



Building a Better World
for All of Us®

UPDATED TECHNICAL MEMORANDUM

TO: Tony Marusiak, Town of Castle Rock

FROM: Erik Nyce, PE

DATE: January 24, 2018

RE: Founders/Fifth/Ridge Road Intersection Improvement Project – Conceptual Design Memo
SEH No. 142054

The existing Founders/Fifth/Ridge Road intersection operates near capacity during the PM peak period due to high volumes in the southbound direction. The southbound left turn and northbound left turn movements both experience average delays of more than 75 seconds per vehicle during this PM peak hour period. Future buildout in the surrounding area will result in added traffic to this intersection resulting in similar delays to the through movements at each approach. As a first task to the Founders/Fifth/SH 86 Intersection Improvement project, Short Elliott Hendrickson (SEH) has been asked to evaluate three conceptual alternatives for the intersection in an effort to improve the overall operations of this intersection. The three alternatives evaluated were:

1. Widening the existing conventional intersection per recommendations from Town of Castle Rock Master Plan
2. Roundabout
3. Continuous Flow Intersection aka Displaced Left Turn

Background

The analysis included conceptual intersection configuration exhibits, level of service and delay time analysis and quantity and cost evaluations for each alternative. The concepts/designs presented in this memo were developed to approximately a 10 percent design level. Concepts have been evaluated using aerial photos and GIS data provided by the Town of Castle Rock. The analysis does not include vertical impacts, drainage, or other evaluations. These impacts will be considered for the concept that is selected to continue to preliminary and final design.

The three alternatives were analyzed based future development traffic volumes. The future development traffic volumes are based on traffic counts conducted by Counter Measures Inc. on January 25, 2017 and a memo titled "Castle Rock Transportation Master Plan Buildout Intersection Analyses" prepared by Felsburg, Holt and Ullevig (FHU) dated April 24, 2017. These were provided to SEH by the Town of Castle Rock. The traffic volumes analyzed for these alternatives were the PM peak hour volumes identified in these documents. With the existing lane geometry and PM peak hour volumes this intersection currently operates at a Level of Service C. With the proposed future buildout PM peak volumes and without any improvement this intersection would operate at a Level of Service F.

The future buildout condition of each of the approaches to the intersection are anticipated to include two through lanes in each direction for Ridge Road, SH 86 and Fifth Street and three through lanes for Founders Parkway. The three through lanes for Founders Parkway will need to continue through the intersection on to Ridge Road to accommodate transitions to the ultimate four lane section on Ridge Road. Each of these alternatives is

Engineers | Architects | Planners | Scientists

Short Elliott Hendrickson Inc., 2000 South Colorado Boulevard, Suite 6000, Colorado Center Tower One, Denver, CO 80222-7938

SEH is 100% employee-owned | sehinc.com | 720.540.6800 | 800.490.4966 | 888.908.8166 fax

evaluated in more detail in this memo in Table 4 at the end of this memo provides a summary of conceptual costs and Right-of-way (ROW) impacts associated with each alternative.

Alternative1: Conventional Intersection Widening

The layout for the standard intersection is based on the Town requirements from the RFP, which were developed from recommendations provided in the Intersection Improvement Table provided in the Felsburg, Holt and Ullevig memo. The proposed recommended improvements includes adding an east-west through lane in each direction, adding a north-south through lane in each direction, adding a northbound left turn lane and adding a southbound left turn lane. This proposed configuration is shown in Figure 1. A new westbound left lane into the Founders Marketplace shopping center from SH 86 could be accommodated with this alternative. This configuration does not take into account adding an additional through lane in each direction for Founders Parkway.

All right turns are free rights with a minimum 250 foot merge length, except the outside right lane from Founders Parkway on the double right which yields to the traffic lane. Also included is a new left turn from westbound SH 86 about 470 feet east of the intersection into the Founders Marketplace shopping center.

The intersection will include standard crosswalks and ADA ramps along with the addition of 10 foot wide sidewalks on the southwest, northwest, and northeast with an existing sidewalk is in place along the southeast quadrant of the intersection. Although the eastbound and westbound will have two through lanes each at the intersection they taper back down to one lane in each direction approximately 1,000 feet each side of the intersection. Founders Parkway north of the intersection is already two lanes in each direction and the concurrent Ridge Road widening project will widen south of the intersection to two lanes in each direction as well. The proposed intersection shown in Figure 1 could require minimal right of way acquisition depending on final design. The Town has recently acquired right-of-way along the northwest quadrant of the intersection. It's likely that this proposed intersection could be designed in a way to require little to no right-of-way impacts and if future lanes become necessary, right of way could be acquired at that time.

Some of the issues associated with this configuration include a short merge length for the southbound to westbound right turns along Fifth Street due to the close proximity of the Bader Court intersection. There are rock outcroppings about 1,000 feet east of the intersection along SH 86 so transitions and tapers would need to match existing before these in order to minimize cost impacts. This configuration proposed two free right turn lanes in the southbound to westbound direction making it challenging for pedestrians.

Table 1 below shows the proposed Level of Service (LOS) and delay times (in seconds) for this configuration as calculated using Sychro 9. Split phasing was not considered as an effort to gain additional left turn lane capacity. If this intersection is selected as the preferred alternative, SEH will look at split phasing in an effort to minimize widening. The overall Level of Service D matches the level of service shown in the FHU memo however critical movement LOS' and delay time may vary as this memo does not account for the Town's signal timing at this intersection. Costs have been provided to accommodate a third northbound and southbound lane through the intersection (Alternative 1b) but a graphic or level of service analysis has not been developed for this Alternative. The additional southbound lane is needed to transition the future six lane section of Founders Parkway through the intersection.

Table 1: Alternative 1 Conventional Intersection LOS and Delay

Intersection and Critical Movements	PM Peak Hour	
	Delay (s)	LOS
Option 1 - Conventional Intersection		
(Future Year Volumes)		
Founders / Fifth / Ridge Road	46.1	D
Eastbound Left	67.8	E
Eastbound Through	29.6	C
Eastbound Right	0.0	A
Westbound Left	29.6	C
Westbound Through	41.5	D
Westbound Right	0.0	A
Northbound Left	47.2	D
Northbound Through	56.0	E
Northbound Right	0.0	A
Southbound Left	57.6	E
Southbound Through	28.7	C
Southbound Right	0.0	A

Alternative 2: Roundabout

The second Alternative developed for this intersection is a roundabout. This roundabout was laid out per FHWA and Town of Castle Rock criteria. Due to the high speeds of the approach roads, increased curvature was introduced at the approaches to the roundabout to decrease the entry speeds into the roundabout to approximately 30 mph. A WB67 as used as a design vehicle.

Two different options were developed for this alternative, a two lane and three lane roundabout. A two lane roundabout could be constructed in the interim condition and expanded to a three lane roundabout in the north south direction due to the high PM peak hour volumes required with the full buildout traffic volumes. RODEL was used to calculate Level of Service for both configurations using both the 50 percent and 85 percent confidence level. The two lane Alternative would operate at a Level of Service A up until about 70% of the future buildout is achieved at which point a third lane would be necessary. Using the 2040 Full Build Out volumes provided in the FHU memo and using a straight line growth this equates to the 2 lane roundabout functioning until approximately 2027. The three lane configuration would operate at a Level of Service C for the entry and exit for Ridge Road and Fifth Street and a Level of Service B for the entry and exit of SH 86 and Founders Parkway. The RODEL calculations are provided at the end of this memo. Depending on the rate of growth a two lane configuration could function adequately for several years. Figures 2 and 2.1 show both the two lane and three lane alternatives. The two lane alternative shows how this roundabout could be converted to three lanes with minimal impacts.

Both the two lane and three lane roundabout configurations would likely require right of way acquisition and or sidewalk easements in the northeast and southwest quadrants. While a three lane roundabout would operate at a Level of Service of C or better there would likely be driver confusion with this alternative due to the size. Three lane roundabouts are fairly new so there is not a lot of data available yet about the safety and operational challenges of this configuration. The Federal Highway Administration (FHWA) has published an article titled “A Evaluation of Signing for Three-Lane Roundabouts” FHWA Publication No.: FHWA-HRT-10-30. Many of the recommendations in this publication could be implement along Founders Parkway and Ridge Road alerting driver of the proper lane to be in to navigate the roundabout safely. Constructability may be challenging with alternative

as there are limited detour alternatives in this area. Temporary bypass lanes may be necessary to successfully phase this construction. These temporary bypass lanes may require temporary construction easements. This alternative will likely not accommodate a left turn into the Founders Marketplace shopping center from SH 86 however left turns into the shopping center could be accommodated by using the roundabout.

Table 2: Alternative 2 Three-Lane Roundabout Level of Service and Delay

Intersection and Critical Movements	PM Peak Hour	
	Delay (s)	LOS
Option 2 - Roundabout		
	(Future Year Volumes)	
Founders / Fifth / Ridge Road	16.8	C
Eastbound Left	22.5	C
Eastbound Through	22.5	C
Eastbound Right	22.5	C
Westbound Left	13.8	B
Westbound Through	13.8	B
Westbound Right	6.8	A
Northbound Left	22.0	C
Northbound Through	22.0	C
Northbound Right	22.0	C
Southbound Left	11.5	B
Southbound Through	11.5	B
Southbound Right	11.5	B

Alternative 3: Continuous Flow (Displaced Left Turn) Intersection

The third alternative considered was a Continuous Flow Intersection (CFI), also known as a Displaced Left Turn intersection. The CFI configuration is shown for the southbound and northbound left turning movements for Founders Parkway and Ridge Road. The eastbound and westbound left turns along Fifth Street and SH 86 would continue to operate as a standard intersection. This alternative was laid out per guidance provided in Federal Highway Administration (FHWA) Report No. FHWA-SA-14-068 titled Displaced Left Turn Informational Guide.

This alternative would remove the left turn phases from Founders and Ridge Road by crossing them with the opposing traffic approximately 325 feet away from the intersection. This layout includes three through lanes for the northbound and southbound for future needs. The third lane would be a striped or raised median during the initial use of the intersection. This was done due to the required medians and to minimize future work. If this alternative is pursued further a two lane layout can also be developed if desired. A level of service using Synchro 9 is shown for each intersection that will have a traffic signal but an overall LOS is not provided for this alternative.

Because of the required angles for the crossover and the medians this concept has the largest right-of-way impact. The southwest and northeast would require right-of-way (and potentially sidewalk easements) and there could be impacts to the northwest as well. As with the roundabout construction phasing may be challenging. Like the roundabout this alternative will likely require temporary bypasses during construction resulting in additional temporary construction easements. The construction limits along Founders Parkway and Ridge Road would be longer than a standard intersection or roundabout in order to accommodate the displaced left turns. Like the

conventional intersection widening, this alternative could accommodate a new left movement into the Founders Marketplace shopping center from westbound SH 86. Costs have been provided for a reduced alternative with two northbound and southbound lanes through the intersection (Alternative 3b) but a graphic or level of service analysis has not been developed for this alternative.

Table 3: Alternative 3 Continuous Flow Intersection Level of Service

Intersection and Critical Movements	PM Peak Hour	
	Delay (s)	LOS
Option 3 - Continuous Flow (Displaced Left Turn) Intersection		
(Future Year Volumes)		
Founders / Fifth / Ridge Road (South Intersection)	10.9	B
Eastbound Right	27.0	C
Northbound Left	25.7	C
Northbound Through	Free	Free
Southbound Through	11.1	B
Founders / Fifth / Ridge Road (North Intersection)	13.9	B
Westbound Right	45.4	D
Northbound Through	8.2	A
Southbound Left	25.9	C
Southbound Through	Free	Free
Founders / Fifth / Ridge Road (West Intersection)	8.7	A
Eastbound Through	4.8	A
Eastbound Right	Free	Free
Westbound Through	0.3	A
Northbound Left	30.6	C
Founders / Fifth / Ridge Road (Central Intersection)	21.4	C
Eastbound Left	49.9	D
Eastbound Through	26.7	C
Westbound Left	46.8	D
Westbound Through	33.8	C
Northbound Through	16.1	B
Northbound Right	0.3	A
Southbound Through	14.4	B
Southbound Right	2.3	A
Founders / Fifth / Ridge Road (East Intersection)	9.7	A
Eastbound Through	0.1	A
Westbound Through	4.7	A
Westbound Right	Free	Free
Southbound Left	31.6	C

Option	Description	Conceptual Cost Estimate	ROW impact area (SF)	Cost with ROW
Alternative 1	Standard Intersection layout (2 through lanes all directions)	\$4,500,000	1,000	\$4,503,000
Alternative 1b	Standard Intersection layout (3 through lanes NB & SB)	\$4,900,000	15,000	\$4,945,000
Alternative 2 and 2b	Roundabout (2 Lane and 3 Lane)	\$4,000,000	15,000	\$4,045,000
Alternative 3	Displaced left turn/Continuous flow intersection (2 lane)	\$7,000,000	38,000	\$7,114,000
Alternative 3b	Displaced left turn/Continuous flow intersection (3 lane)	\$7,500,000	59,000	\$7,677,000

Table 4: Cost Estimate Summary

Recommendation

After reviewing each of these three options for Level of Service, cost and other associated issues we feel that a roundabout, Alternative 2 would be the preferred alternative for this project.

Alternative 2, the two lane roundabout, operates at the best Level of service and has the lowest conceptual cost, and could be expanded to three lanes in the north-south direction to accommodate future buildout. Three lane roundabout configurations are not common and could likely result in driver confusion and potential safety concerns. However the signing recommendations provided in the FHWA Publication listed above could be implement to help alleviate some of these safety concerns. If the future buildout volumes were not achieved and this roundabout could remain in a two lane configuration. Additional analysis of future traffic demands would likely need to be conducted to determine if the final configuration could be achieved with a two lane roundabout.

SEH and the Town of Castle Rock met with CDOT on August 2, 2017. The notes from this meeting have been included as an attachment to this memo. In summary CDOT was in favor of a roundabout at this intersection. Additional Rodel modeling using the 50% and 85% confidence level was requested to verify capacity and geometric assumptions for the roundabout configuration. CDOT also requested a sensitivity analysis to determine when a 2 lane roundabout would reach its maximum capacity.