

Project: Front Range Passenger Rail Service Development Plan and National Environmental Policy Act (NEPA)

Memo Date: Wednesday, September 23, 2020

To: FRPR Project Management Team

From: FRPR Project Development Subcommittee

Subject: FRPR Scenario (Alignment) Design Options + Technology Considerations

INTRODUCTION

The purpose of this memorandum is to:

- Document several alignment design options and hybrid alternatives which were not modeled in the Level 2A analysis, but present potential advantages with respect to operations (freight interaction and speed), environmental/community impacts, and capital cost.
- Document design recommendations that were incorporated into the alternative alignments prior to Level 2 modeling.
- Document the team's research and discussion on viable technologies for a FRPR system and expand upon potential alternative technologies.

Electronic design files are archived on CDOT's ProjectWise system (pw:\cdot-pw.bentley.com:cdot-pw-01P\Documents\01 Major Projects \2020 FRONT RANGE RAIL PROJECT\23289 - COLLABORATION\Design\).

ALTERNATIVES 3 AND 4 DESIGN OPTIONS

North Segment:

Fort Collins Bypass 392 to UP/GWR – shifts path to Ft Collins eastward (purple in Figure 1 below) from a constrained BNSF/Mason St corridor to UP and then GWR corridors into the preferred downtown Ft Collins station location. From stakeholder input, this bypass may be preferred and is a feasible option to avoid further Mason St disturbance for construction and operations through the heart of Fort Collins. Crossing from 392 to the UP/GWR corridor would present the following challenges:

- 1-2 residential property takings.
- Approximately 0.5 miles of aerial structure to fly over Fossil Creek/Wetlands with limited disturbance.
- Approximately 3 miles of added route distance from the current Alternative 3 and 4 North segment.

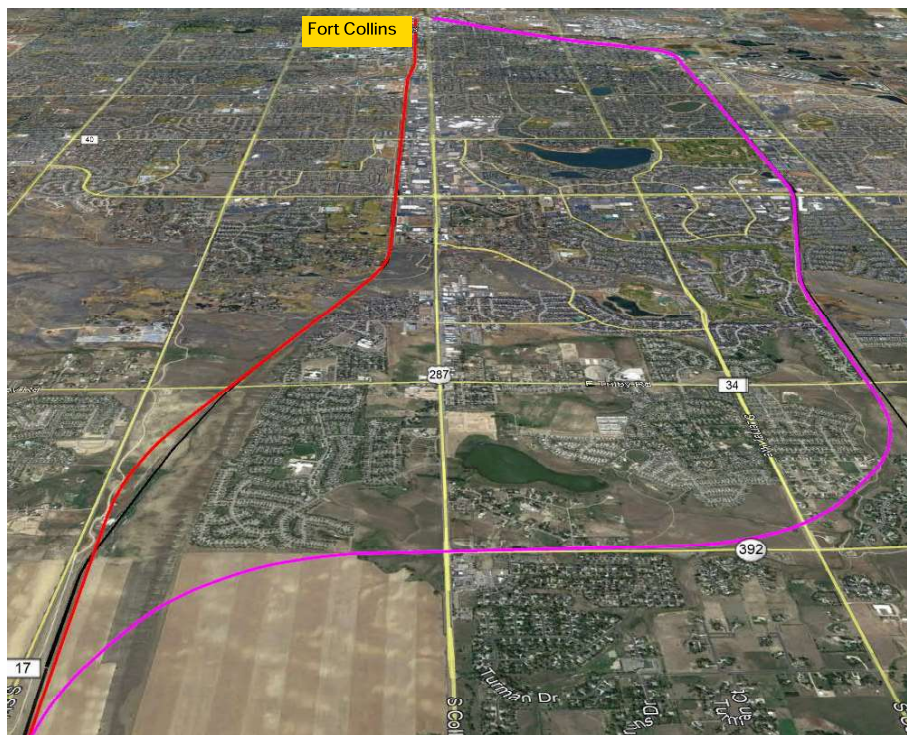


Figure 1. Fort Collins Bypass via 392 shown in purple.

Longmont Bypass (Greenfield) Design Option – shifts greenfield corridor bypass from private property, wetlands, and a small stream into the County Rd 1 corridor/ROW which is mostly undeveloped on the east side. Avoids several residential (farmland) takings north of Ute Highway before rejoining with the current Alternative 3 and 4 North Segment alignment. Slightly slower speed curve (near the sugar mill station to avoid golf course) would have insignificant effects on travel time compared to current design geometry and considering proximity to the Longmont station locations.



Figure 2. Alternate design for the Longmont bypass displayed in light blue.

Alternative 4 North Metro-Longmont Design Options – Accessing a feasible Longmont Station location while still bypassing the city to the east involves an extended greenfield corridor through farmland and over several reservoirs bordering Boulder/Idaho Creek. The only viable alternative (utilizing transportation corridors) involves paralleling I-25 and curving west to the SH119 ROW where the alignment would then continue along SH119 to the sugar mill station location in a stub-end configuration (yellow in Figure 3 below). That would add an extra 2.5 route miles compared to the current design and add an extra ~9 minutes to the station dwell time because the train operator would have to move to the cab coach from the locomotive or vice versa and perform necessary system checks resulting from switching the locomotive from push to pull or vice versa.



Figure 3. Alternative Longmont access shown in yellow.

Alternative 3 US36 Design Option – This option presents an alternate transportation corridor into Boulder.

- Horizontal geometry is more favorable (higher speeds are achievable)
- Reduces the total route distance from Denver Union Station to Boulder by 2 miles.
- The vertical grades would require further study to confirm if 3% or less could be maintained throughout this alignment with cost-efficient building methods. The grade of US 36 about 1 mile west of Marshall Road poses the biggest challenge.
- Significantly less freight interaction/civil speed restrictions.
- Fewer crossings overall (at-grade, overpass, or underpass) but this option would require more major viaduct structure to flyover US36 interchanges.

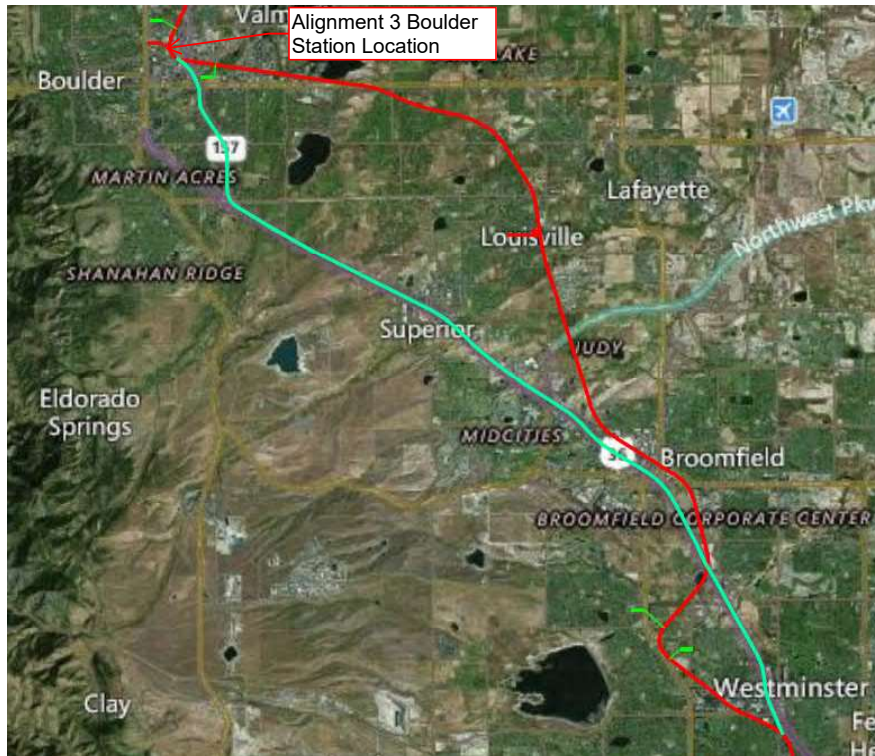


Figure 4. Alternative 3 US 36 Design option shown in teal.

Central Segment:

Alternative 3/4 Plum Creek Avoidance Option –

- Shifts Alternative 3 and 4 Central Segment to US 85 corridor for about 2 miles.
- Avoids significant impact and major structures out of Plum Creek / Wetlands + residential/farmland.
- Adds 2 US 85 crossovers/freight rail overpasses.

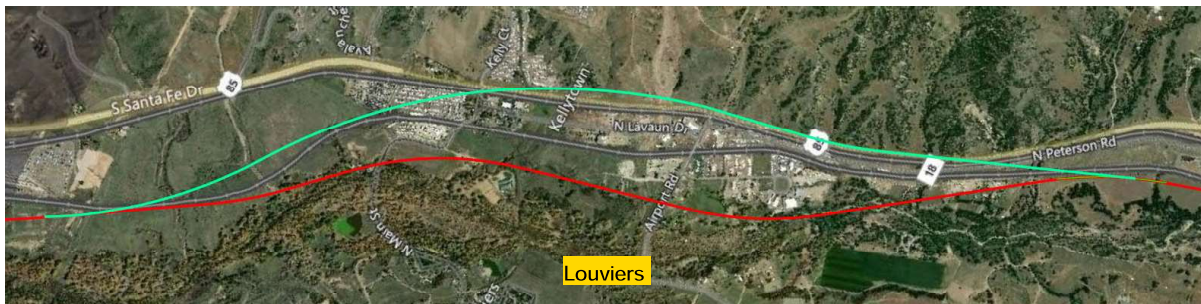


Figure 5. Plum creek avoidance alignment shown in green.

South Segment:

Alternative 3/4 Carpenter Creek/Freight Avoidance –

- Shifts Alt. 3/4 South Segment out of Carpenter Creek/Wetlands which runs between two existing freight lines
- Avoids significant environmental impact and structures to traverse Carpenter Creek area
- Shorter alignment distance than current geometry
- Originally ruled out due to suspected grade challenges, preliminary google earth vertical profile shows less than 3% grades along Spruce Mountain Rd

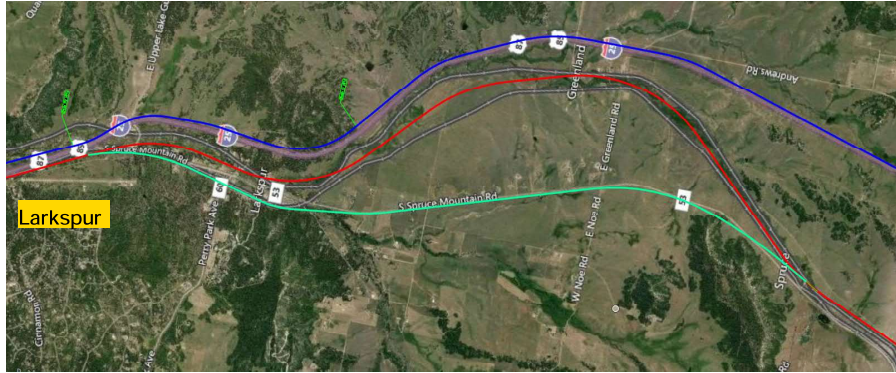


Figure 6. Carpenter creek/freight avoidance alignment shown in green.

ALTERNATIVE 6 DESIGN OPTIONS

North Segment

Alternative 6 Milliken Spur – this option (orange in Figure 7 below) presents an alternate access into Fort Collins utilizing the existing UP and GWR freight corridors

- 11.77 miles of rail corridor vs 12.0 miles of I-25 corridor.
- 0.23 miles shorter than the current Alternative 6 North Segment (blue) into Fort Collins.
- Would eliminate 3 major viaduct interchange flyovers on I-25 plus 1 major structure to traverse an existing reservoir at Horsetooth Rd.
- Existing rail corridor, but proximate to comparatively more residential development



Figure 7. The orange alignment follows an existing UP freight corridor.

HYBRID ALTERNATIVES

- **Alt 6 + Alt 4 after North Metro Station** – this hybrid alternative would follow the Alternative 6 North segment but switch to Alternative 4 at North Metro station. This option presents a potentially higher ridership capture than current design Alternative 6 as the Longmont and Loveland population centers would be accessed instead of stations along N I-25. However, the current I-25 north alignment is shorter and allows faster runtimes.

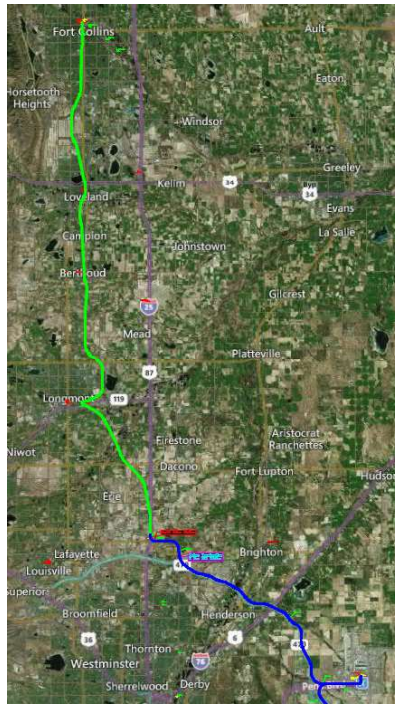


Figure 8. Alternative 6 North Segment to North Metro Station (blue) plus Alternative 4 North Segment from North metro to Fort Collins.

- **Alts 3/4 + Alt 6 South Segment** – this hybrid alternative would utilize the Alternatives 3/4 North and Central segments and then use the Alternative 6 South segment, which performed more favorably in runtime and cost modelling.

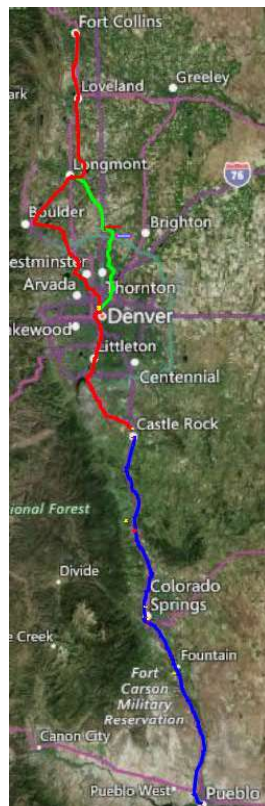


Figure 9. Alternatives 3/4 (red & green) plus Alternative 6 South Segment (blue).

ACCEPTED DESIGN RECOMMENDATIONS (SEE APPENDIX A)

These design changes were recommended based on impact avoidance, potential capital cost savings, and geometric improvements.

TECHNOLOGY/OPERATING CONSIDERATIONS

For Level 2A RAILSIM runtime analysis, the Siemens Charger was chosen as a typical long corridor / intercity diesel-electric locomotive capable of operating at up to 125 mph. The Charger was designed and manufactured for the North American market (Buy America compliant) and is considered a top performing and reliable long corridor locomotive. It meets the specifications set by AASHTO Next Generation Equipment Committee (NGEC), which FRA requires be used on any intercity vehicle procurement that it funds. The simulation assumed 300-400 passengers per trainset, one locomotive and five single level coaches, including one cab coach (a coach with a drivers compartment allowing the trainset to operate in push-pull configuration). The Charger has received Tier 4 Emissions certification and is currently employed in many US states on similar length intercity corridors operated by Amtrak, Brightline, IDOT, Caltrans and WSDOT.

As the study progresses, alternative technologies should be evaluated for operational, cost and environmental advantages. System-wide electrification would allow for quicker accelerating trainsets and reduced runtimes but alignment geometry and civil speed restrictions (due to potential shared corridors with freight and/or RTD) of each Alternative are limiting factors that could make system-wide electrification cost inefficient.

Still, speed is a main driver of ridership generation, and it's important to note that certain segments of the FRPR Alternatives are less constrained from a ROW and geometric perspective, so they have potential for higher speed operation. For example, Alternatives 3/4 Central Segment is constrained by development, existing RTD and freight track infrastructure. Establishing new electrical and catenary infrastructure for Alternative 3 and 4 Central would not be cost efficient since speeds are already constrained by proximity to existing lines. Alternative 6 Central and North segments have comparatively spacious and unimpeded routes paralleling E470 and I-25 and could benefit from the quicker acceleration provided by an electric trainset. Similar cases could be made for the South Segment.

In addition to further evaluation of the Siemens Charger, the following technologies should be evaluated for the FRPR system:

- **Electric locomotives** such as the Amtrak Cities Sprinter ACS-64 Electric Locomotive
 - Quicker acceleration to reduce runtimes.
 - Requires establishment of catenary and electrical power infrastructure.
- **Bi-mode multiple unit (electro-diesel multiple unit)**
 - Powered either by an external electricity supply (catenary and pantograph) or by using an onboard diesel engine.
 - Ability to negotiate both electrified and non-electrified track.
- **Electric multiple units (EMUs)** – this type of technology was chosen and modeled for the ICS study.
 - Quicker acceleration and higher maximum speeds to reduce runtimes
 - Requires establishment of catenary and electrical power infrastructure.
 - EMUs like Alstom's Avelia Liberty have tilting technology which allow the trains to maintain high speeds on sinuous corridors.
- **Diesel multiple units (DMUs)**
 - Quicker acceleration to reduce runtimes
 - Not typical for a corridor of this length

New intercity passenger service is often characterized by gradual introduction of higher speed operations and/or increased frequency – it is reasonable to assume track electrification and/or rolling stock upgrades could be completed over many years once the FRPR system and ridership is established. As the study progresses, detailed operational planning and practical technology comparisons (including cost comparisons related to track electrification and speed/ridership gains) will reveal opportunities to make the FRPR system as efficient as possible.

APPENDIX A – ACCEPTED DESIGN RECOMMENDATIONS

General Notes on Alignment Design / Technical Feasibility:

-Level 2 Travel time/Ridership/Cost modeling based on current working alignments

-Environmental impact/construction feasibility evaluated to ensure realistic modeling. The following figures suggest redesigns for avoidance's that may affect travel times.

-Geometry check excel sheet documents necessary horizontal and vertical design changes based on FRPR and AREMA standards. A conservative 3" Unbalanced design superelevation has been applied for the current geometry. A more unbalanced super would allow for slightly higher speeds through curves.

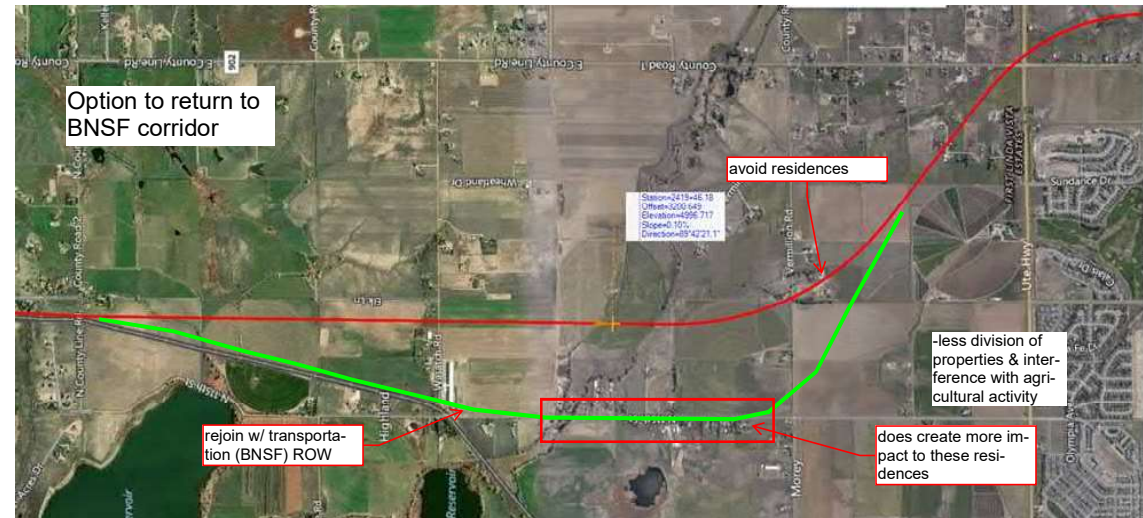
-Engineering fine-tuning and avoidance will be iterative through detailed design but these alignments will serve as basis for Level 2 travel time/ridership/costing.



= Comment incorporated into Level 2 design prior to RAILSIM

Alternative 3 -North Segment







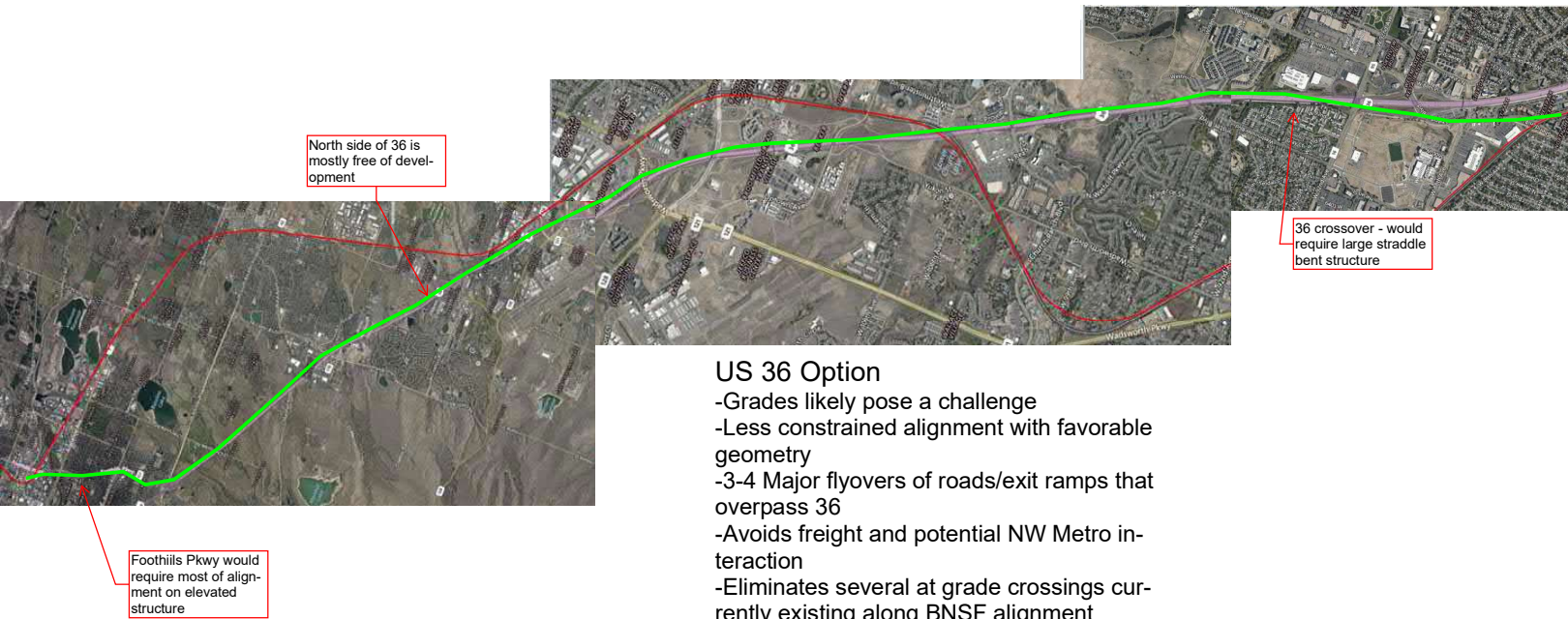
Option for bypass in Longmont

Longmont Station

potential location for maintenance facility

tangent extended - avoids golf course

Potentially avoids Fox Hill Country Club, less at grade crossings, retrofitting complex underpass. Introduces slow curve but proximate to station slow down area



US 36 Option

- Grades likely pose a challenge
- Less constrained alignment with favorable geometry
- 3-4 Major flyovers of roads/exit ramps that overpass 36
- Avoids freight and potential NW Metro interaction
- Eliminates several at grade crossings currently existing along BNSF alignment

*** BNSF ROW width is limited - fitting freight and passenger service(s) (with separate trackage to maintain design speeds) would be a challenge in many sections. Freight and FRPR could share trackage, which presents another set of challenges with track design, sidings, station stops, etc. That potential interaction would affect travel time modeling. Having another option into Boulder could be prudent. Benefits of US36 include potential for higher speed operation (less curvature) , less development and impact surrounding the corridor (compared to Louisville).

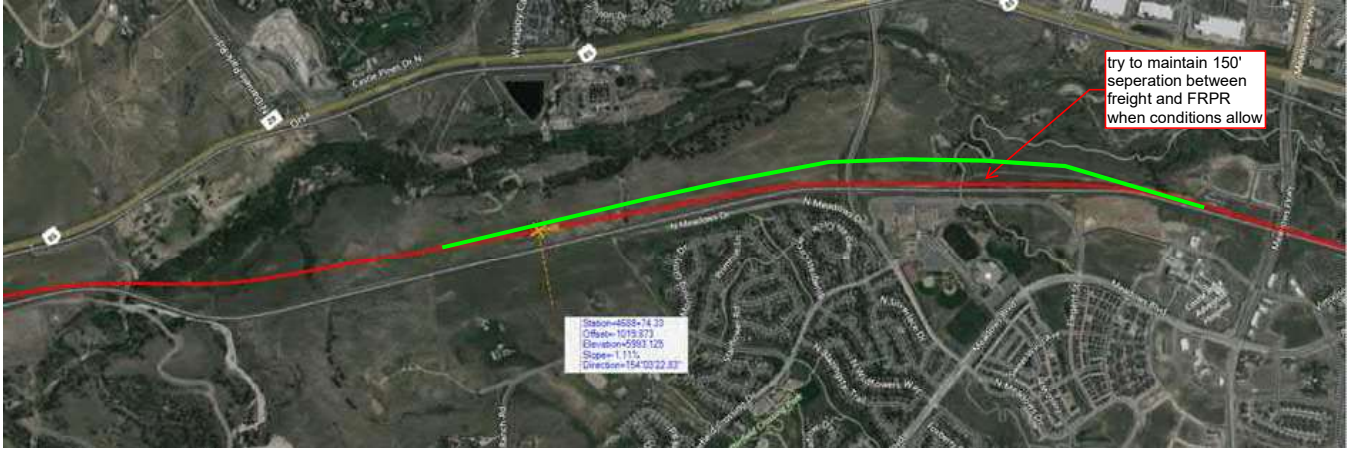
Alternative 3 - Central Segment

Option for East side of 85 (but adds 2 major crossovers) - hugging freight ROW like original Alt. 3 also less impactful



try to maintain 150' separation between freight and FRPR when conditions allow

Station=4528+74.33
Offset=1073.871
Elevation=2983.125
Slope=1.111
Direction=154°02'22.83"



Alternative 3 - South Segment

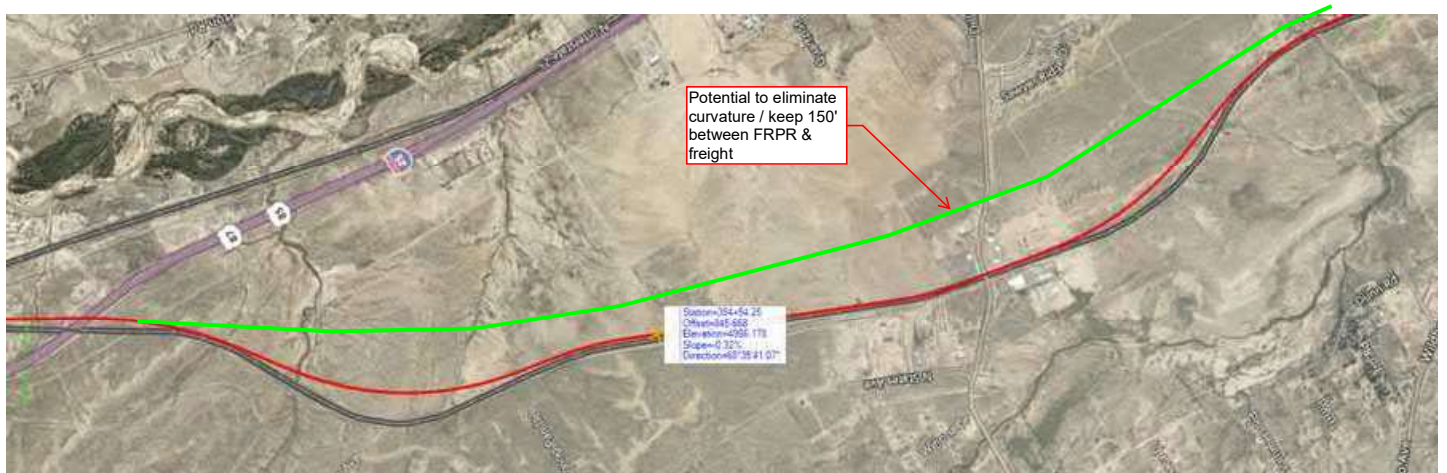


Option for avoidance of neighborhood in Monument

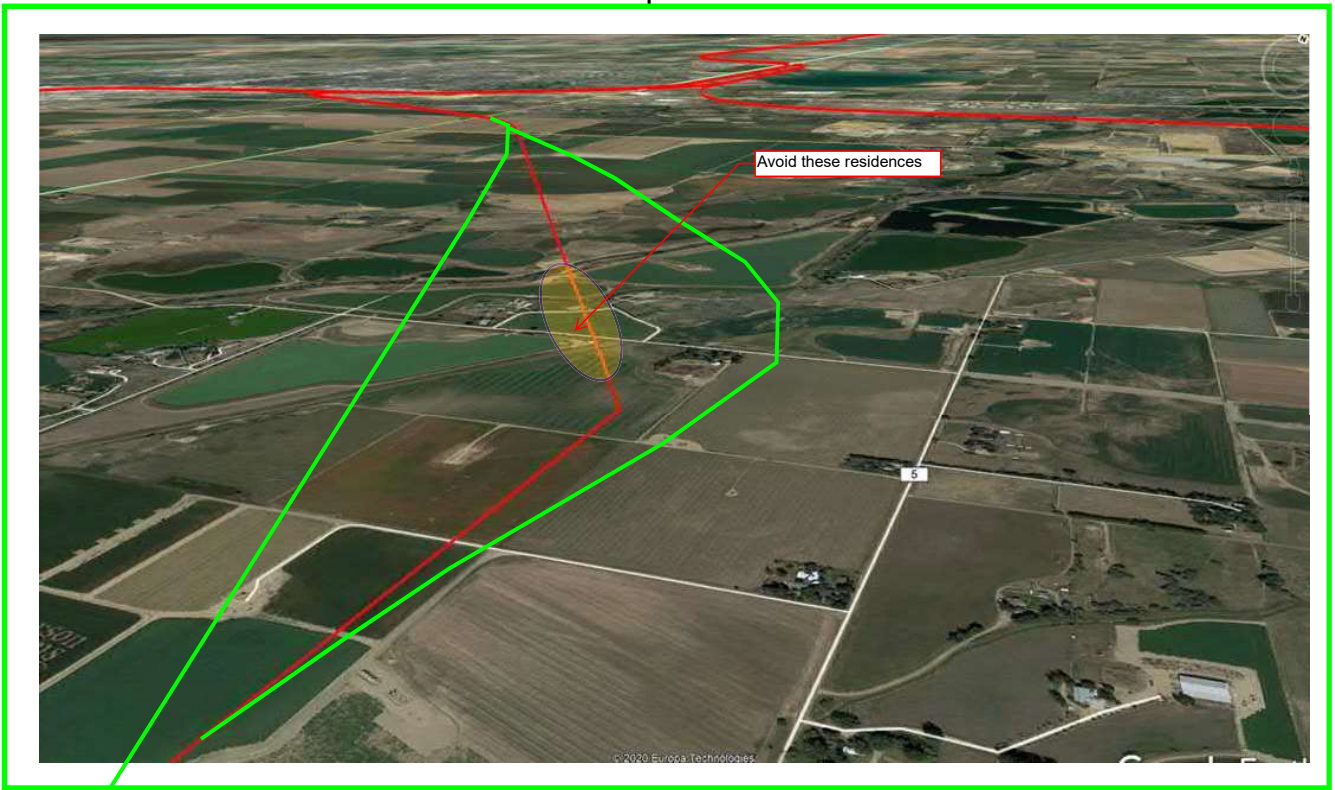


NEPA process will likely push this section back into freight ROW with suboptimal curve





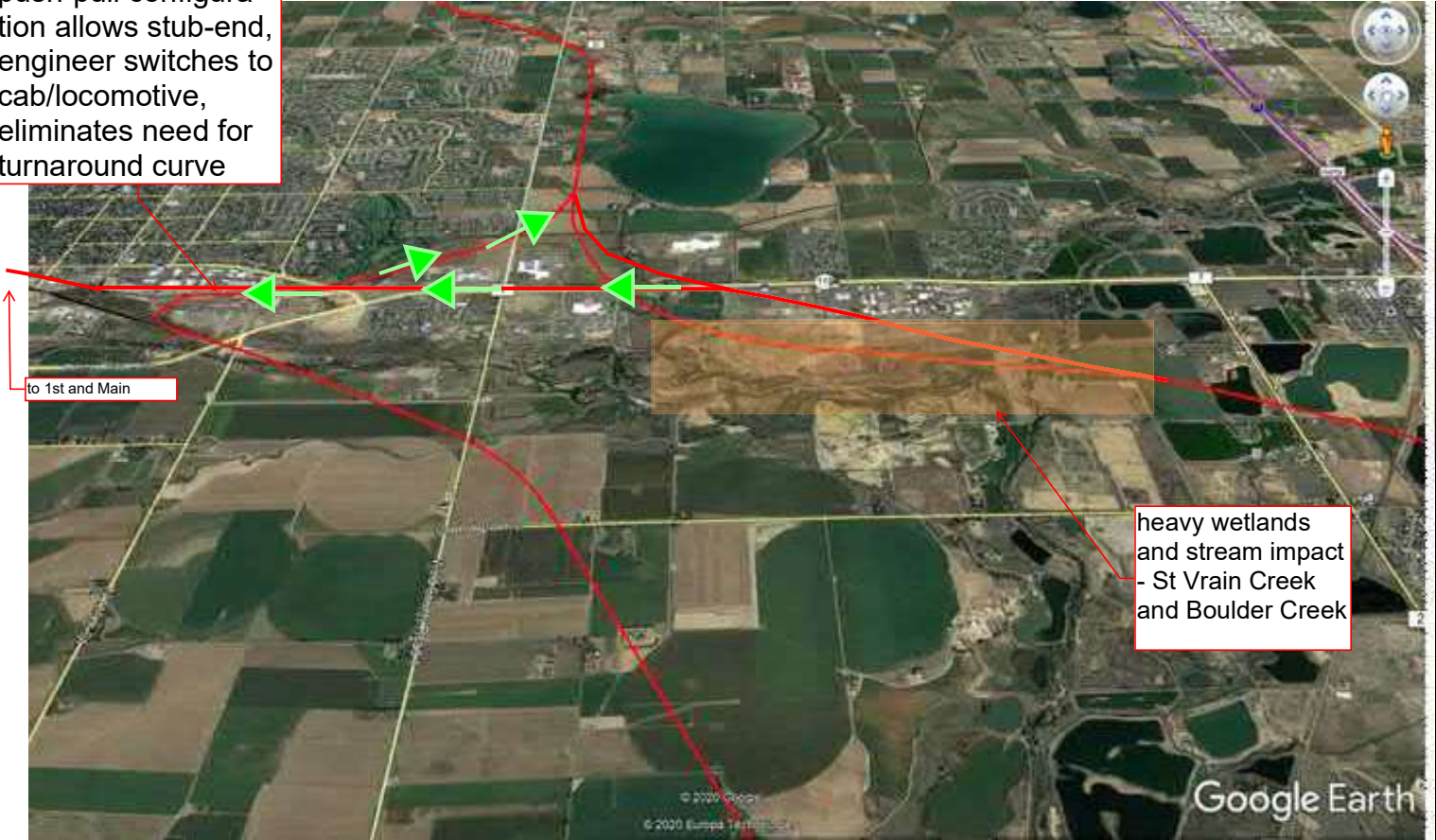
Alt 4 Option 1a



Alt 4 Option 1b



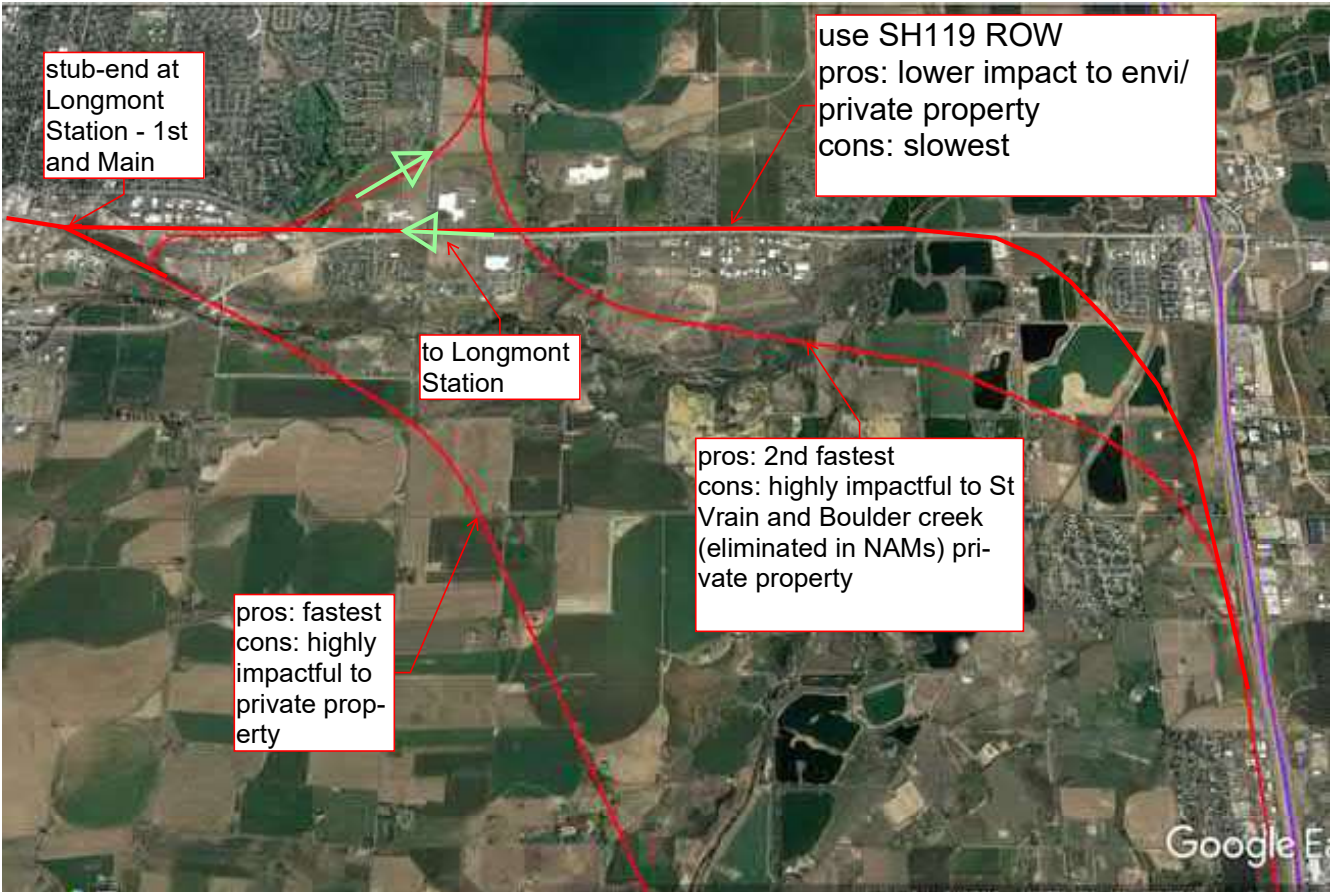
push-pull configuration allows stub-end, engineer switches to cab/locomotive, eliminates need for turnaround curve



to 1st and Main

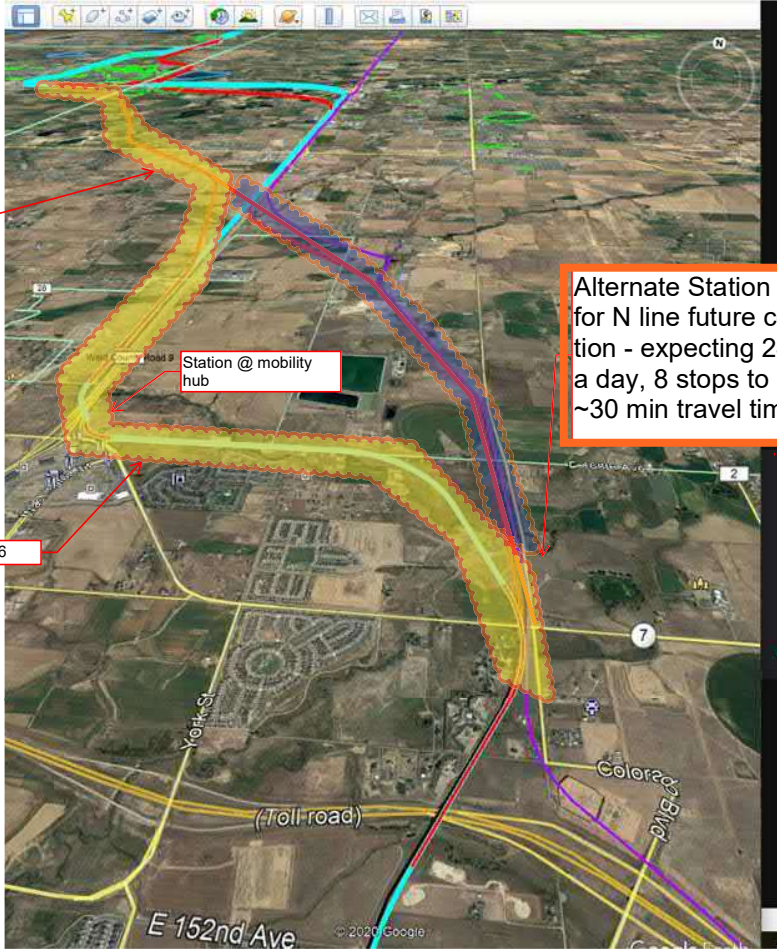
heavy wetlands and stream impact - St Vrain Creek and Boulder Creek

Google Earth



Alternative 4

Alternatives 4,5,6



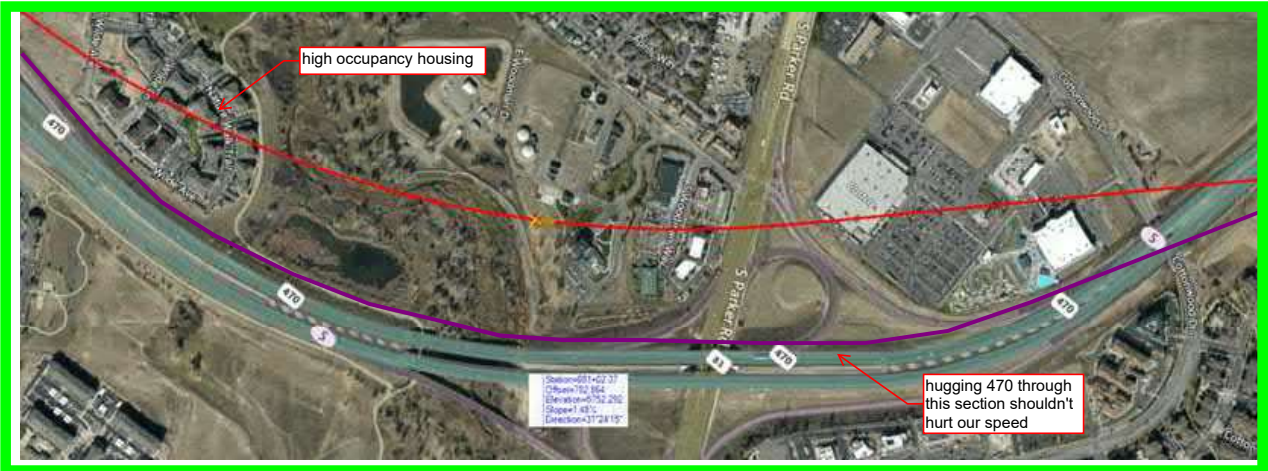
Alternate Station - EOL for N line future construction - expecting 24k riders a day, 8 stops to DUS, ~30 min travel time

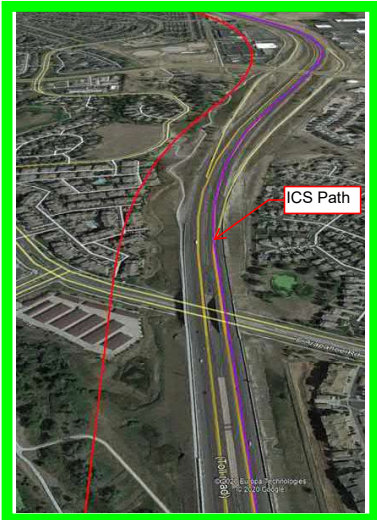
Alternative 6 - Central Segment Suggested Avoidances



Design Recommendation Accepted
and Incorporated prior to Level 2 Mod-
elling





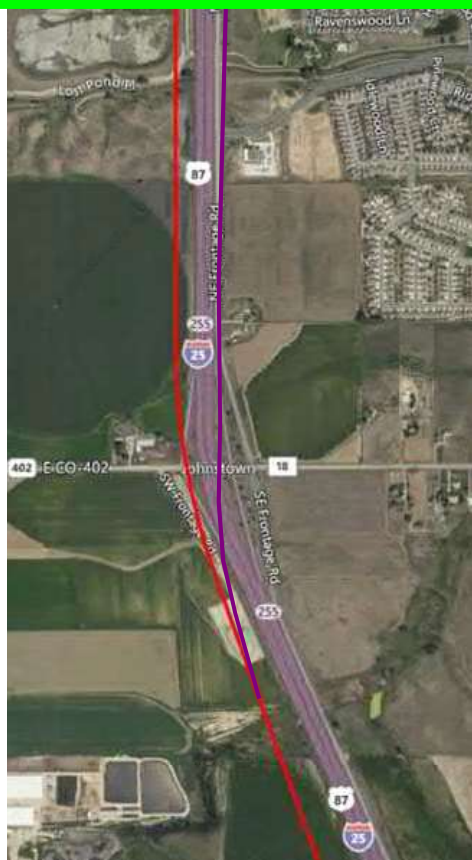


South/East side of 470 much less impactful through these sections Stations 1043+00 - 1275+00



Alternative 6 - North Segment Suggested Avoidances





Potential for Crossover at SR18 -
-North of this point the east side of I-25 is much less impactful (all images on previous page)
-Generally, the tighter to I-25, the better on either side