on the vehicular approaches, colored pavement on the bikeway across the intersection, and orienting the path approaches toward the direction of incoming traffic. The typical crossing configuration at low-volume roadways is depicted in the figure below.

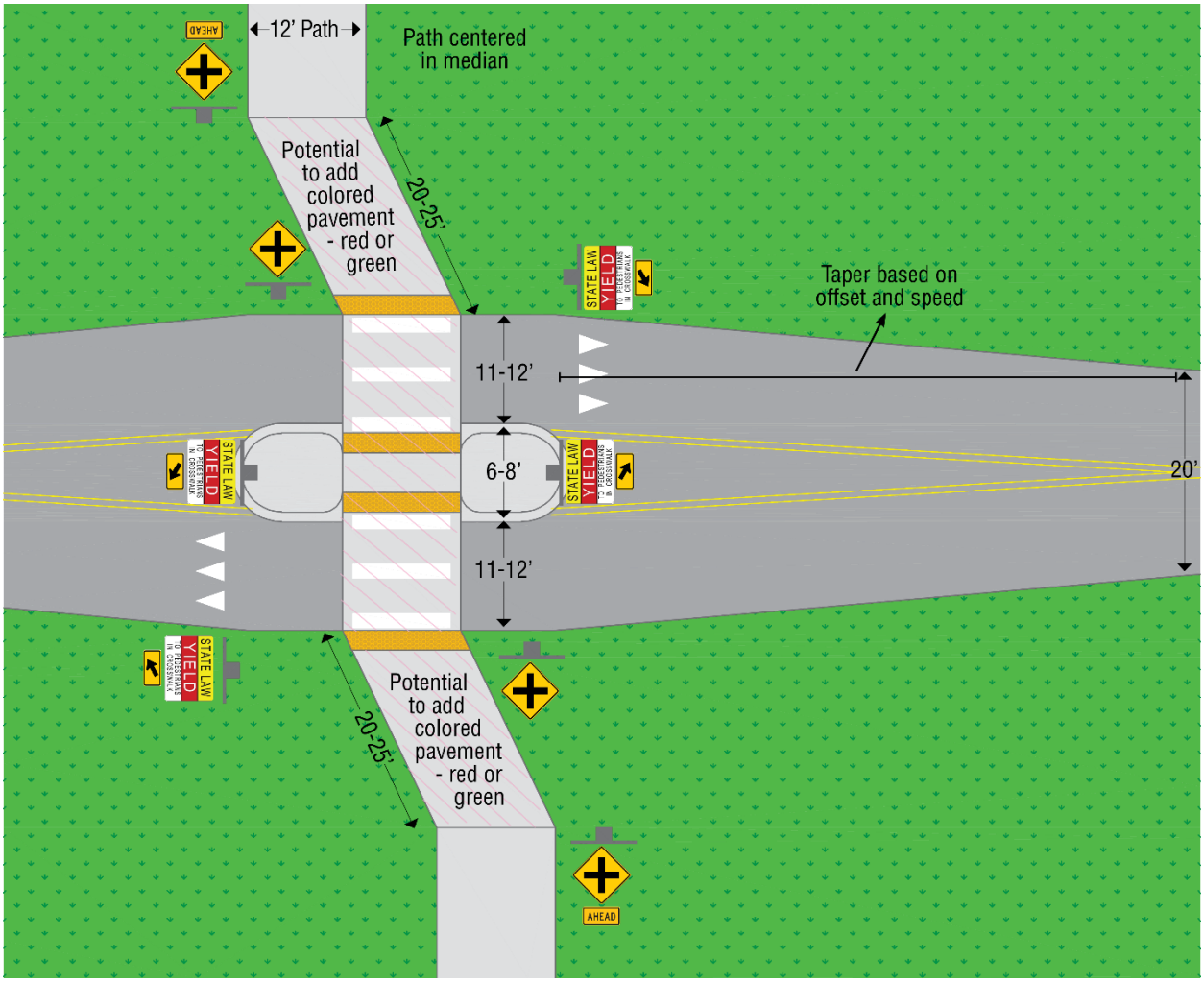


Figure 3 Type 2 – Low-Volume Roadway Crossings

Type 3: Moderate-Volume Roadway Crossings – The corridor includes one moderate-volume roadway crossing at South Fordham Street. Crossing treatments at moderate-volume roadways are similar to those that can be implemented at low-volume roadways with a few optional, supplemental improvements. These additional measures can include a raised table crossing or an enhanced crossing treatment, such as a Rectangular Rapid Flashing Beacon (RRFB), if warranted. The typical crossing configuration for a moderate-volume roadway is shown in the figure below.

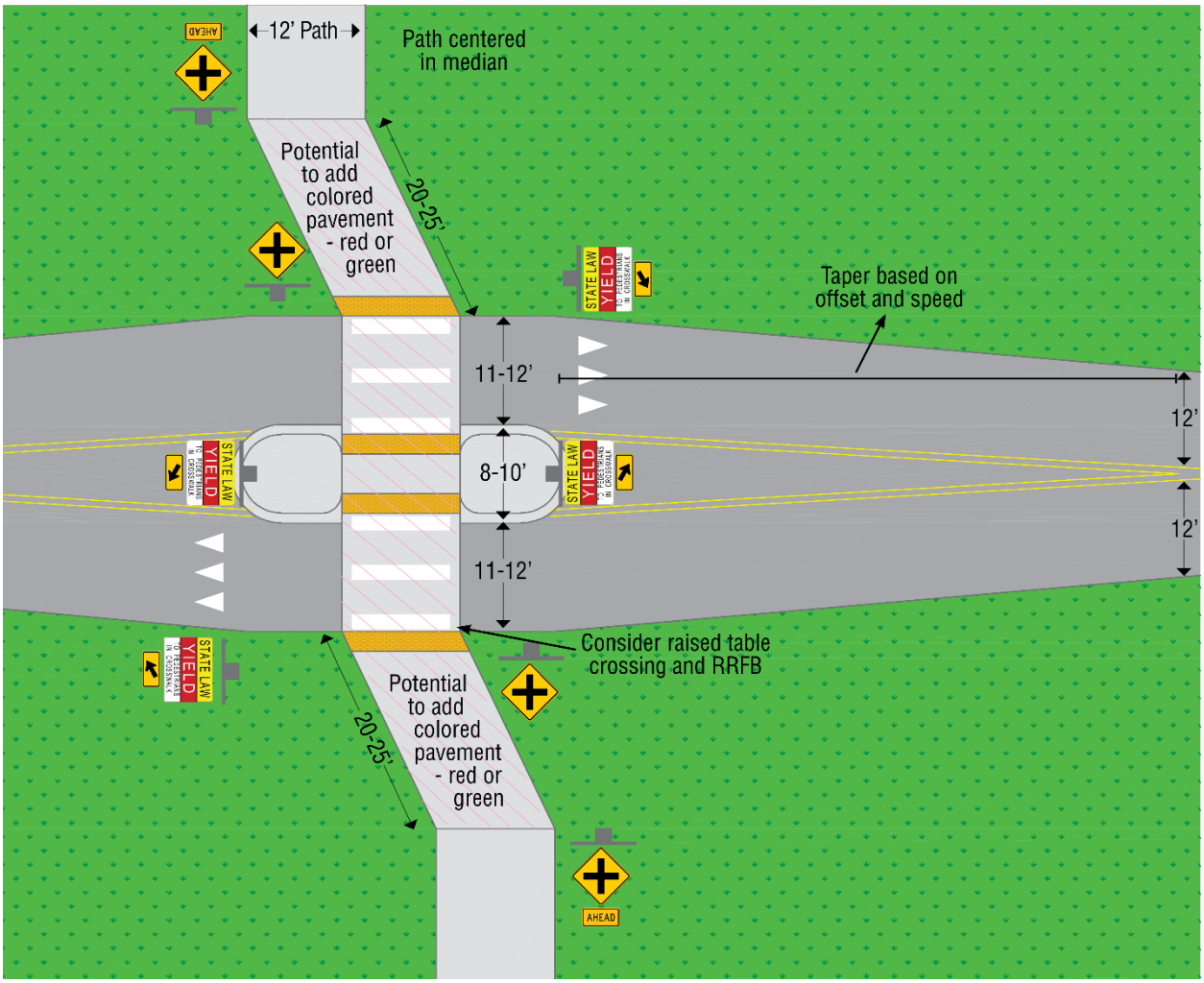


Figure 4 Type 3 – Moderate-Volume Roadway Crossings

Type 4 - Channelized Pedestrian Crossings at Station Areas – The Safety and Mobility Project along CO 119 includes three planned station areas along the bikeway corridor at 63rd Street, CO 52, and Niwot Road. At the interface with these station areas, the bikeway can be impacted by a concentration of crossing pedestrians and speed differentials between users on the path. In order to avoid bicycle-pedestrian conflicts at station areas, it is important to provide additional width along the path and controlled crossings of the bikeway. Therefore, crossing treatments at these areas will include widening the path to 16 feet, providing channelized pedestrian crossings with optional manual swing gates, as well as crossing signage and striping improvements. The figure below shows the typical layout for pedestrian crossings at station areas.

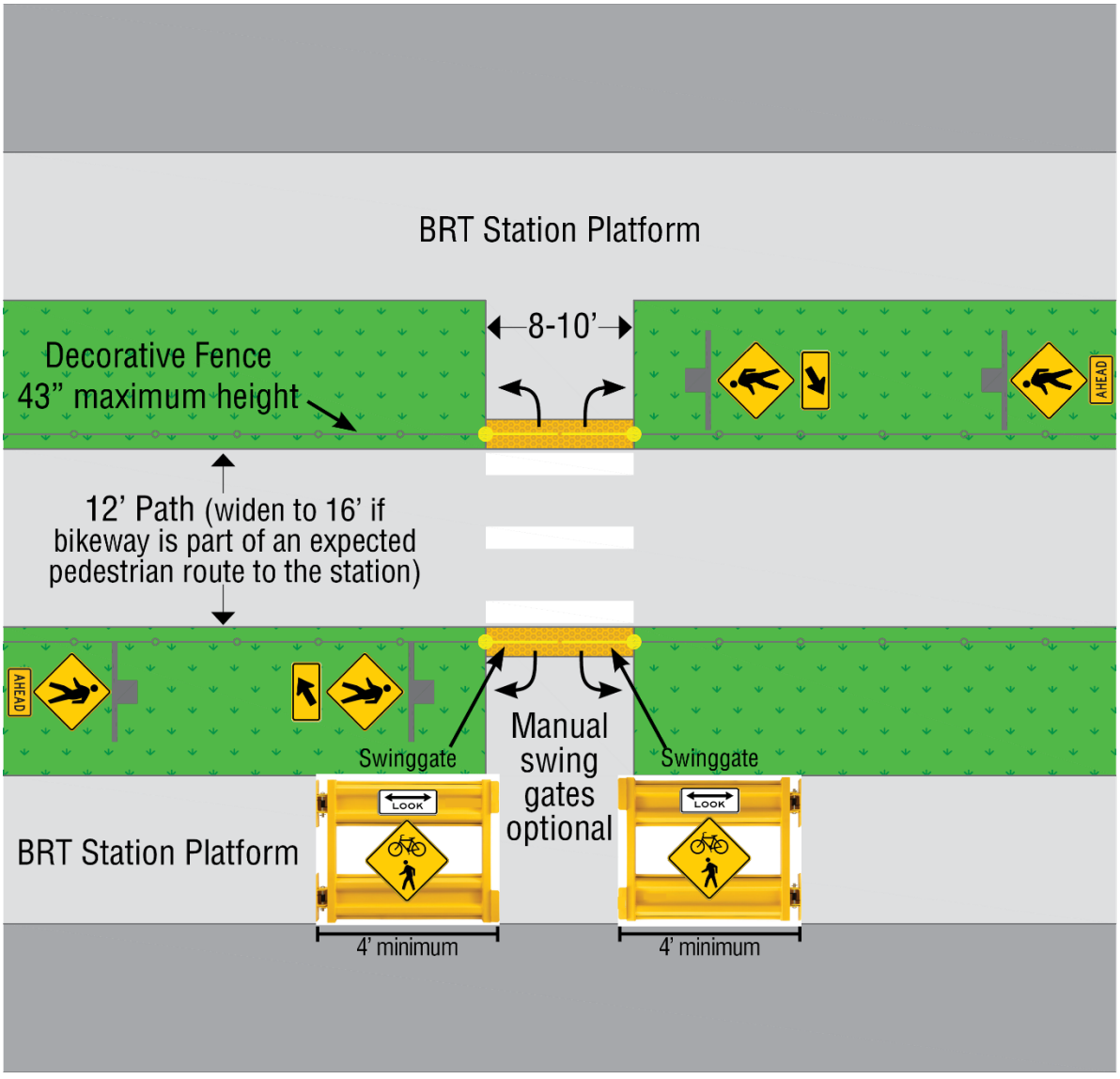


Figure 5 Type 4 – Channelized Pedestrian Crossings at Station Areas

Geometric Design Elements at At-Grade Crossings

The geometric design of the crossing approaches should be designed to reduce bikeway speeds, provide ample sight-distance and encourage bikeway users to look towards the direction of approaching traffic. The following design elements should be considered.

- S-curves with 27' horizontal curve radii (12 MPH) are recommended to reduce user speeds. The curves should be oriented to direct bikeway users to look in the direction of on-coming traffic.
- Crossing approaches should be designed to provide a smooth ride across the intersecting roadway.

Pavement Markings

An intensive use of pavement markings is proposed in this project as a mitigation measure to safely accommodate higher user speeds. The following pavement markings are proposed:

- Yellow Centerline Striping: Centerline striping is proposed to be used throughout the length of the bikeway to encourage bikeway users to stay on the right side of the bikeway and reduce the likelihood of head-on collisions. Centerline striping shall be dashed in areas with sufficient passing sight distance and solid in areas with reduced sight distance, curves, within high activity areas, and at approaches to at-grade crossings roadway or bikeway intersections.
- White Edge Striping: Solid edge striping should be considered throughout the length of the project. This is intended to improve visibility of the edge of the pavement, especially in low light levels considering that continuous lighting is not proposed.

Section 3. Alignment Considerations

Bikeway alignment alternatives and connectivity to existing facilities have been considered at both the south end (City of Boulder) and the north end (City of Longmont). The alignments shown in the Concept Plan were reviewed in detail and other potential alignments were also considered. Considerations and recommendations for both ends of the project are outlined below. Also see Appendices C-F for additional information.

South End Alignment Considerations

Two primary alignment options between Jay Road and 47th Street were evaluated. A third option along the east side of CO 119 was also considered but was deemed infeasible to due encroachment on railroad right-of-way, steep terrain, and potential vehicle conflicts at the Independence Road crossing.

Alignment B1 (Red)

This is the alignment developed in the 2018 CDOT Bikeway Concept Study. It includes an underpass beneath SB CO 119 approximately ¼ mile south of Jay Road to cross from the median of CO 119 to the west side of CO 119. It continues along the west side of the corridor and crosses Fourmile Creek and then passes beneath the 47th Street bridge over CO 119 and then connects to the existing bike path near Pleasant View Fields.

Primary constraints/challenges:

- Requires a long bridge span of the Floodway at Fourmile Creek crossing and the existing Fourmile Creek Trail
- Places bikes on northwest side of CO 119 while most users/destinations are south

Primary benefits/opportunities:

- Provides the greatest separation from CO 119 and least physical constraints
- Can be constructed within existing right-of-way

Alignment B2 (Blue)

This alignment keeps the bikeway in the center median and connects directly to the existing underpass north of the Diagonal Crossing development. The alignment would utilize the existing 12' wide Diagonal Crossing bike path with an at-grade controlled crossing at 47th St / Independence Rd and then extend south to the intersection of 47th Street / CO 119. A variation of this alignment alternative (dashed blue line) would utilize the existing 22' wide shoulder of NB CO 119 to route the Bikeway over Fourmile Creek and avoid impacts to the Flood Plain. Both options require an underpass under SB CO 157 (Foothills Parkway) north of Fourmile Creek.

Primary constraints/challenges:

- Constrained space between lanes of CO 119
- Users may feel more confined in the crossing area of Fourmile Creek (solid line option)
- Dashed line option places users along highway bridge with barrier separation from high-speed traffic
- Will require approval from CDOT to utilize CO 119 bridge (dashed line option)
- Requires minor ROW parcel take north of Fourmile Creek

Primary benefits/opportunities:

- Most direct alignment for most users
- Use of CO 119 bridge shoulder would avoid any impact to Fourmile Creek Flood Plain
- Use of CO 119 bridge shoulder would eliminate bridge structure over Fourmile Creek
- Allows for potential future connection (green dash line) to west side of 47th St
- Utilizes existing bike path infrastructure built with Diagonal Crossing development
- Provides greatest opportunities for a grade separated connection to Foothills Path, Wonderland Creek and Goose Creek Path

South End Alignment Recommendation

The consultant team's recommendation is to proceed with Alignment B2 (Blue) due to its more direct route for most users and most opportunities to provide future grade separated connections to the Foothills Path and Wonderland Creek Path. The final alignment selection will be subject to additional discussion with Boulder County and other stakeholders.

The consultant team's recommendation is to proceed with Alignment B2 (Blue) due to its more direct route for most users and most opportunities to provide future grade separated connections to the Foothills Path and Wonderland Creek Path. The final alignment selection will be subject to additional discussion with Boulder County and project stakeholders.

North End Alignment Considerations

Two primary alignment options were evaluated from Airport Road to Fordham Street and three alignments from were evaluated Fordham Street to south of Hover Street.

Airport Road to Fordham Street

Alignment L1 (Red) – This is the concept design alignment developed in the 2018 CDOT Bikeway Concept Study. It includes an at-grade crossing of Airport Road using the existing traffic signal at SB 119 and then a median alignment to the northeast with an at-grade crossing of Fordham Street midway between SB and NB CO 119.

Primary constraints/challenges:

- At-grade crossing of Airport Road (highest volume at-grade crossing in the corridor)

Primary benefits/opportunities:

- No ROW required
- Preferred location for crossing Fordham Street
- Avoids wetlands and stormwater issues at Airport Rd and Fordham St
- Maximizes separation of bikeway from CO 119
- Allows for potential future underpass across Airport Rd within the CO 119 median

Alignment L2 (Blue) – This alignment includes a new underpass across SB 119 southwest of Airport Road. It utilizes the existing underpass of Airport Road at Left Hand Creek and then travels along the west side of SB 119 towards Fordham Street where it diverts away from SB 119 to avoid existing trees, irrigation and drainage facilities on the northwest corner of Fordham Street. It crosses Fordham Street at-grade approximately 250' northwest of SB 119.

Primary constraints/challenges:

- Requires ROW from multiple parcels near Fordham St
- Significant drainage issues near Fordham St and at underpass southwest of Airport Rd
- At-grade crossing of Fordham St is at higher volume location than Alignment L1
- Users may have personal safety concerns at underpass of Airport Road
- Significant improvements needed at existing Airport Road underpass to bring it up to CO 119 Bikeway Standards (width, sight distance, and curve radii).
- Possible on-going maintenance issues with Airport Road underpass

Primary benefits/opportunities:

- Utilizes existing underpass of Airport Road
- Avoids turning vehicle conflicts at Airport Rd
- Improves access to existing Airport Road Shared Use Path and Fordham Street bike lanes.

Fordham Street to south of Hover Street

Alignment L1 (Red) – Alignment continues in the median and then passes under SB 119 north of the Connector Road where it aligns with the existing 8' wide bike path (to be replaced) eventually connecting with the existing CO 119 underpass that serves the Bike-n-Shelter Station on the east side of CO 119.

Primary constraints/challenges:

- Potential Prairie Dog impacts in median of CO 119

Primary benefits/opportunities:

- Avoids vehicle turning conflicts at Connector Road
- Avoids wetlands/drainage impacts

Alignment L2 (Blue) – Alignment continues along the west side of SB 119 where it aligns with the existing 8' wide bike path (to be replaced) eventually connecting with the existing CO 119 underpass that serves the Bike-n-Shelter Station on the east side of CO 119.

Primary constraints/challenges:

- Requires at-grade crossing of Connector Road, which is a busy public street serving multiple businesses
- Potential wetlands and drainage issues northwest of Fordham Street
- May require ROW
- Minimal separation between bike path and CO 119 traffic

Primary benefits/opportunities:

- Provides direct access to businesses east of Fordham Street and south of Pike Road

Alignment L3 (Gold) – Alignment continues in the median from Fordham Street to south of where NB and SB CO 119 rejoin and then provides an underpass across NB CO 119. On the east side of NB 119, the path would lie between Oskar Blues and the highway before connecting to the Bike-n-Shelter Station.

Primary constraints/challenges:

- Potential Prairie Dog impacts in median of CO 119
- Will need to avoid artwork/sculpture in median of CO 119
- Requires large retaining walls along NB CO 119 near Oskar Blues restaurant

Primary benefits/opportunities:

- Most direct route to Hover Street and Pike Road east of CO 119

North End Alignment Recommendation

The consultant team's recommendation is to proceed with Alignment L1 (Red) because it avoids ROW acquisition adjacent to Fordham Street, crosses Fordham Street at a safer location, and provides for greater separation from CO 119. The addition of a grade-separated crossing of Airport Road should be considered to address safety concerns at the at-grade crossing of Airport Road. The final alignment selection will be subject to additional discussion with Boulder County and other stakeholders.

The consultant team's recommendation is to proceed with Alignment L1 (Red) because it avoids ROW acquisition adjacent to Fordham Street, crosses Fordham Street at a safer location, and provides for greater separation from CO 119. The addition of a grade-separated crossing of Airport Road should be considered to address safety concerns at the at-grade crossing of Airport Road. The final alignment selection will be subject to additional discussion with Boulder County and project stakeholders.

Section 4. Design Review

In addition to the north end and south end alignments, the Concept Plans have been reviewed in detail as shown in Appendix A. Potential design changes and additional considerations are outlined below (Stationing references are shown in Appendix A at the top of each sheet).

Boulder to Jay Road

See Section 3 – South End Alignment Considerations above.

Jay Road Underpass

- The south approach to the Jay Road Underpass should be shifted east to locate the bikeway closer to NB 119 to accommodate the bikeway on an extension of the existing culvert at STA 145 rather than constructing a separate culvert.
- Increase the approach radii to 115' minimum.
- Underpass drainage and the existing drainage facilities north of Jay Road will require close review in design.
- Consider raising the profile of Jay Road to improve underpass drainage.

Jay Road to 55th St

- Shift alignment east from STA 158 to 166 to avoid wetlands.

- Shift alignment west at STA 168 to 180 and extend the existing culvert to accommodate the bikeway and reduce wetlands impacts.

55th St At-Grade Crossing

- There is a significant amount of vegetation on the west side of 55th St near the roadway that would create sight distance and visibility concerns for cyclists using the path and crossing 55th St at this location. It is recommended that bushes and shrubs be removed to create adequate sight triangles for bicyclists and motorists at this location. Also, more detailed review of the tree locations and species types should be performed to determine which trees should be removed to create clear sight distance triangles for all users.

55th St to 63rd St

- Shift alignment west at STA 230 and extend the existing culvert to accommodate the bikeway and reduce wetlands impacts.
- Shift alignment west between STA 240 to 245 to avoid wetlands.

63rd St Underpass

The design of the underpass and bikeway approaches to the underpass will need to be closely coordinated with RTD's proposed BRT Station. The Concept Design Plans included a concept design of the BRT station parking area from RTD's CO 119 Planning and Environmental Linkages (PEL) Study. The station and parking layout is subject to design refinements as part of CDOT's Safety and Mobility project. The Bikeway project will need to closely coordinate design with CDOT's project to ensure a safe and efficient alignment of the bikeway through the station area. The following comments are based on the station design developed during RTD's PEL project.

- Shift alignment west at STA 260 and extend the existing culvert to accommodate the bikeway and reduce wetlands impacts.
- Coordinate underpass location with 63rd St Station. Consider locating the underpass at the west side of the station rather than east to improve drainage. The profile of 63rd St increases from east to west, with the west side being nearly 7 feet higher in elevation. Consider increasing underpass width from 16' to 20' to accommodate bicycles and BRT park-n-ride activity.
- Provide a bikeway connection between WB 63rd St and the bikeway.

63rd St to CO 52

- Shift alignment west at STA 278 and extend the existing culvert to accommodate the bikeway and reduce wetlands impacts.
- Shift alignment west at STA 290 to 294 to reduce wetlands impacts.

CO 52 Intersection

This area was not reviewed in detail. It is understood that CO 119 will be divided at the CO 52 intersection as part of CDOT's CO 119 Safety and Mobility Project. This is a significant change from the design shown in the Concept Plan. As a result, the bikeway design will be changed significantly from the Concept Plan and should be closely coordinated with the intersection changes in the Safety and Mobility Project as that project develops. It is expected that the bikeway will be located in the median through this section and will include an underpass beneath CO 52.

CO 52 to Niwot Road

- Shift alignment if needed at STA 389 to avoid large cottonwoods.

Niwot Road Underpass

The design of the underpass and bikeway approaches to the underpass will need to be closely coordinated with RTD's proposed BRT Station. The Concept Design Plans included a concept design of the BRT station parking area from RTD's CO 119 PEL Study. The station and parking layout is subject to design refinements as part of CDOT's Safety and Mobility project. The Bikeway project will need to closely coordinate design with CDOT's project to ensure a safe and efficient alignment of the bikeway through the station area. The following comments are based on the station design developed during RTD's PEL project.

- Underpass drainage is expected to be a significant challenge in this area. The area to the north of Niwot Road appears to be designed to be a stormwater detention area. The outfall elevation if this area is less than 10' below the elevation of Niwot Road. Close review of the existing drainage facilities will be required. Extensive waterproofing and a stormwater lift station is expected. Consider increasing underpass width from 16' to 20' to accommodate bicycles and BRT park-n-ride activity.
- Increase the skew of the underpass to improve sight distance. Consider visual obstruction of approach retaining walls.
- The design of the Niwot Station should provide a connection to NB Niwot Road.

Niwot Road to Airport Road

- Shift alignment east STA 405 to 413 to avoid impacts to existing trees. Also provide adequate clearance from Safety and Mobility Project widening.
- Shift alignment west at STA 420 to avoid wetlands.
- Refine alignment at STA 432 to go through large trees with minimal impact.
- Shift alignment west at STA 440 to avoid wetlands.
- Shift alignment west at STA 470 and extend the existing culvert to accommodate the bikeway and reduce wetlands impacts and avoid existing trees.
- Shift alignment east at STA 485 to 492 to avoid existing trees.
- Reconfigure alignment at STA 503 to provide a continuous mainline alignment. Replace existing 8' wide concrete path with 12' wide bikeway to project standards to Airport Road.

Airport Road Crossing

In the current concept design the path is planned to cross Airport Rd on the south side of the SB 119/Airport Rd intersection at grade. This intersection is currently signalized and pedestrian signal heads are in place for pedestrian crossings of the south and east legs of the intersection. In order to enhance safety for the path crossing at this intersection, it is recommended that:

- A protected only phase be implemented for the SB 119 to SB Airport Rd movement. This will eliminate the conflict between path users and left turning traffic.
- A bicycle signal head and phase be installed for the path crossing of the south leg of the intersection. This phase can coincide with the existing pedestrian signal phase. Specific timing and clearance intervals will be determined as the design progresses.
- Enhanced crosswalk markings should be considered for the path crossing of Airport Rd.

Airport Road to Fordham St

Assuming that Alignment L1 is selected, the following modifications to the Concept Plan are recommended.

- Shift alignment west STA 605 to 612 to minimize wetlands impacts.

- Shift alignment west STA 615 to 625. Locate the bikeway bridge directly adjacent to SB 119 to minimize impacts to floodplains and wetlands. Consider including the bikeway with a potential widening of SB 119 with the Safety and Mobility Project, if appropriate.
- Refine alignment STA 630 to 635 to avoid existing cottonwoods.

Fordham St At-Grade Crossing

Assuming that Alignment L1 is selected, the following modifications to the Concept Plan are recommended.

- Consider reducing Fordham Street from 2 northbound lanes to 1 with the additional of a median island (Type 3 – Moderate Volume Roadway Crossing)

Fordham St to Hover St

Assuming that Alignment L1 is selected, the following modifications to the Concept Plan are recommended.

- Relocate underpass from STA 652 to 667. This will minimize impacts to wetlands, avoid standing water and other expected drainage challenges on the west side of NB 119 in this area. This will also avoid the at-grade crossing at the business park Connector Road while still providing an opportunity for connection to the bikeway from the development further east.
- The underpass at STA 667 must consider roadway drainage on the west side of NB 119 coming from the south.

PoDI / NHS	
FHWA PROJECT OF DIVISION INTEREST (PoDI)?	☐ NO ☐ YES
NATIONAL HIGHWAY SYSTEM?	☐ NO ☐ YES

DEPARTMENT OF TRANSPORTATION
STATE OF COLORADO

SH 119 BICYCLE AND PEDESTRIAN CONNECTIVITY STUDY

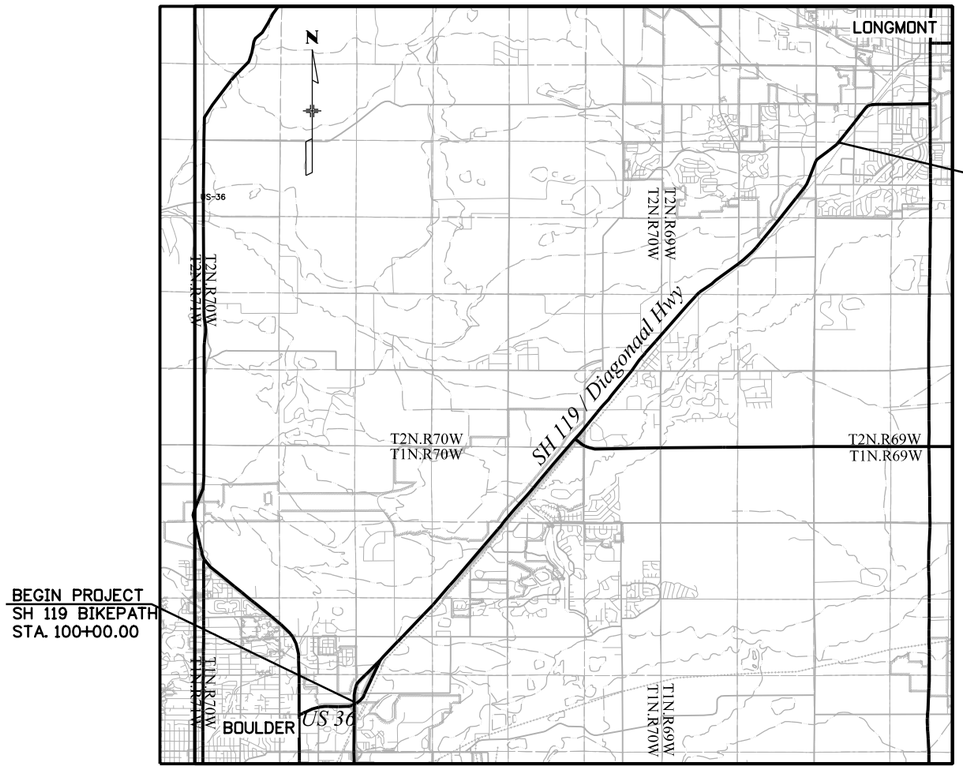
CDOT PROJECT NUMBER STA 1191-035

Related Projects:
P. E. UNDER PROJECT:
Project Number STA 1191-035
Project Code: 22455

R.O.W. Projects:
R.O.W. Project Description

CONCEPT SUBMITTAL

JULY 2019



PROJECT LOCATION MAP

INDEX OF SHEETS

LEGEND

- BIKEWAY ALIGNMENT REFINEMENT
- ALTERNATIVE BIKEWAY ALIGNMENT
- DIRECTION OF DRAINAGE
- DELINEATED WETLANDS

Appendix A
Concept Plan Mark-Up

Know what's **below** **Call** before you dig.

Print Date: 7/9/2019	Sheet Revisions	Colorado Department of Transportation	As Constructed
File Name: 15020DES_TitleSht.dgn	Date: / Comments / Init.	1050 Lee Hill Road, Boulder, CO 80302	No Revisions:
Horiz. Scale: 1:1 Vert. Scale: As Noted		Phone: 303-546-5658 FAX: 303-444-0751	Revised:
Unit Information Unit Leader Initials		Region 4 RDM	Void:
MULLER ENGINEERING COMPANY			

Contract Information	Project No./Code
Contractor:	STA 1191-035
Resident Engineer:	22455
Project Engineer:	Sheet Number 1
PROJECT STARTED: / / ACCEPTED: / /	
Comments:	

kcronk 3:44:25 PM P:\2018 Projects\18-031.01 CDOT SH119 Bike Study - CDOT R-4\22455\Design\Drawings\15020DES_TitleSht.dgn
7/9/2019 CDOT-DefaultPrinter_V8i.pltcfg

STATION NUMBER REFERENCED MEMO

105+00 110+00 115+00 120+00 125+00

TIE INTO EXISTING TRAIL

BEGIN TYPICAL SECTION 1

TRAIL PASSES UNDER EXISTING 47th STREET BRIDGE

END TYPICAL SECTION 4, BEGIN TYPICAL SECTION 1

47th St.

Project Control Line SH 119 Bikepath

Four Mile Creek Trail

LIMIT OF FILL (TYP.)

Existing Right of Way (Typ.)

BRIDGE OR LOW-WATER CROSSING TBD BY HYDRAULICS. IF BRIDGE. CONSIDER LOCATING CLOSER TO ROAD

PEDESTRIAN OVERPASS

TOP OF CUT (TYP.)

0' 100' 200' 400'

SH 119 SB

SH 119 NB

END TYPICAL SECTION 1, BEGIN TYPICAL SECTION 4

BARRIER (TYP.)

BRIDGE ALT

ALT ALIGNMENT B2

CONCEPTUAL BRT DESIGN (BY OTHERS)

MATCH LINE STA. 128+00

ALIGNMENT REFINEMENT (TYP)

VERIFY LOW POINT

SH 119 NB On Ramp

BEGIN PROJECT SH 119 BIKEPATH
SH 119 BIKEPATH STA. 100+00
N: 258530.991
E: 72196.315

NOTE:
1. TOES AND SLOPES OF BRT NOT KNOWN AT THIS TIME.

VARIATION OF ALT B2 USING EX BRIDGE SHOULDER

RECONSTRUCT THIS INTERSECTION SO THRU DIRECTION IS DOMINANT

Four Mile Creek Trail

V.C. = 110.00'
K = 20.76
e = 0.73'

V.C. = 50.00'
K = 18.15

V.C. = 100.00'
K = 17.88
e = 0.70'
SSD = 125'

K = 19.45
e = 0.23
SSD = 219'

CONSDIER SPLITTING BIKEWAY AT EXISTING BRIDGE PIER INTO 2 ONE-WAY SECTIONS TO AVOID THE NEED FOR A RETAINING WALL. ADD BACKING TO EXISTING GUARDRAIL. THERE IS GREATER THAN 8' CLEAR AT EACH SIDE OF THE PIER

CHECK DRAINAGE LP IN SECTION. CONSIDER SHIFTING TOWARDS THE FENCE IF NEEDED

AVOID EX RIPRAP

VPC-119+25.00

Low Point 119+60.75
ELEV=5283.23'

0' 100' 200'

40' 20' 0'

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Drawing File Name: 22455DES_Plan01.dgn		Date:	Comments	Init.	1050 Lee Hill Road Boulder, CO 80302 Phone: 303-546-5658 FAX: 303-444-0751
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Unit Information	Unit Leader Initials				
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Void:	Detailer: REW			Sheet Number
	Sheet Subset: P&P	Subset Sheets:	1 of 18	

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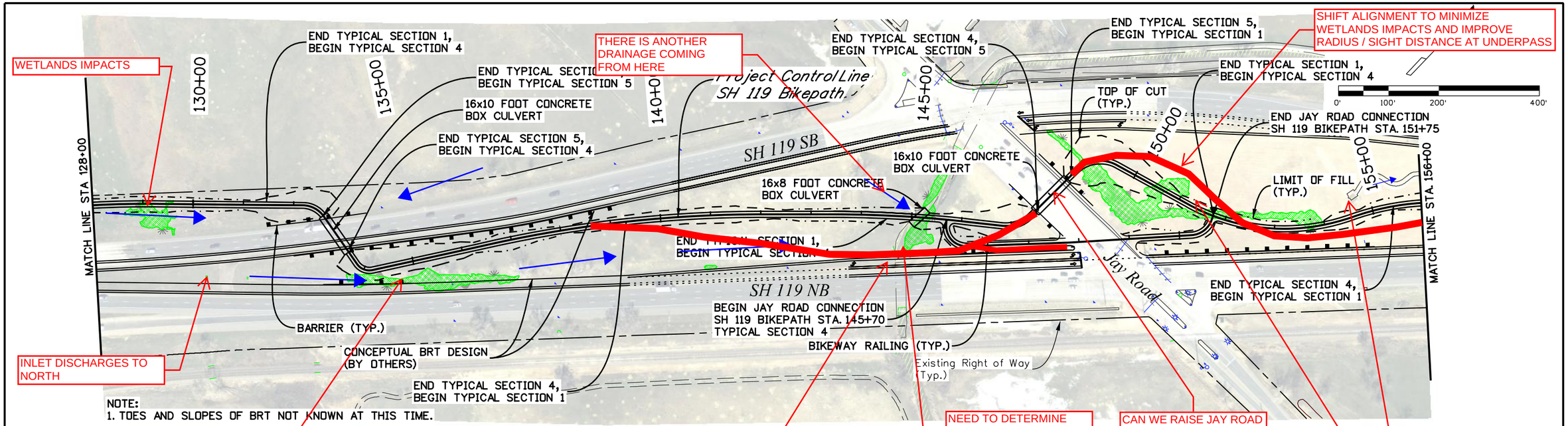

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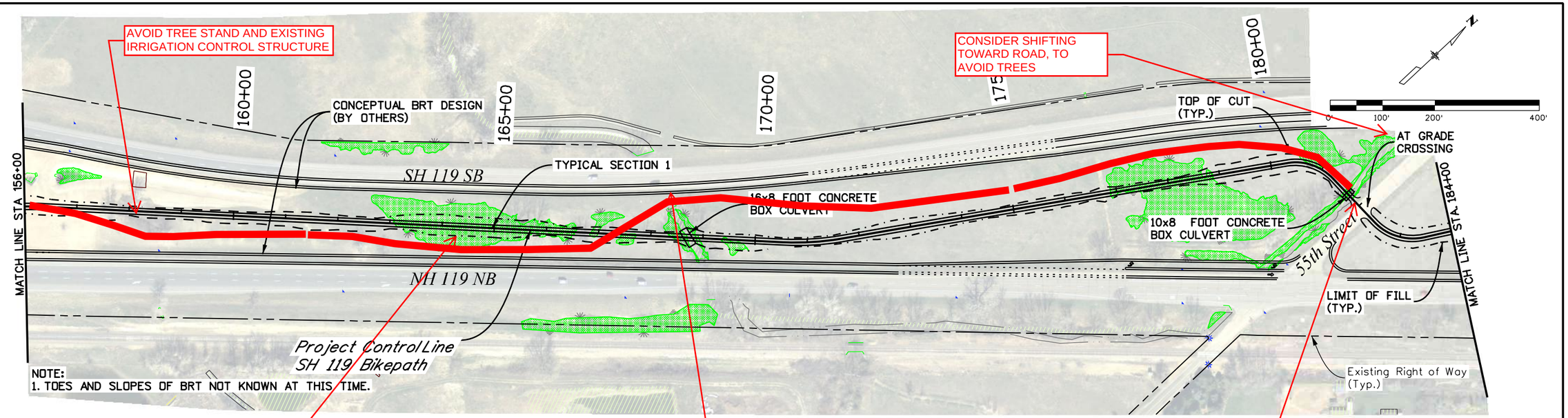

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Unit Information Unit Leader Initials

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Detailer: REW
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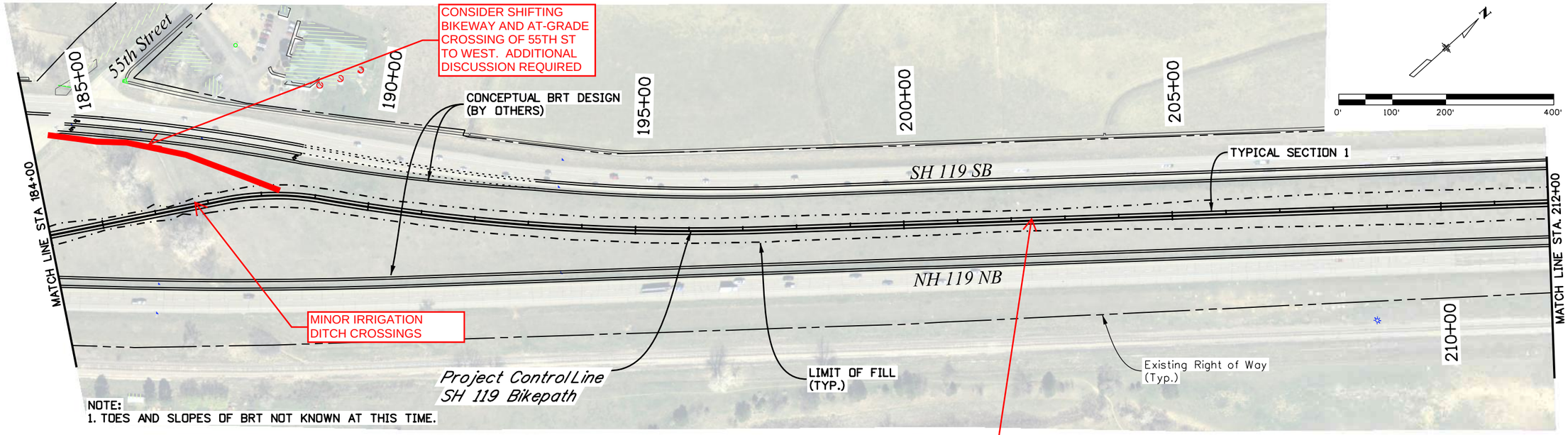

ALIGNMENT GOOD AS-IS. TERRAIN IS FLAT AND WIDE OPEN WITH NO TREES OR WETLANDS

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Drawing File Name: 22455DES_Plan04.dgn	Date:	Comments	Init.
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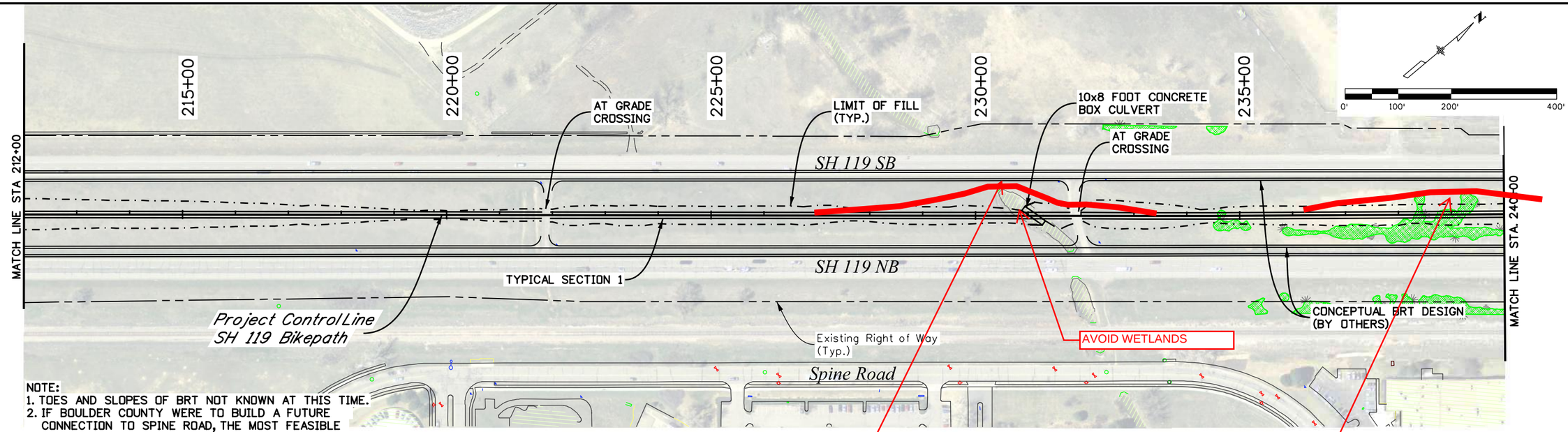

NOTE:
1. TOES AND SLOPES OF BRT NOT KNOWN AT THIS TIME.
2. IF BOULDER COUNTY WERE TO BUILD A FUTURE CONNECTION TO SPINE ROAD, THE MOST FEASIBLE ALTERNATIVE WOULD BE ON THE SOUTHEAST SIDE OF SPINE ROAD.

V.C. = 30.00'
K = 18.16
e = 0.06'
SSD = 123'

EMERGENCY CROSSING

SHIFT BIKEWAY WEST TO AVOID WETLANDS. EXTEND EXISTING BOX CULVERT

EMERGENCY CROSSING

V.C. = 80.00'
K
SHIFT TO AVOID WETLANDS

VPI-231+50.00
EL.=5182.56'
K =
SD =

5250 5240 5230 5220 5210 5200 5190 5180 5170 5160 5150 5140 5130 5120 5110 5100 5090

212+00 213+00 214+00 215+00 216+00 217+00 218+00 219+00 220+00 221+00 222+00 223+00 224+00 225+00 226+00 227+00 228+00 229+00 230+00 231+00 232+00 233+00 234+00 235+00 236+00 237+00 238+00 239+00 240+00

0' 100' 200' 40' 20' 0'

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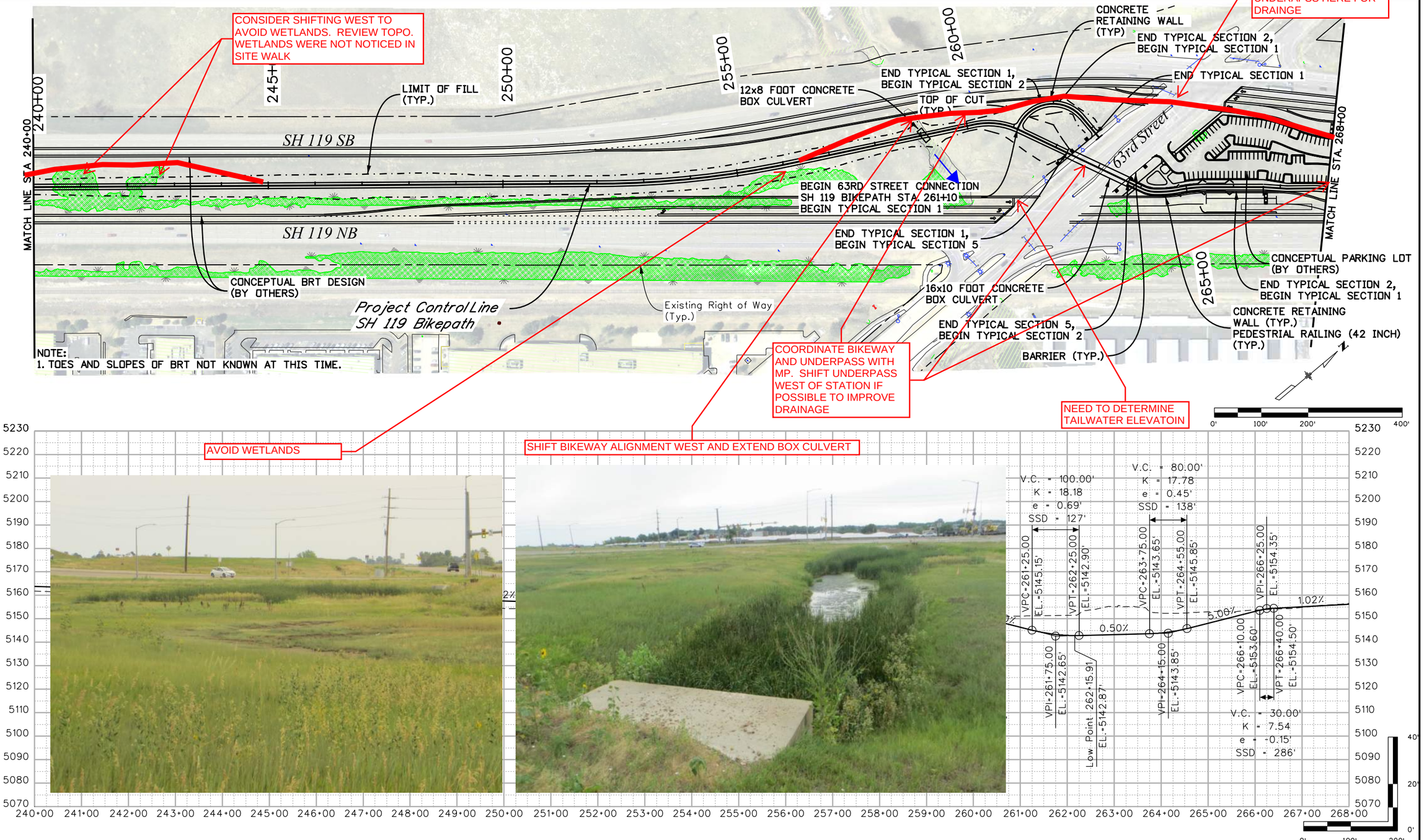

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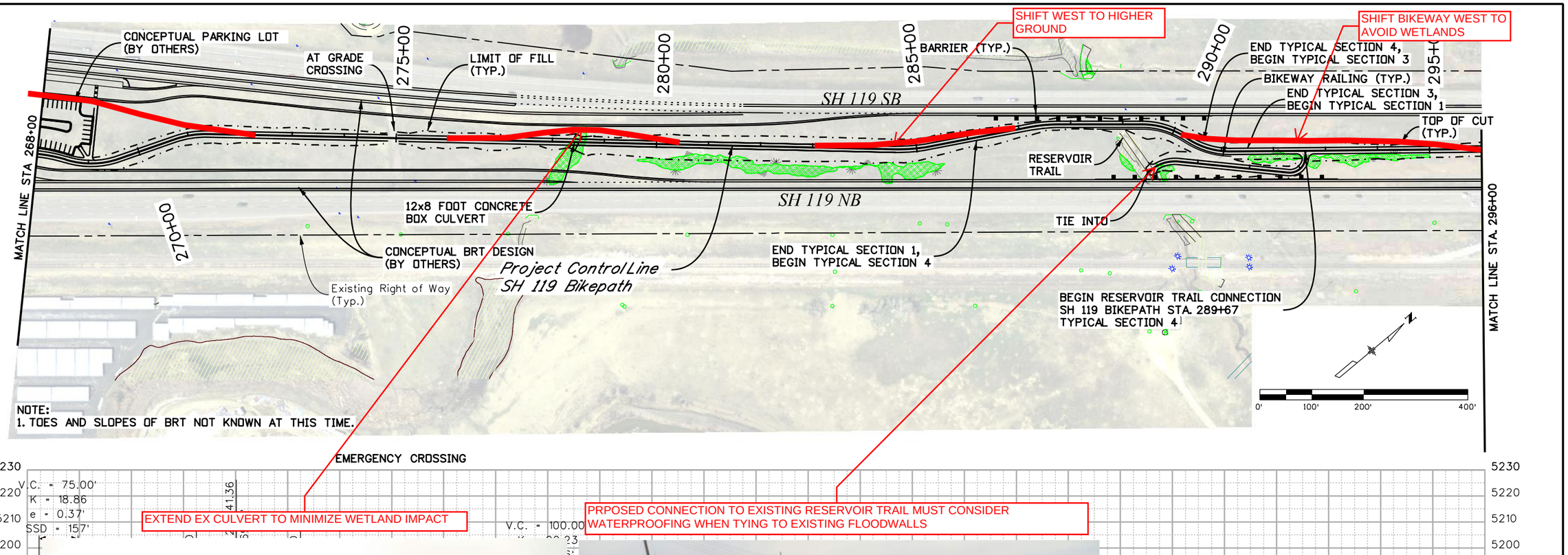

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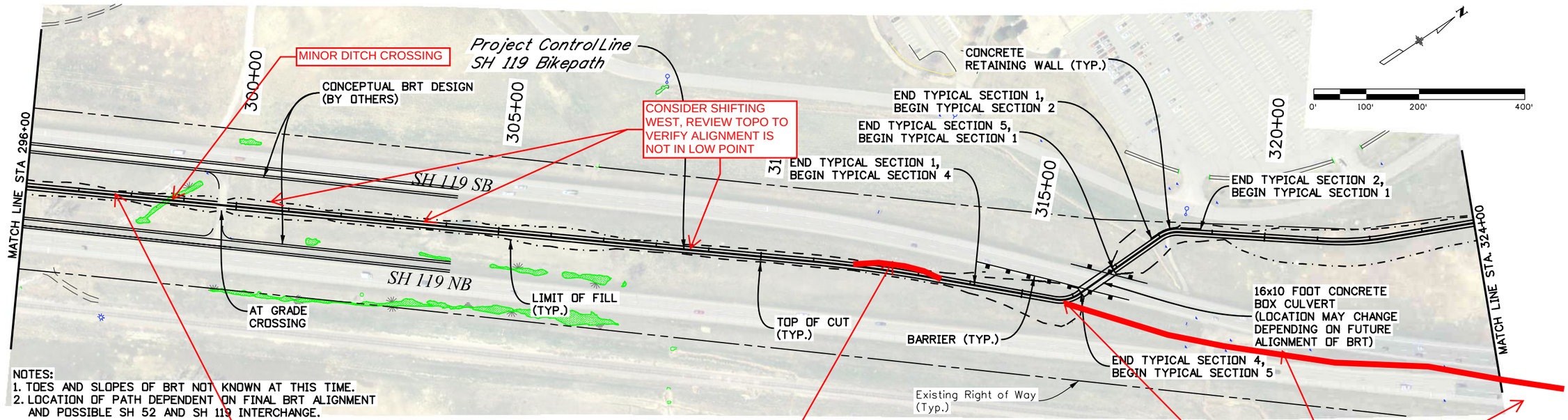

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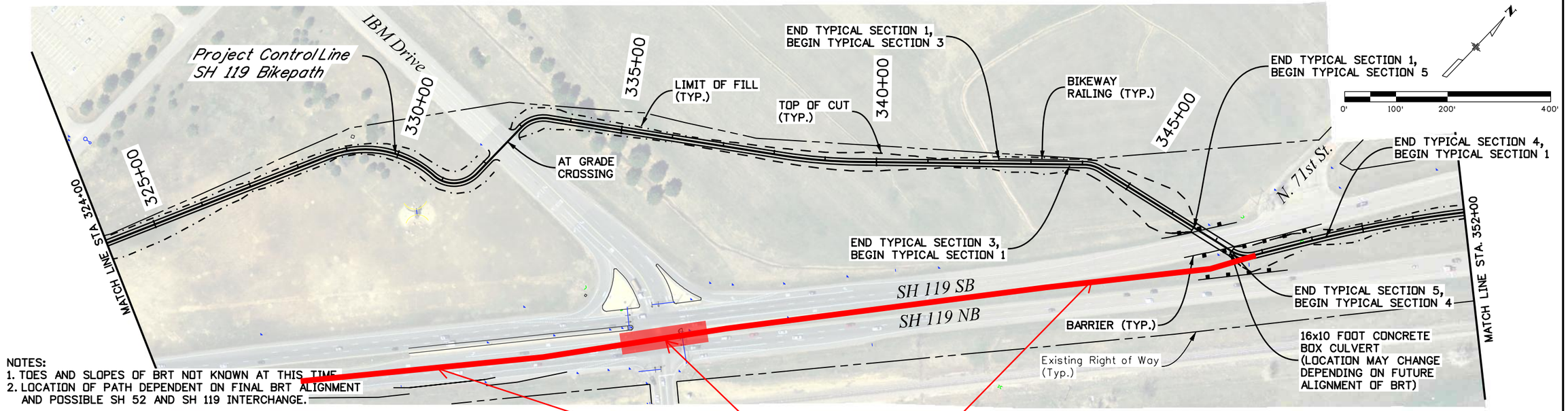
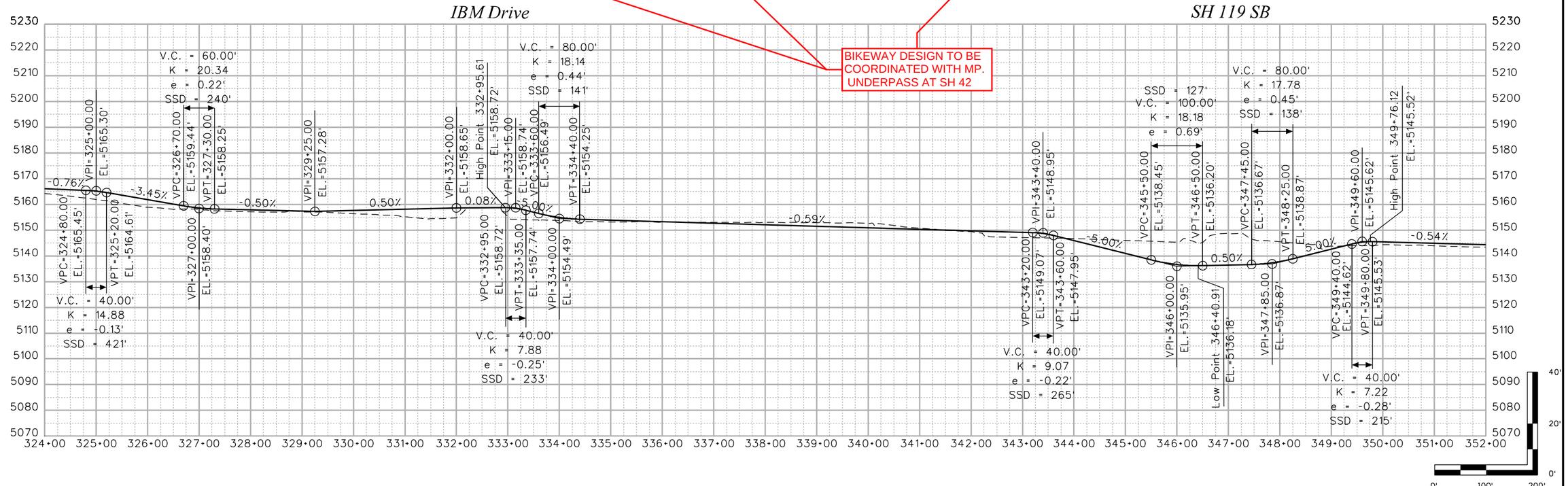


NOTES:
1. TOES AND SLOPES OF BRT NOT KNOWN AT THIS TIME.
2. LOCATION OF PATH DEPENDENT ON FINAL BRT ALIGNMENT AND POSSIBLE SH 52 AND SH 119 INTERCHANGE.



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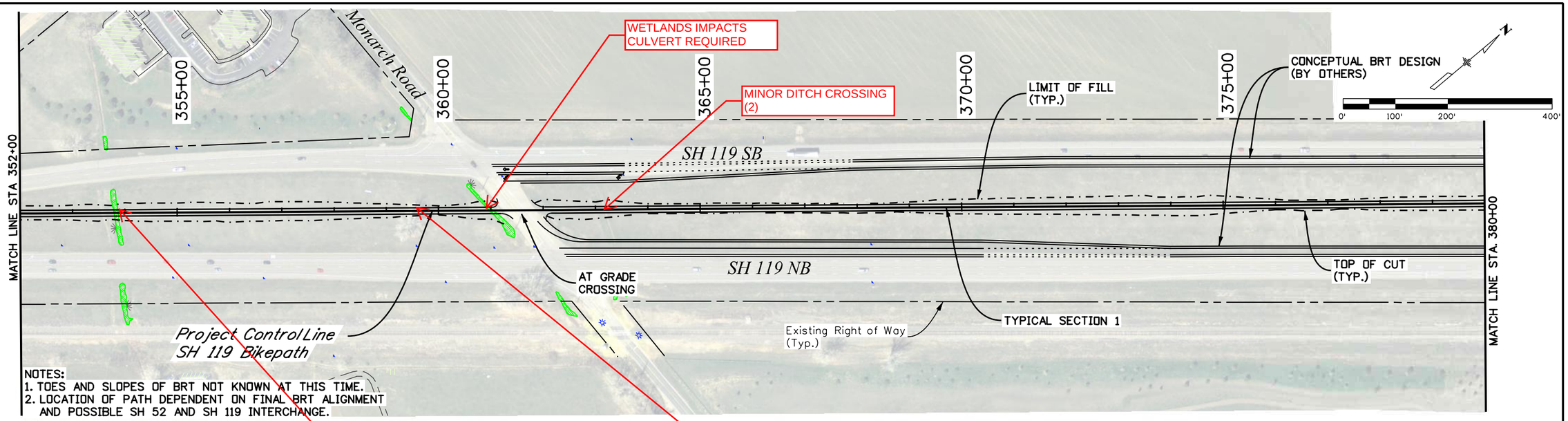

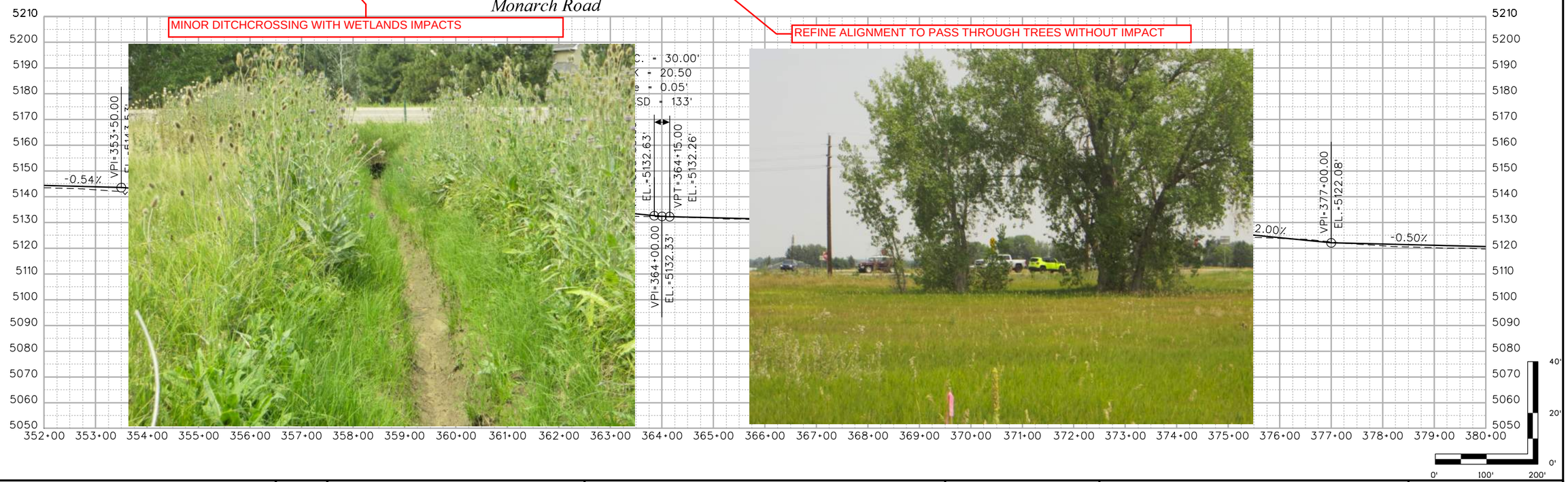

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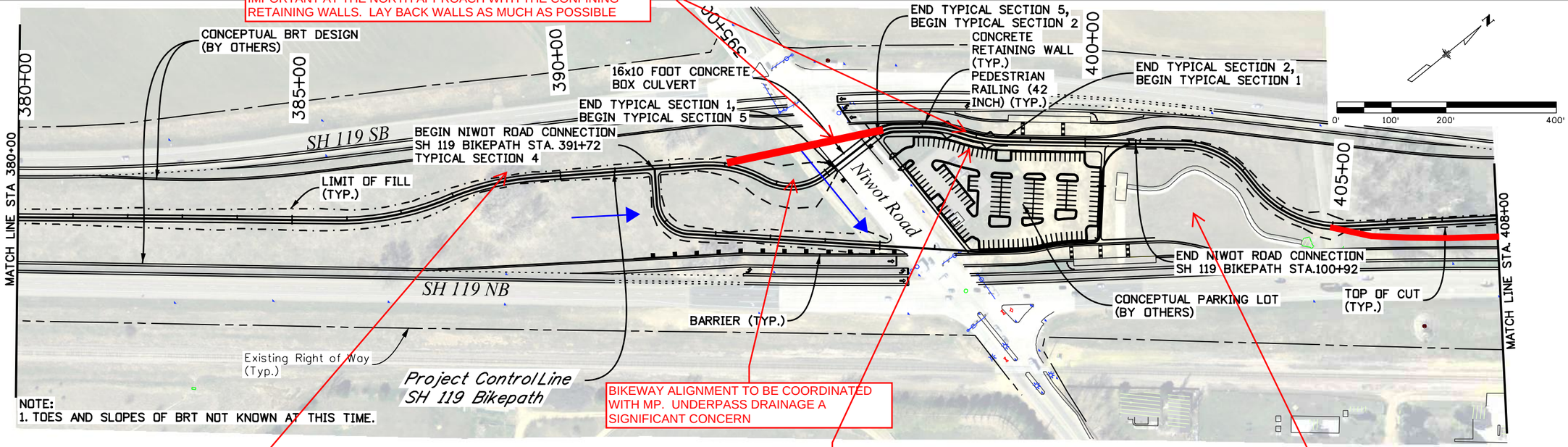
INCREASE SKEW OF UNDERPASS TO IMPROVE SIGHT LINES AT BOTH SIDES OF THE UNDERPASS. THIS WILL BE ESPECIALLY IMPORTANT AT THE NORTH APPROACH WITH THE CONFINING RETAINING WALLS. LAY BACK WALLS AS MUCH AS POSSIBLE



NOTE:
1. TOES AND SLOPES OF BRT NOT KNOWN AT THIS TIME.

BIKEWAY ALIGNMENT TO BE COORDINATED WITH MP. UNDERPASS DRAINAGE A SIGNIFICANT CONCERN

VERIFY THAT ALIGNMENT AVOIDS IMPACTS TO TALL COTTONWOODS

SOIL AND VEGETATION SHOWS SIGNS OF STANDING WATER WHERE THE UNDERPASS IS PROPOSED

REVIEW EXISTING DRAINAGE FACILITIES AND DRAINAGE REPORT

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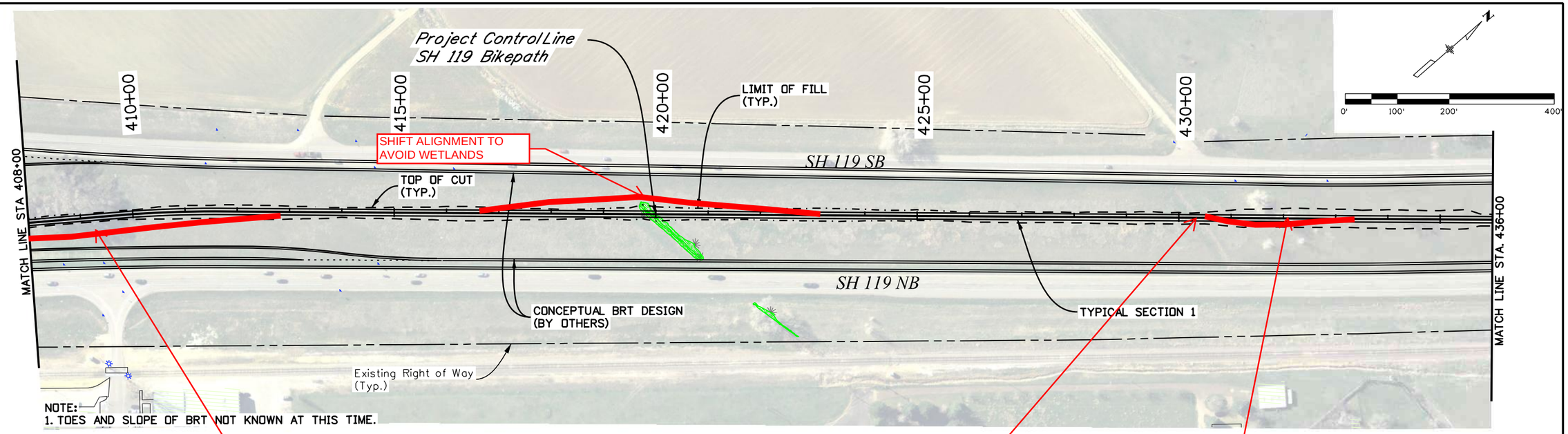

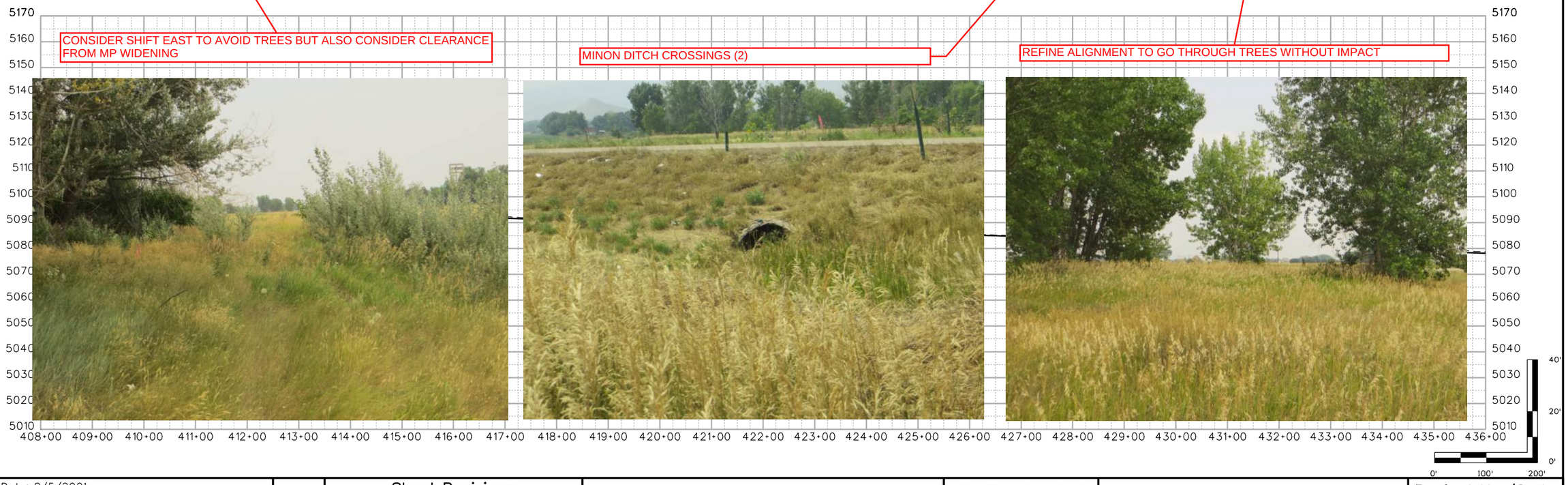

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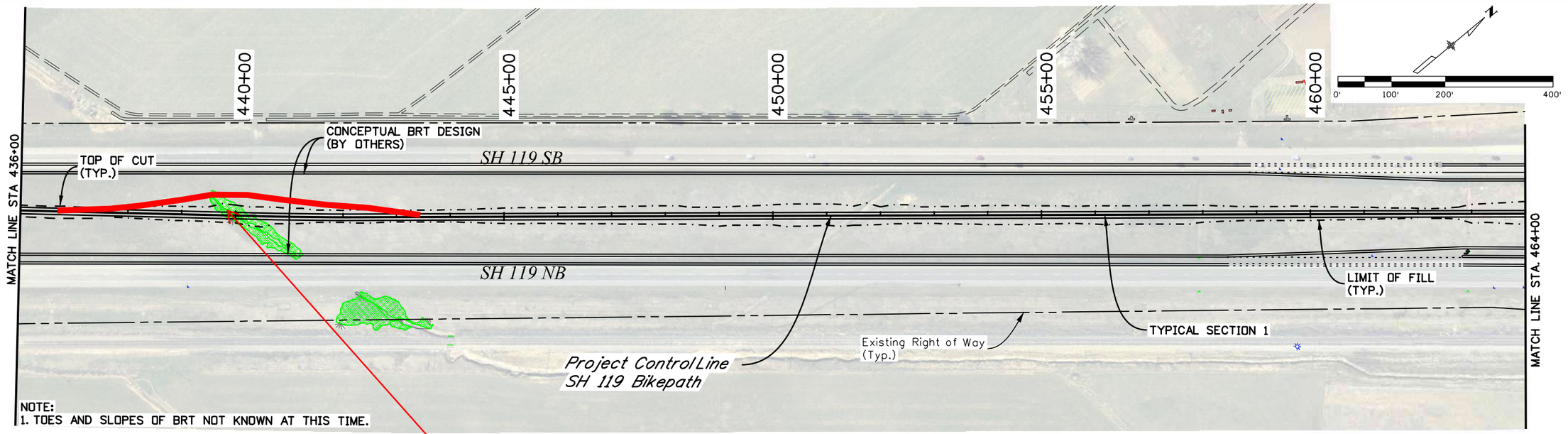

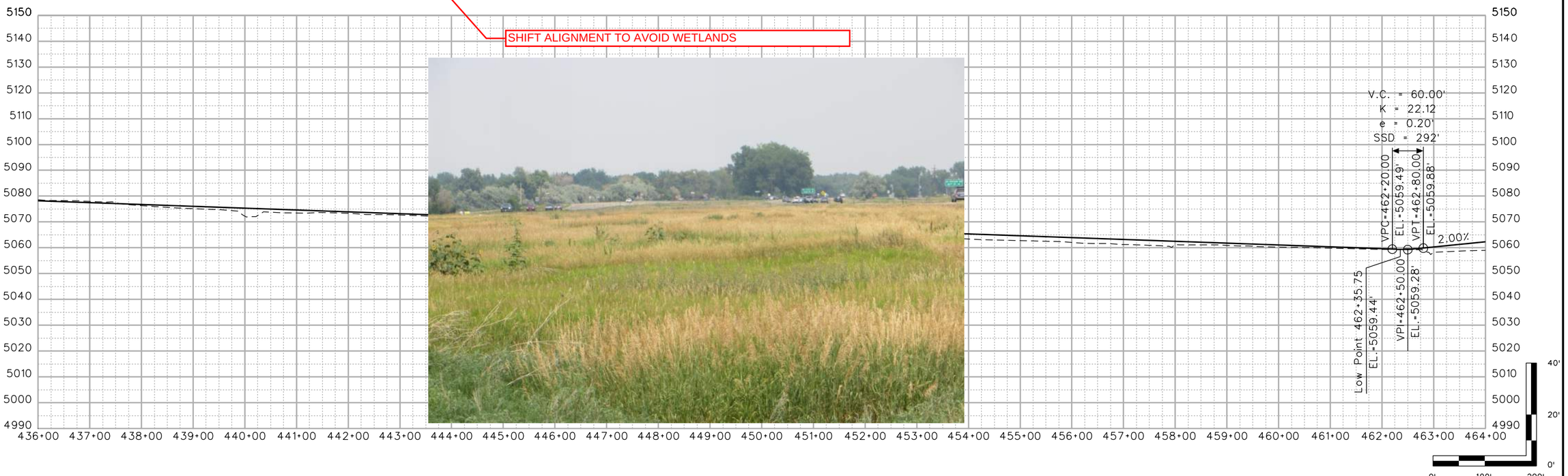

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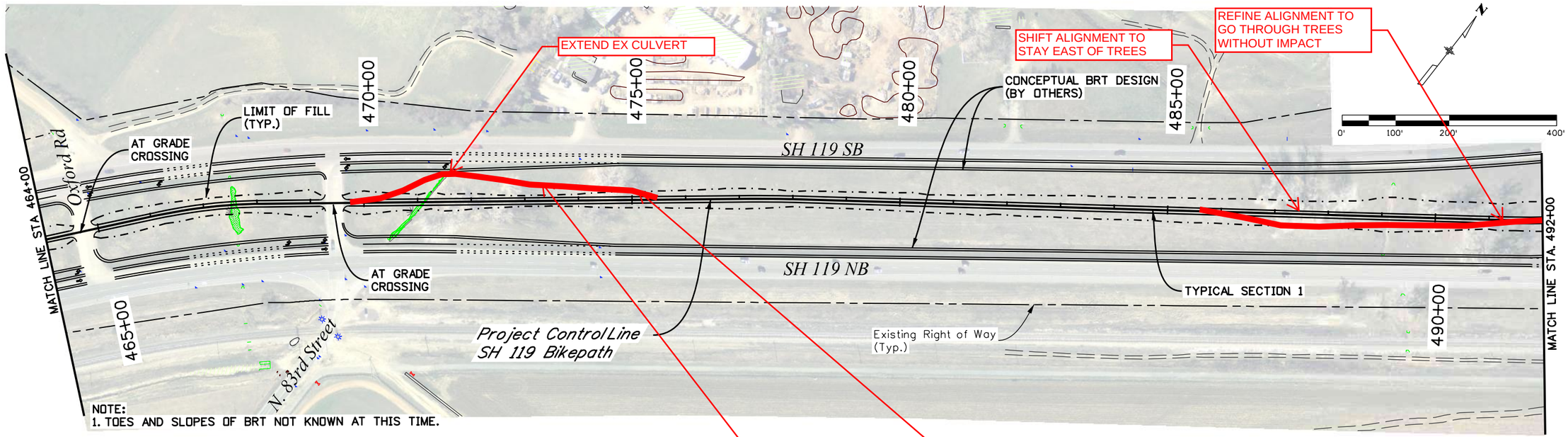

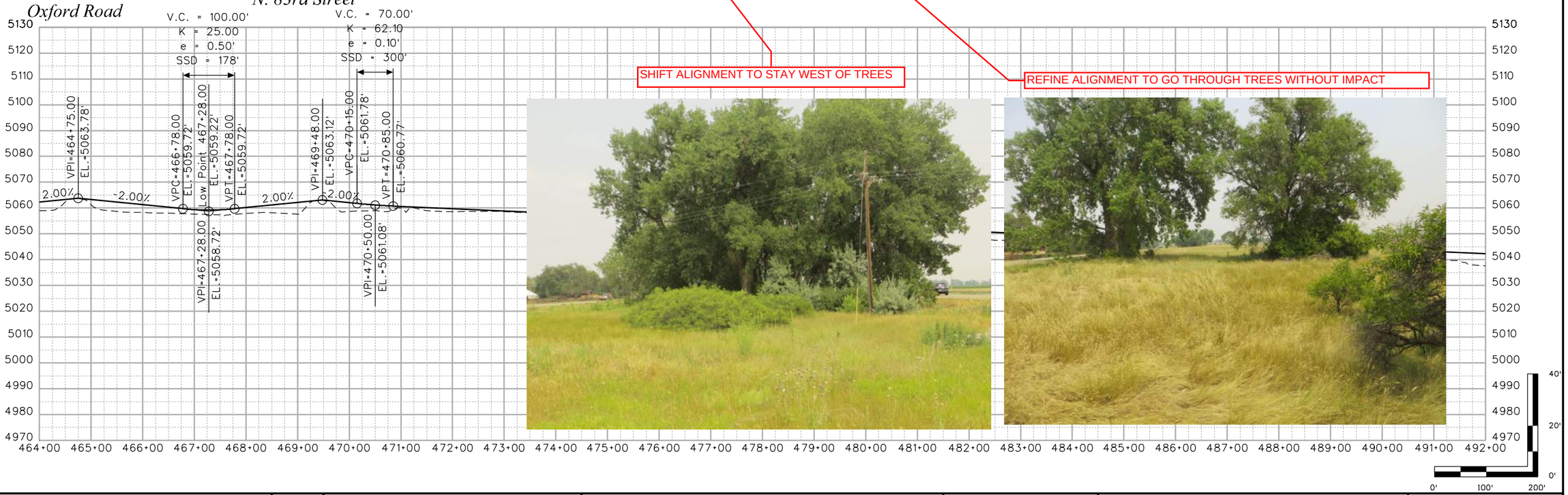

SHIFT ALIGNMENT TO STAY WEST OF TREES

REFINE ALIGNMENT TO GO THROUGH TREES WITHOUT IMPACT

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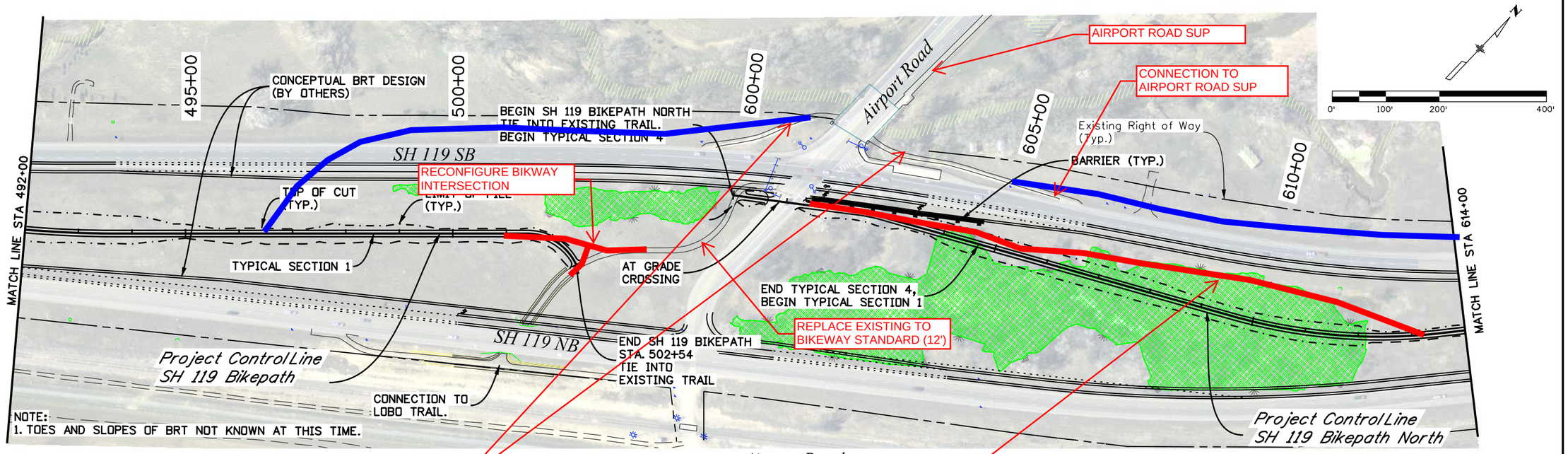

IMPROVEMENTS TO ALIGNMENT, SIGHT DISTANCE AND WIDTH REQUIRED TO MEET BIKEWAY DESIGN CRITERIA

SHIFT ALIGNMENT TO MINIMIZE WETLANDS IMPACTS

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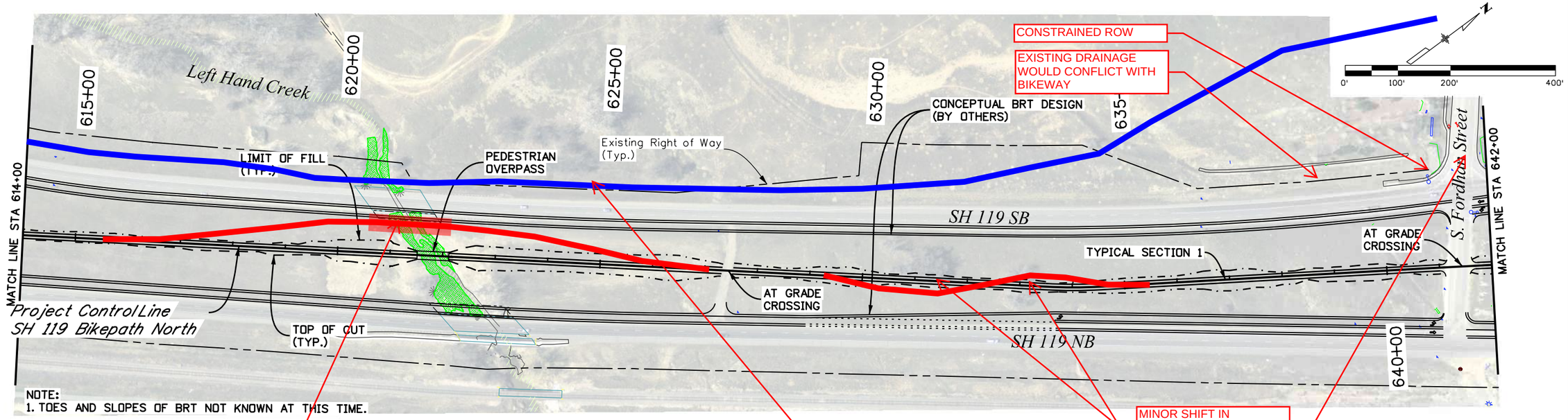

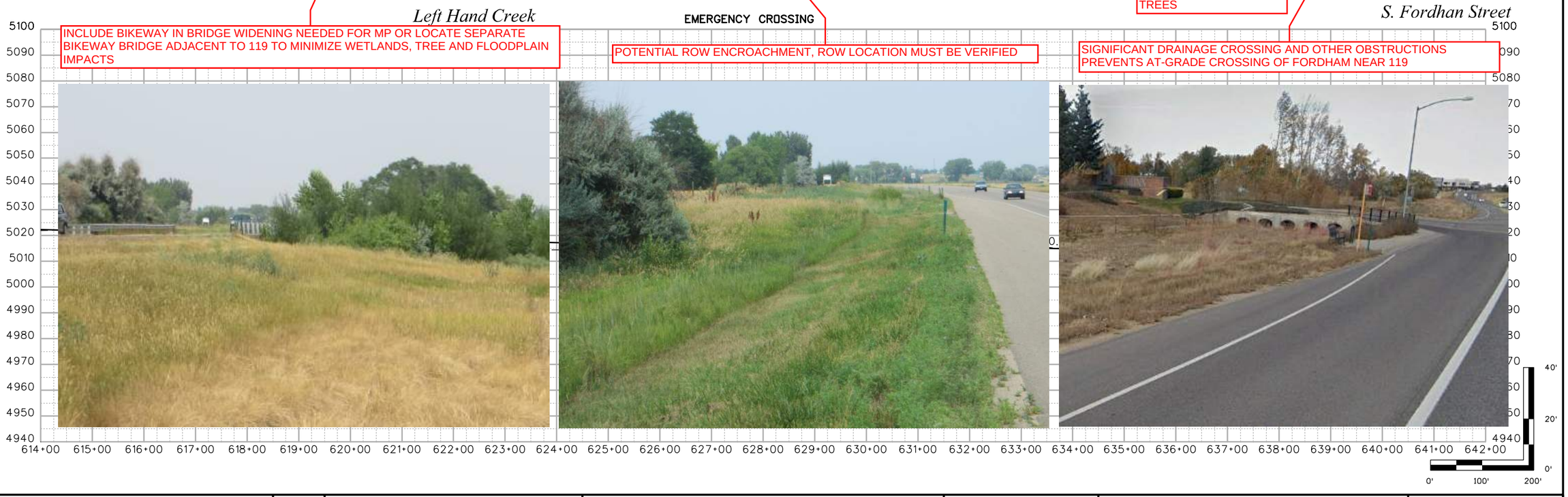

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Unit Information	Unit Leader Initials

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Sheet Revisions

Date:	Comments	Init.

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1050 Lee Hill Road
Boulder, CO 80302
Phone: 303-546-5658 FAX: 303-444-0751
Region 4 RDM

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PLAN AND PROFILE

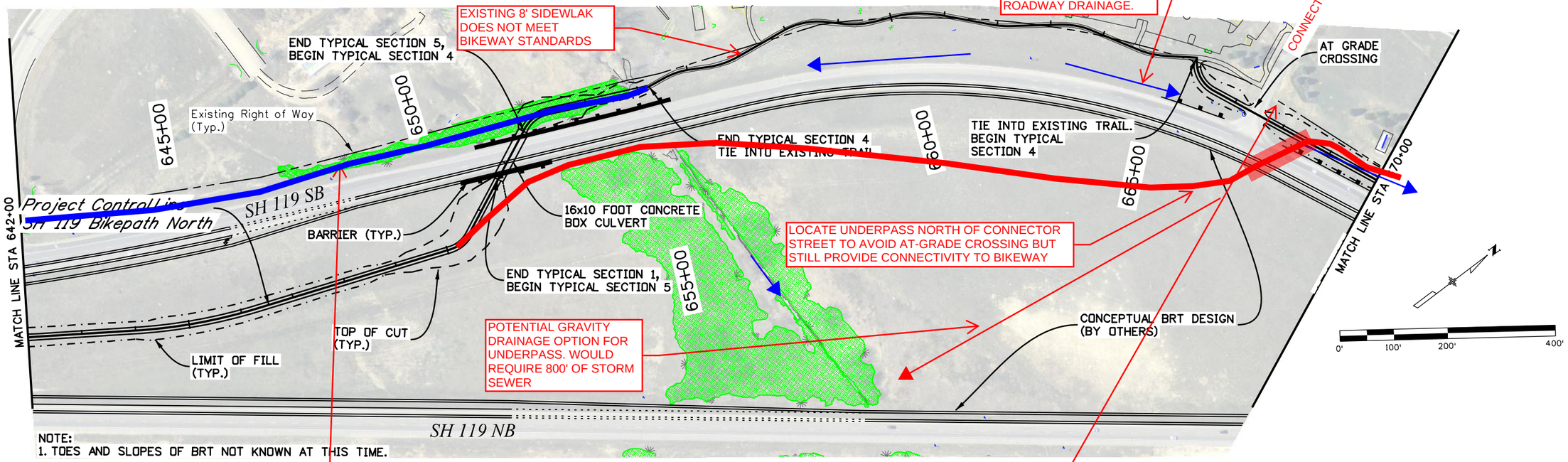
Designer:	KRC	Structure Numbers	
Detailer:	REW		
Sheet Subset:	P&P	Subset Sheets:	16 of 18

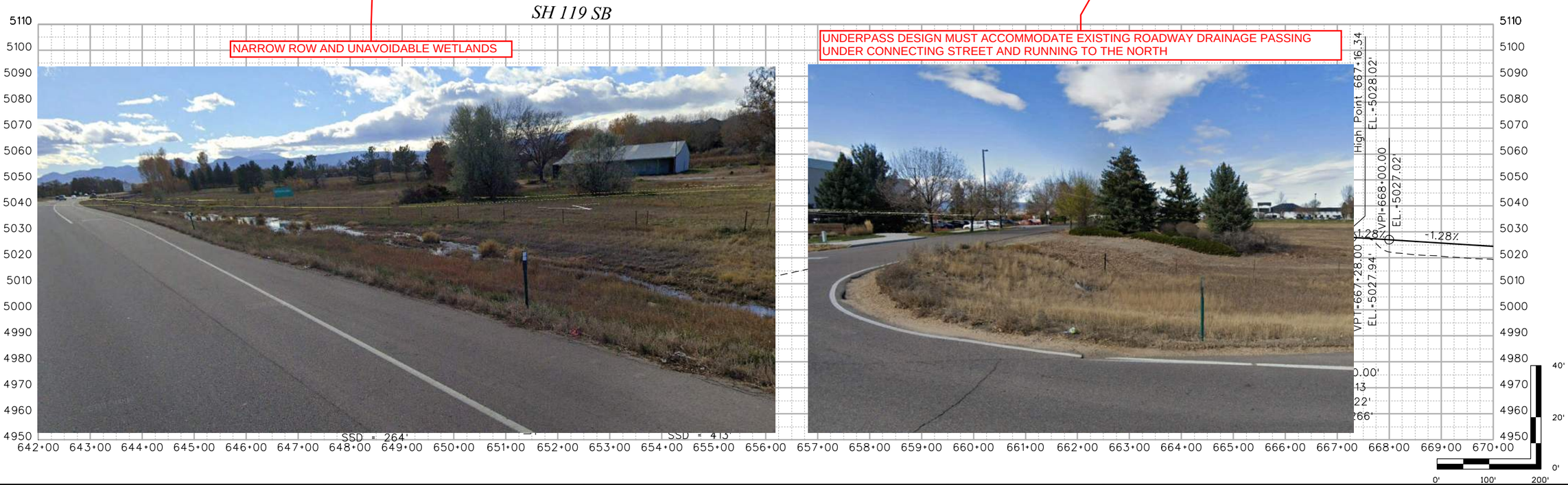
Project No./Code

STA 1191-035

22455

Sheet Number





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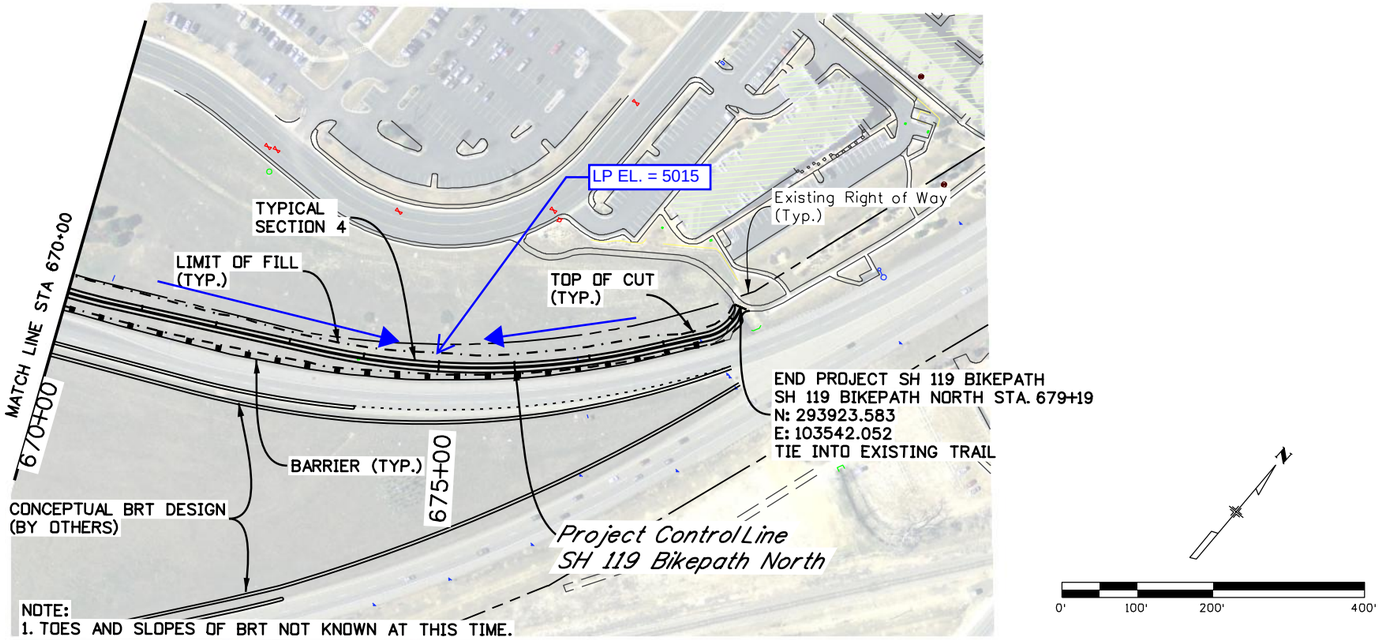
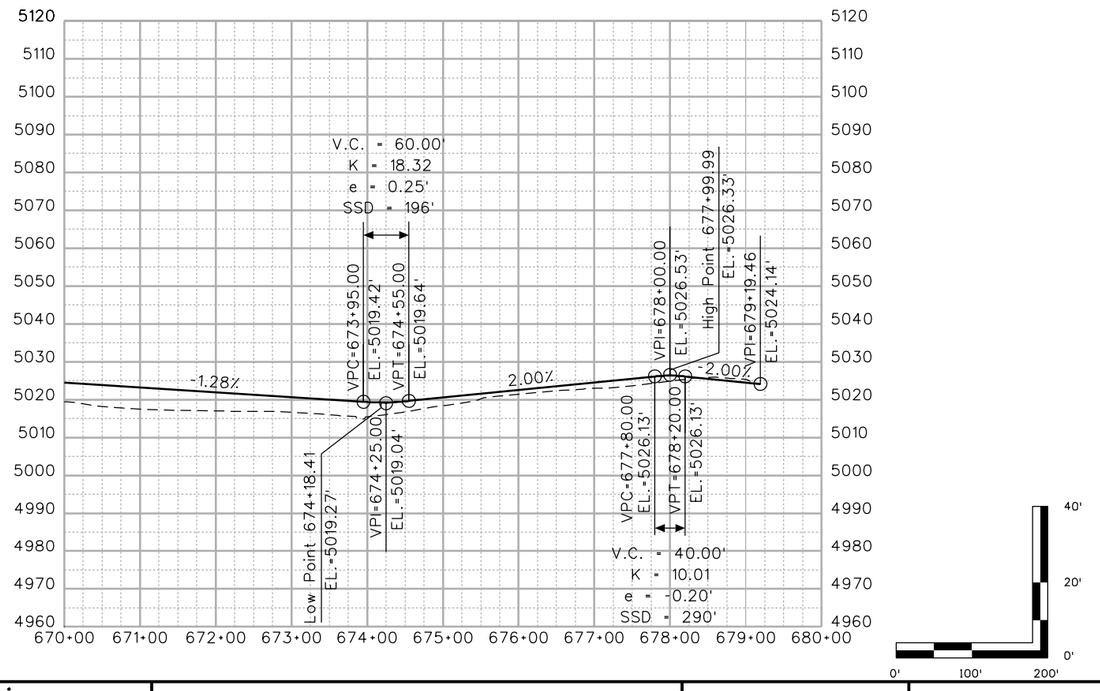
Detailer:	REW		
Sheet Subset:	P&P	Subset Sheets:	17 of 18

Project No./Code
STA 1191-035
22455
Sheet Number





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Horiz. Scale: 1:200 Vert. Scale: As Noted			
Unit Information Unit Leader Initials			
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No Revisions:				STA 1191-035
Revised:	Designer: KRC	Structure Numbers		22455
Void:	Detailer: REW			Sheet Number
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Appendix B
Bikeway Design Criteria

SH 119 BIKEWAY

BOULDER COUNTY

MULLER ENGINEERING PROJECT NUMBER 21-015.01

BIKEWAY DESIGN CRITERIA

Prepared by Muller Engineering Company, Inc.

DESIGN PARAMETERS	AASHTO GUIDE FOR THE DEVELOPMENT OF BICYCLE FACILITIES (2012)		CDOT ROADWAY DESIGN GUIDE CHAPTER 14 (2015)		BOULDER COUNTY MULTIMODAL TRANSPORTATION STANDARDS (2012)		OTHER		PROJECT RECOMMENDATION
DESIGN CONTROLS	**CRITERIA**	**REFERENCE**	**CRITERIA**	**REFERENCE**	**CRITERIA**	**REFERENCE**	**CRITERIA**	**REFERENCE**	
DESIGN SPEED (MPH) (AREAS OF OPEN TRAIL)	18 MPH (TYPICAL) 12 MPH (MINIMUM) 30 MPH (MAXIMUM)[2]	5.2.4	18 MPH (TYPICAL) 12 MPH (MINIMUM) 30 MPH (MAXIMUM)	14.2.2	15 MPH (PREFERRED) 2 MPH (MINIMUM)	5.7.3.1	15 MPH (LEVEL SURFACE) 30 MPH (DOWNHILL) 5-12 MPH (UPHILL)	DENVER BIKEWAY DESIGN GUIDELINES	25 MPH (TYPICAL)
DESIGN SPEED (MPH) (CONGESTED AREAS / NEAR TRANSIT)	18 MPH (TYPICAL) 12 MPH (MINIMUM) 30 MPH (MAXIMUM)[2]	5.2.4	18 MPH (TYPICAL) 12 MPH (MINIMUM) 30 MPH (MAXIMUM)	14.2.2	15 MPH (PREFERRED) 2 MPH (MINIMUM)	5.7.3.1	15 MPH (LEVEL SURFACE) 30 MPH (DOWNHILL) 5-12 MPH (UPHILL)	DENVER BIKEWAY DESIGN GUIDELINES	8 MPH (TYPICAL) 12 MPH (MAXIMUM)
DESIGN USER	ADULT BICYCLIST	5.2.5	UPRIGHT ADULT BICYCLIST	TABLE 14-1					UPRIGHT ADULT BICYCLIST
SURFACE	PAVED	5.22.9	PAVED	14.2.1.1					PAVED
ELEMENTS OF DESIGN									
CROSS SECTIONAL ELEMENTS	**CRITERIA**	**REFERENCE**	**CRITERIA**	**REFERENCE**	**CRITERIA**	**REFERENCE**	**CRITERIA**	**REFERENCE**	
WIDTH, MINIMUM (FT)	10' (TWO-DIRECTIONAL, SHARED USE) 10'-14' (TYPICAL) 8' (CONSTRAINED)	5.2.1	10' (TWO-DIRECTIONAL, SHARED USE) 11' (ALLOWS PASSING IN SAME DIRECTION WITH SOMEONE APPROACHING FROM OPPOSITE DIRECTION) 14' (HIGH VOLUME) 8' (CONSTRAINED)	14.2.4	10' (TYPICAL)	5.7.3.2, TABLE A-1	WIDTH BASED ON RUSH HOUR VOLUME 2 m (6.5 FT) - 0-50 bikes/hr 3 m (10 FT) - 50-100 BIKES/HR 4m (13 FT) - 100-300 BIKES/HR 5 m (16.5 FT) - 300+ BIKES/HR	CROW MANUAL SECTION V3	12' (TWO-DIRECTIONAL, SHARED USE) 14' - 16' (HIGH VOLUME AREAS) 10 ' (CONNECTION TO TRANSIT) MATCH EXISTING (CONNECTION TO TRAILS)
CROSS SLOPE (%)	1% (MINIMUM) 2% (MAXIMUM) 1% (MAX W/ CENTER CROWN)	5.2.5, 5.2.6, 5.2.11	1% (MINIMUM) 2% (MAXIMUM) UNIFORM CROSS SLOPE PREFERRED OVER CROWNED	14.2.5	2% (MAXIMUM)	5.7.3			1.5% (TYPICAL) 2% (MAXIMUM)
CROSS SLOPE RATE OF CHANGE, MINIMUM	5' PER 1% OF CHANGE (MINIMUM)	5.2.6							5' PER 1% OF CHANGE (MINIMUM)
SHOULDER WIDTH, MINIMUM (FT)	3'-5' (TYPICAL) 2' (MIN TO OBSTRUCTIONS) 1' (MIN WITH RAILING OR FENCE)	5.2.1	3' (TYPICAL) 2' (TO VERTICAL OBSTRUCTIONS) 1' (TO RAILINGS)	14.2.6	1' (MINIMUM) 2' (ALONG CONTINUOUS OBSTRUCTIONS)	5.7.3.2			3' (PREFERRED) 2" (MINIMUM)
SHOULDER CROSS SLOPE	6:1	5.2.1	6:1	14.2.6	2% (PREFERRED) 6:1 (MAXIMUM)	5.7.3.2			2% (PREFERRED) 6:1 (MAXIMUM)
CLEAR ZONE WIDTH, DESIRABLE (FT)	5' (EDGE OF PATH TO TOP OF SLOPES)	5.2.1	5' (TO DROP-OFFS OR SLOPES GREATER THAN 4:1)	14.2.6	5'	5.7.3.2			5'
UNDERPASS ELEMENTS	**CRITERIA**	**REFERENCE**	**CRITERIA**	**REFERENCE**	**CRITERIA**	**REFERENCE**	**CRITERIA**	**REFERENCE**	
WIDTH, MINIMUM (FT)	10' (TWO-DIRECTIONAL, SHARED USE) 10'-14' (TYPICAL) 8' (CONSTRAINED)	5.2.1	10' (TWO-DIRECTIONAL, SHARED USE) 11' (ALLOWS PASSING IN SAME DIRECTION WITH SOMEONE APPROACHING FROM OPPOSITE DIRECTION) 14' (HIGH VOLUME) 8' (CONSTRAINED)	14.2.4	10' (TYPICAL)	5.7.3.2, TABLE A-1	WIDTH BASED ON RUSH HOUR VOLUME 2 m (6.5 FT) - 0-50 bikes/hr 3 m (10 FT) - 50-100 BIKES/HR 4m (13 FT) - 100-300 BIKES/HR 5 m (16.5 FT) - 300+ BIKES/HR	CROW MANUAL SECTION V3	16' (MINIMUM) 20' (DESIRABLE)
VERTICAL CLEARANCE, MINIMUM (FT)	10' (TYPICAL) 8' (CONSTRAINED) +10' (FOR MAINTENANCE AND EMERGENCY VEHICLES)	5.2.1, 5.2.10	8.33' (MINIMUM VERTICAL CLEARANCE TO OBSTRUCTIONS) (BICYCLIST OPERATING HEIGHT) 8' (CONSTRAINED CONDITIONS WITH NO MOTOR VEHICLE ACCESS) 10' (DESIRABLE)	14.2.6, 14.2.10.1					8' (MINIMUM) 10' (DESIRABLE)

SH 119 BIKEWAY

BOULDER COUNTY

MULLER ENGINEERING PROJECT NUMBER 21-015.01

BIKEWAY DESIGN CRITERIA

Prepared by Muller Engineering Company, Inc.

DESIGN PARAMETERS	AASHTO GUIDE FOR THE DEVELOPMENT OF BICYCLE FACILITIES (2012)		CDOT ROADWAY DESIGN GUIDE CHAPTER 14 (2015)		BOULDER COUNTY MULTIMODAL TRANSPORTATION STANDARDS (2012)		OTHER		PROJECT RECOMMENDATION
HORIZONTAL ELEMENTS	**CRITERIA**	**REFERENCE**	**CRITERIA**	**REFERENCE**	**CRITERIA**	**REFERENCE**	**CRITERIA**	**REFERENCE**	
MINIMUM HORIZONTAL CURVE RADIUS (FT)	18 MPH: 60' 20 MPH: 74' 25 MPH: 115' 30 MPH: 166' MINIMUM RADIUS BASED ON 20-DEGREE LEAN ANGLE	TABLE 5-2	18 MPH: 85' 20 MPH: 109' 25 MPH: 192' 30 MPH: 316' RADIUS BASED ON ADVERSE CROWN	TABLE 14-7					8 MPH: 14' 12 MPH: 33' 25 MPH: 192' RADIUS BASED ON ADVERSE CROWN
RADIUS RETURN AT TRAIL INTERSECTIONS, MINIMUM (FT)			2'	14.2.9.5					15' (TYPICAL AT TRAIL CONNECTIONS) 2' (MINIMUM)
SEPARATION BETWEEN ROADWAY AND BIKE PATH (FT)	5 MINIMUM BETWEEN FL OF CURB AND EDGE OF PATH OR EOP AND EDGE OF PATH PROVIDE RAILING/BARRIER IF WITHIN 5 MINIMUM MORE THAN 5 IS RECOMMENDED IF ADJACENT TO A HIGH SPEED FACILITY	5.2.2	5' MINIMUM BETWEEN BACK OF CURB / EDGE OF PAVEMENT AND EDGE OF PATH PROVIDE RAILING/BARRIER IF WITHIN 5 MINIMUM, ROADWAYS WITH 45 MPH OR LESS SPEEDS DO NOT NECESSARILY NEED A CRASH WORTHY BARRIER 8' RECOMMENDED TO ACCOMMODATE SNOW STORAGE	14.2.14	5' - 10'	TABLE A-1			BIKEWAY TYPICALLY OUTSIDE SH 119 CLEAR ZONE 5 MINIMUM BETWEEN FL OF CURB AND EDGE OF PATH OR EOP AND EDGE OF PATH (NEAR INTERSECTIONS) PROVIDE RAILING/BARRIER IF WITHIN 5 MINIMUM, ROADWAYS WITH 45 MPH OR LESS SPEEDS DO NOT NECESSARILY NEED A CRASH WORTHY BARRIER 8 RECOMMENDED TO ACCOMMODATE SNOW STORAGE
PEDESTRIAN / BICYCLE RAILING OR BARRIER REQUIREMENTS	USE RAILING IN THE FOLLOWING CONDITIONS IF THE 5' CLEAR ZONE IS NOT PROVIDED: SLOPE - 3:1 OR STEEPER, DROP OFF - 6' OR GREATER SLOPE - 2:1 OR STEEPER, DROP OFF - 4' OR GREATER SLOPE - 1:1 OR STEEPER, DROP OFF - 1' OR GREATER SLOPE - 3:1 OR STEEPER AND ADJACENT TO A HAZARD (PARALLEL BODY OF WATER) FLAIR AWAY RAILING AT THE ENDS OF THE RAILING OUTSIDE THE 2' CLEAR AREA OR USE OBJECT MARKERS PROVIDE BARRIER BETWEEN A SIDE PATH AND THE ROADWAY IF THE SEPARATION IS LESS THAN 5' FROM EDGE OF PATH TO FACE OF CURB OR EDGE OF TRAVELED WAY. IF THE SIDE PATH IS ADJACENT TO A HIGH-SPEED HIGHWAY, CONSIDER A LARGER SEPARATION FOR PATH USER COMFORT	5.2.1, 5.2.2	USE RAILING IN THE FOLLOWING CONDITIONS IF THE 5' CLEAR ZONE IS NOT PROVIDED: SLOPE - 3:1 OR STEEPER, DROP OFF - 6' OR GREATER SLOPE - 2:1 OR STEEPER, DROP OFF - 4' OR GREATER SLOPE - 1:1 OR STEEPER, DROP OFF - 1' OR GREATER SLOPE - 3:1 OR STEEPER AND ADJACENT TO A HAZARD (PARALLEL BODY OF WATER) FLAIR AWAY RAILING AT THE ENDS OF THE RAILING AT LEAST 3' FROM THE EDGE OF PATH PROVIDE BARRIER BETWEEN A SIDE PATH AND THE EDGE OF PAVEMENT OR BACK OF CURB OF THE ROADWAY IF THE SEPARATION IS LESS THAN 5'	14.2.6, 14.2.14					USE RAILING IN THE FOLLOWING CONDITIONS IF THE 5' CLEAR ZONE IS NOT PROVIDED: SLOPE - 3:1 OR STEEPER, DROP OFF - 6' OR GREATER SLOPE - 2:1 OR STEEPER, DROP OFF - 4' OR GREATER SLOPE - 1:1 OR STEEPER, DROP OFF - 1' OR GREATER SLOPE - 3:1 OR STEEPER AND ADJACENT TO A HAZARD (PARALLEL BODY OF WATER) FLAIR AWAY RAILING AT THE ENDS OF THE RAILING AT LEAST 3' FROM THE EDGE OF PATH PROVIDE BARRIER BETWEEN A SIDE PATH AND THE EDGE OF PAVEMENT OR BACK OF CURB OF THE ROADWAY IF THE SEPARATION IS LESS THAN 5'
RAILING, BARRIER AND FENCE HEIGHT (FT)	42" (MINIMUM)	5.2.10	42" (MINIMUM)	14.2.6					42" (MINIMUM)
VERTICAL ELEMENTS	**CRITERIA**	**REFERENCE**	**CRITERIA**	**REFERENCE**	**CRITERIA**	**REFERENCE**	**CRITERIA**	**REFERENCE**	
LONGITUDINAL GRADE, MAXIMUM (%)	5% (MAXIMUM) GRADE SHOULD GENERALLY MATCH THE GRADE OF THE ADJACENT ROADWAY	5.2.7	5% [6]	14.2.1.2, 14.2.8	5% (MAXIMUM) 8.33% - 200' MAXIMUM RUNNING LENGTH 10% - 30' MAXIMUM RUNNING LENGTH 12.5% - 10' MAXIMUM RUNNING LENGTH	5.7.3.4, TABLE 5.7.3.4	5% [4,5] RAMPS CAN BE USED AT A MAX SLOPE OF 12:1 FOR A TOTAL OF 2.5' OF RISE, WITH 5' LONG LANDINGS WITH NO SLOPE ON EITHER ENDS OF THE RAMP	PROWAG	5% (MAXIMUM)
MAXIMUM GRADE DIFFERENCE REQUIRING NO VERTICAL CURVE (%)			2%	14.2.8					USE VERTICAL CURVES FOR ALL MAINLINE BIKEWAY GRADE BREAK UP TO 2% PERMISSIBLE AT CONNECTIONS TO EXISTING TRAILS ONLY
MINIMUM CREST VERTICAL CURVE LENGTH (FT)	3' (MINIMUM)[3]	Figure 5-8	3' (MINIMUM) SEE TABLE 14-6	TABLE 14-6, 14.2.8					SEE CDOT DESIGN GUIDE TABLE 14-6

SH 119 BIKEWAY

BOULDER COUNTY

MULLER ENGINEERING PROJECT NUMBER 21-015.01

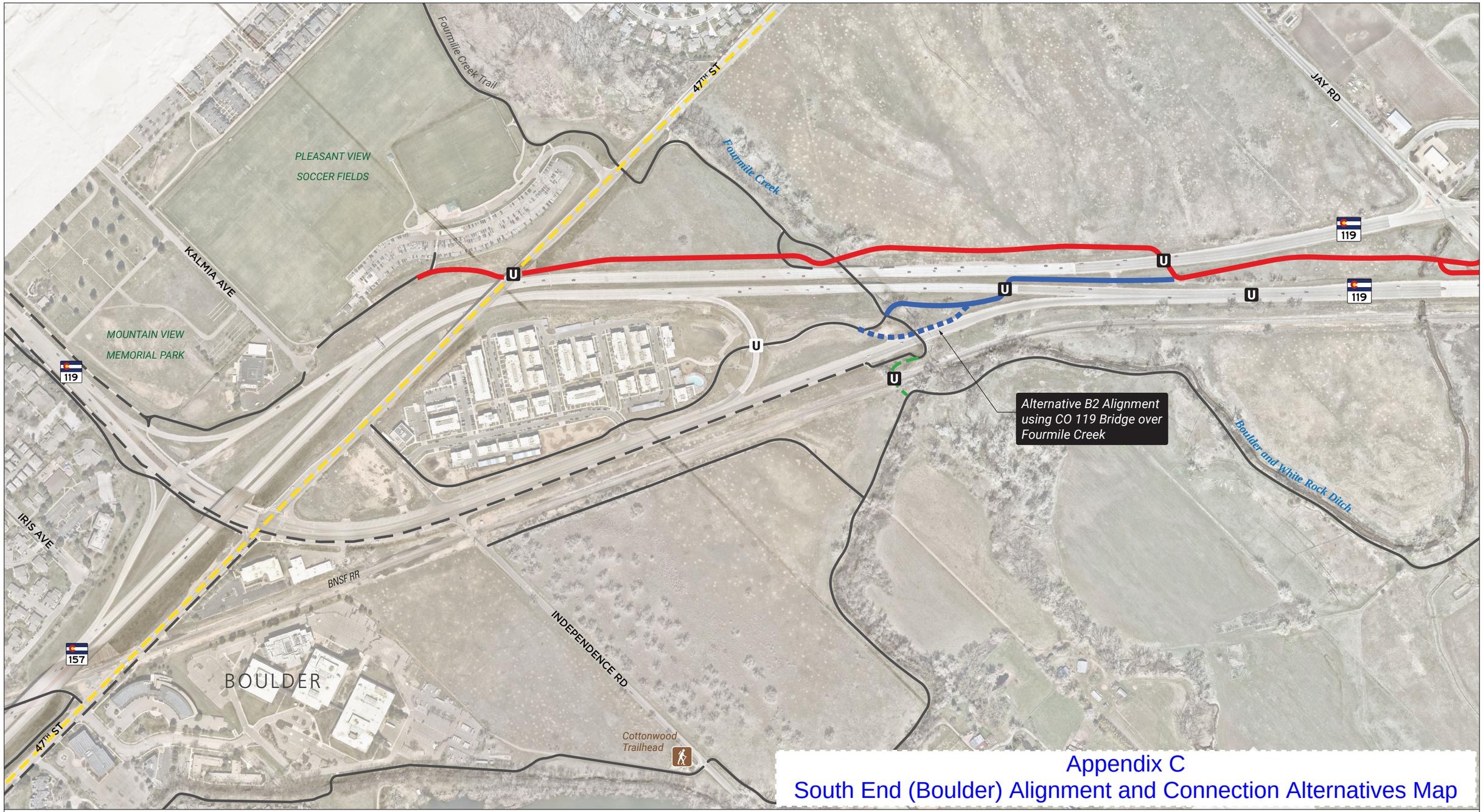
BIKEWAY DESIGN CRITERIA

Prepared by Muller Engineering Company, Inc.

DESIGN PARAMETERS	AASHTO GUIDE FOR THE DEVELOPMENT OF BICYCLE FACILITIES (2012)		CDOT ROADWAY DESIGN GUIDE CHAPTER 14 (2015)		BOULDER COUNTY MULTIMODAL TRANSPORTATION STANDARDS (2012)		OTHER		PROJECT RECOMMENDATION
SIGHT DISTANCE	**CRITERIA**	**REFERENCE**	**CRITERIA**	**REFERENCE**	**CRITERIA**	**REFERENCE**	**CRITERIA**	**REFERENCE**	
INTERSECTION SIGHT DISTANCE	INTERSECTION TYPE SPECIFIC (SEE 5.3.2)	5.3.2	INTERSECTION TYPE SPECIFIC (SEE 14.2.9)	14.2.9					SEE CDOT DESIGN GUIDE 14.2.9 [7]
STOPPING SIGHT DISTANCE, FLAT (FT)	18 MPH: 134' 20 MPH: 157' 25 MPH: 222' 30 MPH: 298' ADJUST FOR GRADES	5.2.8	18 MPH: 134' 20 MPH: 157' 25 MPH: 222' 30 MPH: 298' ADJUST FOR GRADES	TABLE 14-4					12 MPH: 80' 25 MPH: 222' ADJUST FOR GRADES
OBJECT HEIGHT (FT)			0'	14.2.3.3					0'
HEIGHT OF EYE (FT)			4.5'	14.2.3.3					4.5'
HORIZONTAL SIGHTLINE OFFSET (FT)	~'34' 18 MPH DESIGN SPEED / R = 60' / SSD = 134'	Table 5-6	~25' 18 MPH DESIGN SPEED / R = 85' / SSD = 134'	TABLE 14-5					PER CDOT ROADWAY DESIGN GUIDE
DRAINAGE	**CRITERIA**	**REFERENCE**	**CRITERIA**	**REFERENCE**	**CRITERIA**	**REFERENCE**	**CRITERIA**	**REFERENCE**	
BIKEWAY LOCATION WITH RESPECT TO FLOODPLAIN (FT)					SEE SURFACE TYPE/MATERIAL NOTES	5.7.2.2			CONCRETE PATH WITHIN THE 10-YEAR FLOODPLAIN
DITCH CAPACITY					ACCOMMODATE 5-YEAR DESIGN FLOW	5.7.4			ACCOMMODATE 5-YEAR DESIGN FLOW
CROSS CULVERTS					ACCOMMODATE 5-YEAR DESIGN FLOW LOCATE OPENINGS 5' FROM EDGE OF BIKEWAY	5.7.4			ACCOMMODATE 5-YEAR DESIGN FLOW LOCATE OPENINGS 5' FROM EDGE OF BIKEWAY
FREQUENCY OF OVERTOPPING							10% VOLUME OF 100-YEAR DESIGN FLOW		10% VOLUME OF 100-YEAR DESIGN FLOW

NOTES

1. WHEN GRADES ARE USED IN EXCESS OF 4% FOR MORE THAN 300', AN INCREASED DESIGN SPEED SHOULD BE USED, CONSIDERING BICYCLISTS TRAVELING DOWNHILL.
2. 18 MPH IS APPROPRIATE IN RELATIVELY FLAT AREAS. FOR AREAS WITH HILLY TERRAIN AND SUSTAINED STEEPER GRADES (6% OR GREATER), CONSIDER A HIGHER DESIGN SPEED BASED UPON ANTICIPATED TRAVEL SPEEDS OF BICYCLISTS GOING DOWNHILL.
3. SAG VERTICAL CURVE CRITERIA IS NOT DISCUSSED IN THE AASHTO GUIDE FOR THE DEVELOPMENT OF BICYCLE FACILITIES 2012, 4TH EDITION
4. INFORMATION OBTAINED FROM THE PROPOSED ACCESSIBILITY GUIDELINES FOR PEDESTRIAN FACILITIES IN THE PUBLIC RIGHT-OF-WAY (2011).
5. GRADES ARE ALLOWED TO FOLLOW THE GENERAL GRADE ESTABLISHED FOR THE ADJACENT STREET EXCEPT WHERE PEDESTRIAN ACCESS ROUTES ARE CONTAINED WITHIN PEDESTRIAN STREET CROSSINGS.
6. ON GRADES STEEPER THAN 5%, PROVIDE RESTING AREAS AT LEAST 5' LONG WITH A MAXIMUM DISTANCE OF 200' IN-BETWEEN.
7. INCORPORATE MITIGATION MEASURES IF MINIMUM SIGHT DISTANCE REQUIREMENTS CANNOT BE MET.



Appendix C
South End (Boulder) Alignment and Connection Alternatives Map

State Highway 119 Bikeway Project
Boulder County
Preliminary Alignments

Southern Section - CO 157 to Jay Road

August 25, 2021

0 400 800
feet
1" = 400'

Facilities

- Existing Bike Path
- Existing Bike Lane
- Future Connection
- Future Protected Bike Lane or Multiuse Path
- B1 - Concept Design
- B2 - Center Alignment
- U Existing Underpass
- U Proposed Underpass

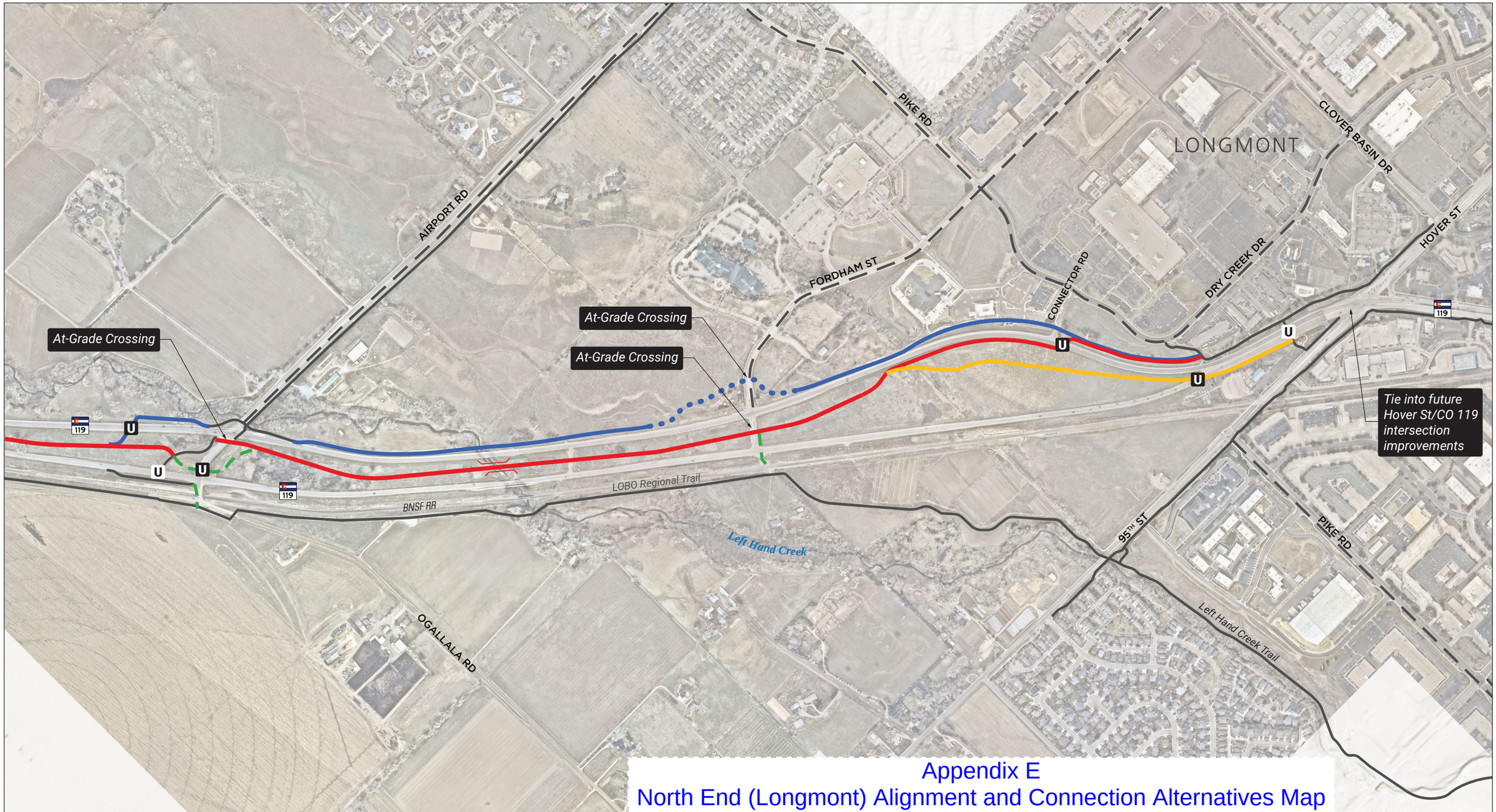
Boulder County

MULLER ENGINEERING COMPANY

Appendix D
South End (Boulder) Alignment Alternative Analysis

2	Highly Favorable
1	Favorable
0	Neutral
-1	Unfavorable
-2	Highly Unfavorable

Category	Evaluation Considerations	B1 - RED Concept Plan alignment, Northwest of CO 119		B2 - Blue Central Alignment		B3 - Orange Southeast of CO 119	
		Score	Comment	Score	Comment	Score	Comment
ACCESSIBILITY	Connectivity to adjacent origins destinations	2	All Alts provide similar opportunities for access via the Fourmile Creek Path and existing connections. Directness of access varies as outlined below.	2	All Alts provide similar opportunities for access via the Fourmile Creek Path and existing connections. Directness of access varies as outlined below.	2	All Alts provide similar opportunities for access via the Fourmile Creek Path and existing connections. Directness of access varies as outlined below.
DIRECTNESS (Efficient of travel)	Directness from/to Areas Northwest of 119 (Pleasantview Fields and beyond)	2	Provides improved/direct access to southbound separated bike lane on 119 and Pleasant View fields.	2	Nearly equivalent to B1	-2	Requires backtracking to cross to east side of 119 then back to median
	Directness from/to Diagonal Crossing	-1	Requires backtracking to cross to the west side of 119 then back to median	2	Direct connection with no backtracking	-1	Requires backtracking to cross to east side of 119 then back to median
	Directness from/to Areas Southeast of 119. (Cottonwood Trail, LOBO Trail, Foothills Path, and Wonderland Creek Path).	-1	Requires backtracking to cross to the west side of 119 then back to median	1	Slightly less direct than B3. However, provides for a potential future fully grade separated connection to Wonderland Creek Path and Foothills Path via an overpass over NB 119.	2	Provides direct connection to southeast without at-grade crossing of 119 and no backtracking
COMFORT / USER EXPERIENCE	Separation from roadways	1	Provides greatest separation from 119	-1	In close proximity to 119 adjacent to underpass location. Grade separation will minimize effects	-2	Tightly constrained between 119 and RR. Location directly adjacent to 119 may be required with narrowing of shoulders.
	Feeling of confinement	1	Better than B2 but still confined at northeast end of underpass	0	Approach retaining walls required at both ends of underpass. Should be limited to less than 100' at each end. Opportunities to terrace walls to mitigate.	-1	Similar to B2 but even more confined at RR tracks
SAFETY	Avoids At-Grade Roadway Crossings	0	Avoids at-grade crossing of Independence Road. However, users will likely use other less safe routes to access the bikeway.	0	Provides for the possibility of avoiding at-grade crossing of Independence Road. Also, crosses Independence Road at a lower volume location.	-2	Requires at-grade crossing of Independence Rd
SITE CONSIDERATIONS	Uses Existing Facilities	1	Uses existing bikeway between Foothills Highway and Pleasant View Fields	1	Uses existing bikeway and underpass in Diagonal Crossing.	-1	Does not use existing facilities. All new bikeway alignment required.
	Minimal Topographic Constraints (Minimal Grading or Structures)	1	Constraints at 47th St bridge will require walls	0	Underpass approach will require additional walls compared to B1 and B3	0	Walls required adjacent to private properties at south end.
HYDRAULICS / DRAINAGE	Frequency of Overtopping / Flooding	-1	Crossing of Fourmile likely will result in bikeway overtopping	-1	Crossing of Fourmile likely will result in bikeway overtopping	-1	Crossing of Fourmile likely will result in bikeway overtopping
	Impacts to Floodplains	-1	Crossing of Fourmile may require CLOMR	-1	Crossing of Fourmile may require CLOMR	-1	Crossing of Fourmile may require CLOMR
	Difficulty in Dealing with Stormwater	-1	Gravity drainage may be possible but would require over 1200 LF of piping to Jay Road, which would impact wetlands and would capture roadway drainage also.	-1	A pump system may be required for drainage. However, there is a good discharge point near the underpass and minimal roadway drainage is directed to the underpass.	-1	Gravity drainage may be possible but would require over 900 LF of piping to Jay Road, which would impact wetlands and would capture even more roadway drainage compared to B1.
RIGHT OF WAY	Availability of public ROW to complete the project	2	No new ROW or easements required.	0	ROW or Easement required from Diagonal Crossing Apartments LLC. The area is small and unuseable. It is expected that this will be attainable.	-2	Easement acquisition and potential impacts to private parking and access drives. Encroachment into BNSF RR also required.
ENVIRONMENTAL / SITE IMPACTS	Tree Impacts	-1	Similar tree impacts at Fourmile, additional impacts at underpass location	0	Similar tree impacts at Fourmile, reduced impacts at underpass location	-1	Similar tree impacts at Fourmile, reduced impacts at underpass location
	Wetlands Impacts	-1	Similar wetlands impacts at Fourmile, additional impacts at underpass location	0	Similar wetlands impacts at Fourmile, avoids impacts at underpass location	-1	Similar wetlands impacts at Fourmile, additional impacts at underpass location
CDOT Approval	CDOT	0	CDOT Approval required at 47th St. Bridge.	1	Smilar to B1 without modifications to the 47th St. Bridge.	-1	May require modifications to existing 119 shoulders
SUMMARY	**Greatest Benefit**		Provides the greatest separation and least physical constraints		Most direct alignment for most users.		Avoids at-grade crossing of 119 for users coming from southeast
	Greatest Concern		Requires travel to the north side of 119 while most users/destinations are south		Constrained between lanes of 119 at underpass.		Tightly confined between 119 and BNSF RR. At-grade crossing of Independence Road.



Appendix E
North End (Longmont) Alignment and Connection Alternatives Map

State Highway 119 Bikeway Project
Boulder County
Preliminary Alignments

Northern Section - Airport Road to Hover Street

August 19, 2021

0 700 1,400
feet
1" = 700'

Facilities

- Existing Bike Path
- Existing Bike Lane
- Potential Future Connections
- Existing Underpass
- Proposed Underpass
- L1 - Concept Design
- L2 - West Alignment
- L3 - Center Alignment

Boulder County

MULLER ENGINEERING COMPANY

Appendix F
North End (Longmont) Alignment Alternative Analysis

2	Highly Favorable
1	Favorable
0	Neutral
-1	Unfavorable
-2	Highly Unfavorable

Category	Evaluation Considerations	L1 (Red)		L2 (Blue)	
		Concept Plan Alignment (Median Alignment with At-Grade Crossing of Airport Road)		North Side Alignment Utilizing Ex. Airport Road Underpass at Lefthand Creek	
		Score	Comment	Score	Comment
ACCESSIBILITY	Connectivity to adjacent destinations	0	Similar connectivity with at-grade crossing of 119 to access Airport Road shared use path. Access to LOBO trail via existing underpass beneath NB 119. At the intersection of 119/Airport Rd, this alternative provides connections to the existing shared use path along Airport Rd via the traffic signal and to the LOBO trail via the existing undercrossing of northbound 119. At the north end, this alternative ties into the existing path network and would access the bus stop in the median via the existing tunnel under southbound 119.	2	Provides opportunity to connect to Airport Road Shared Use Path without crossing 119. Also provides opportunity to connect at Fordham without crossing 119. Access to LOBO trail via existing underpass beneath NB 119 This alternative would provide the same connections to the existing cycle infrastructure that Alts A and B would and, additionally, would connect to Fordham St for the potential to link future development to the 119 bikeway.
DIRECTNESS	Efficiency of Mainline Travel	0	Similar to L2 with potential delay at Airport Road at-grade crossing Potential delay at Airport Road at-grade crossing	2	Direct route with minimal crossing delays. Direct route with minimal delay anticipated at the crossing of Fordham St west of 119.
COMFORT / USER EXPERIENCE	Separation from roadways	1	This alternative provides good separtion from 119 and the at-grade crossing of Airport Rd is controlled by a traffic signal. The at-grade crossing of Fordham St, however, is uncontrolled and although there is potential to provide crossing enhancements, trail users may need to stop for cross traffic and may experience slight discomfort caused by traffic.	0	Constrained ROW compared to median in L1. However, utilizing the existing underpass at Airport Rd would prioritize the bikeway and provide a high level of comfort at the crossing. The at-grade crossing of Fordham St west of southbound 119 has the potenital to require trail users to stop and may cause dismofort due to the existing potenital conflict with vehicular traffic.
SAFETY	Avoids At-Grade Roadway Crossings	-1	Requires at-grade crossing of Airport Road at signal. Has at-grade crossing of Fordham at favorable location in median with opportunities for safety enhancements.	-2	Requires at-grade crossing of Fordham (west of 119) without signal and at grade crossing of busy Connector Rd north of Fordham St.
SITE CONSIDERATIONS	Uses Existing Facilities	0	Existing 8' walks should be replaced to meet Bikeway design criteria	1	Uses existing airport road underpass combined with Left Hand Creek bridge. Some modification of approaches required to meet bikeway standard
	Minimal Topographic Constraints (Minimal Grading or Structures)	0		-1	Constrained ROW on west side of CO 119
HYDRAULICS / DRAINAGE	Frequency of Overtopping / Flooding	2	Avoids Left Hand Creek floodplain	-1	Maintenance concerns with existing Airport Road flooding and spring closures?
	Impacts to Floodplains	2	Non expected but this should be verified. Impacts at Left Hand Creek should be avoidable.	-1	Possible impacts due to improvements to existing underpass
	Difficulty in Dealing with Stormwater	1	Avoids stormwater and groundwater issues at Airport Road and Fordham. North underpass stormwater will be challenging and costly but possible.	0	Avoids water at Airport Road and does not require an underpass at north end. (Need to verify drainage at new underpass south of Airport Road). However, stormwater at Fordham may be problematic.
RIGHT OF WAY	Availability of public ROW to complete the project	2	No ROW acquisition required	-2	ROW acquisition required from 3-4 parcels adjacent to Fordham.
ENVIRONMENTAL / SITE IMPACTS	Tree Impacts	1	Avoids impacts to trees north of Airport Road	-1	Impacts trees to improve existing Airport Road Underpass
	Wetlands Impacts	1	Minimizes impacts to wetlands	-2	Some impacts may be required to improve existing Airport Road underpass. Avoids wetlands in median north of Airport Road but impacts wetlands north of Fordham
COST	Basic Infrastructure Construction Cost	2	No new underpass at Airport Road	1	No new underpass at Airport Road
SUMMARY	**Greatest Benefits**		Avoids cost and impacts of wetlands for new underpass at Airport Road. Improved at-grade crossing of Fordham in median.. Maximizes separation from 119. Avoids ROW acquisition.		Uses existing underpass of Airport Road and improves access to Airport Road Shared Use Path and Fordham
	Greatest Concerns		At-grade crossing of Airport Road.		ROW acquisition/constraints, drainage and at-grade crossing of Fordham