

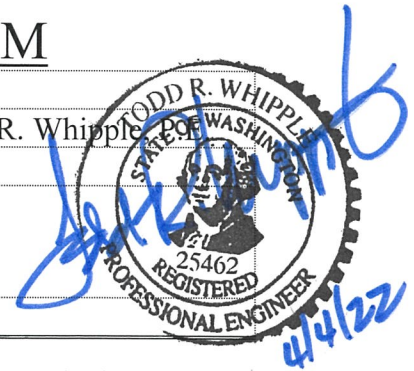
WCE

Whipple Consulting Engineers, Inc.

21 S. Pines Road
Spokane Valley, WA 99206
Ph 509-893-2617 Fax 509-926-0227

TECHNICAL MEMORANDUM

TO:			
FROM:	Ben Goodmansen, E.I.T. Ken Kim, P.E.(ID) Todd R. Whipple		
DATE:	March 24, 2022		
PROJECT NO:	20-2564 19-2318 20-2695	NAME:	Latah Glen Residential/ Marshall Creek Estates/ Qualchan View Estates
REGARDING:	J-Turn Analysis Method Recommendation		



This letter is intended to provide a recommendation of the J-Turn analysis at the intersections of Thorpe Road, North Median U-Turn, and South Median U-Turn with SR 195 and the proposed North Median U-Turn at Meadowlane Road & SR 195.

History

The SR 195 corridor studies include the analysis of the J-turn at Thorpe and the future J-turn at Meadowlane. Previously approved studies included LOS analysis at the main intersection. Per WSDOT comment the north and south connections were requested to be analyzed for LOS. The movements were included in the analysis. The results were LOS E, which seems high for the singular left turn movement. Although still acceptable for level of service, the intent of the J-turn (Median U-Turn - MUT) was to take a LOS F intersection separate the left turn movements reduce central conflict points and bring the intersection to acceptable levels of service for years to come. Unfortunately, with the high amount of average delay and corresponding level of service. This solution does not appear to have the expected life span, or analysis methodologies need to mature.

So WSDOT took a look back on the methodology used and found within the HCM an RCUT analysis also known as a jug handle WSDOT then requested that the J-turn analysis include the RCUT methodology the following is the RCUT methodology as presented in the HCM.

Problem Statement

Per the comments of WSDOT, the J-Turn intersection at Thorpe Road including north and south MUT analysis has been requested using the Restricted Crossing U-Turn (RCUT) methods from Chapter 23 in the 6th Edition Highway Capacity Manual (HCM) as implemented in the Highway Capacity Software (HCS) 7. Based upon the conversation with WSDOT and the RCUT methods in HCM, however, we found that the Truck Loon and Acceleration Lane at Thorpe Road J-Turn is not covered by the RCUT methods as the method is intended for urban arterial at non highway speeds with stop control opportunities as implemented in HCS 7. Base upon HCM RCUT method as implemented in HCS 7, the levels of service at Thorpe Road on SR 195 is anticipated to operate at an unacceptable service for the 2026 with development scenarios as shown in Table 1.

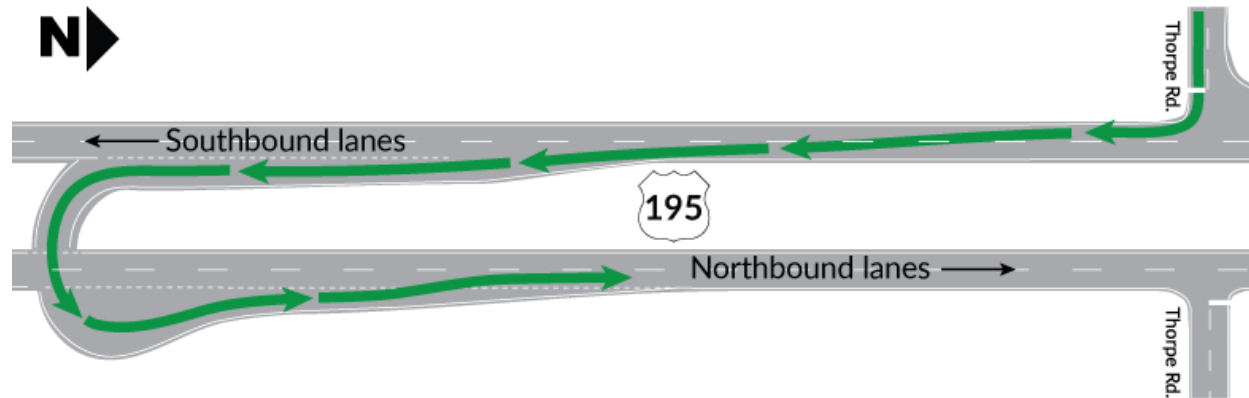


Exhibit 1 – WSDOT J-Turn at Thorpe Road on SR 195

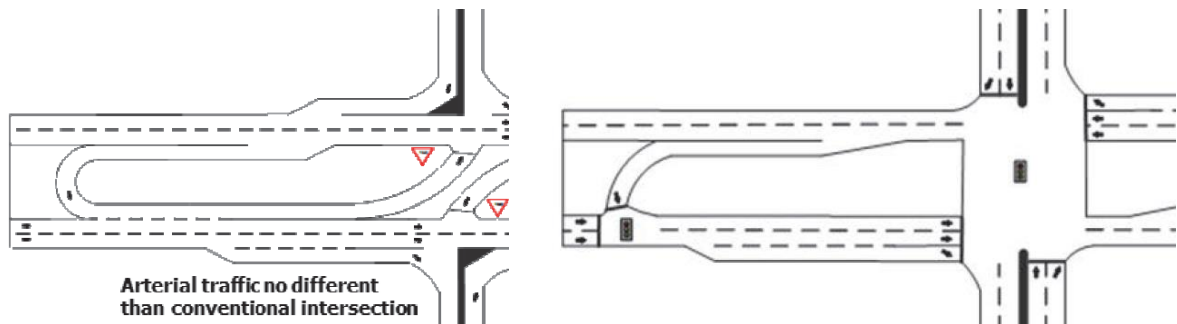


Exhibit 2 – RCUT Geometry Examples (Four-Legged RCUT with Merges and Diverges (Left) and Four-Legged MUT with Signals (Right)) in HCM

North J-Turn
(Median U-Turn (MUT))

Thorpe

South J-Turn
(MUT)

Table 1 – HCS Analysis at Thorpe & SR 195 (Per WSDOT RCUT Method)

INTERSECTION			AM Peak Hour			PM Peak Hour		
			Delay (sec)	LOS	95 th % Q (veh)	Delay (sec)	LOS	95 th % Q (veh)
2021 Existing	N. MUT	U	9.8	A	0.3	20.4	C	1.4
	Thorpe & SR 195	U	24.2	C	0.7	19.4	C	1.2
	S. MUT	U	26.9	D	2.3	10.9	B	0.4
2026 w/ BK Growth Rate	N. MUT	U	10.0	A	0.3	22.7	C	1.7
	Thorpe & SR 195	U	26.5	D	0.9	21.0	C	1.4
	S. MUT	U	31.6	D	2.8	11.2	B	0.5
2026 w/ Project	N. MUT	U	10.6	B	0.4	47.4	E	4.3
	Thorpe & SR 195	U	41.2	E	1.6	39.8	E	3.6
	S. MUT	U	64.0	F	4.8	13.1	B	0.6

*Delay, LOS, and Queue Length based on critical movement – NBL @ N. MUT, WBR @ Thorpe & SR 195 in AM, EBR @ Thorpe & SR 195 in PM, SBL @ S. MUT

** 2026 w/ Project scenario includes Eagle Ridge 13th Addition, The Summit, Tangle Ridge, Wheatland Estates, Latah Glen, Marshall Creek, The Greens at Meadowlane, and Qualchan View Estates based upon the Qualchan View Estates Traffic Impact Analysis (TIA) report.

HCS7 RCUT uses left turn-merge-acceleration as a complete maneuver.

HCM RCUT Method

The HCM RCUT method be used to analyze the J-Turn at Thorpe Road considering the Truck Loon and Acceleration Lane. In the description of the RCUT analysis in Step 5: Additional Control-Based Adjustments from Chapter 23 in HCM(Page 23-77), two types of the unsignalized RCUT Junctions were considered; one with merges and the other with Stop Signs.

Step 5: Additional Control-Based Adjustments

This step estimates additional control-based adjustments needed to approximate control delay in Step 6. This step is applied for each RCUT or MUT junction.

RCUT Junctions with Merges

The procedure assumes that there is no control delay associated with merging onto the major street or, for vehicles that need to weave, weaving from one side of the major street to the other. Analysts should consider whether this assumption holds for any particular RCUT with merges, since these maneuvers could add travel time.

RCUT and MUT Junctions with STOP Signs

The procedure from Chapter 20, Two-Way STOP-Controlled Intersections, is applied to estimate control delay at junctions with STOP signs. The two additional parameters that must be applied at an RCUT or MUT U-turn crossover with a STOP sign are (a) the base critical headway and (b) the base follow-up time. Because of the U-turn crossover geometry, it is reasonable to believe that the critical headway and follow-up time from that crossover are different from the left-turn cases presented in Chapter 20. If field data or representative local data for critical headway and follow-up time are unavailable for the U-turn crossover, default values can be applied on the basis of a site with three through lanes and a 55-mi/h speed limit (12), where a critical headway of 4.4 s and a follow-up time of 2.6 s were observed. It is reasonable that these values are less than the default values for these parameters given in Chapter 20, since the maneuver is relatively simple, with only one conflicting traffic stream for motorists to observe.

Exhibit 3 – RCUT Junction with Merge and RCUT Junction with Stop Signs in HCM (Page 23-77)

As shown in Exhibit 3, for the RCUT Junction with Stop Signs, the procedure from chapter 20 in the HCM, Two-Way Stop-Controlled (TWSC) Intersections is applied to estimate control delay. For the RCUT Junction with Merges, the procedure assumes that there is no control delay associated with merging onto the major street or, for vehicles that need to weave, weaving from one side of the major street to the other.

Solution

Based upon the information, the J-Turns at Thorpe Road should be analyzed in two separate parts; one for the left-turn lane on SR 195 to the Truck Loon and the other for the merge from the acceleration lane to the mainlane on SR 195 which can be assumed that there is no control delay as described in the HCM.

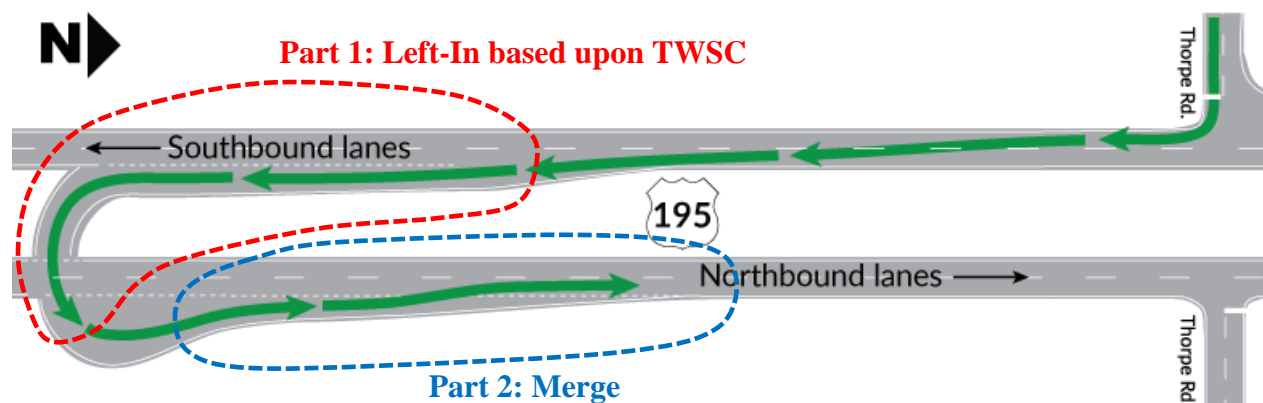


Exhibit 4 – WSDOT J-Turn at Thorpe Road on SR 195

Based upon the RCUT method in HCM and WSDOT J-Turn configuration as shown in Exhibit 4, it is recommended that the RCUT Junctions at Thorpe Road and the proposed Meadowlane Road on SR 195 be evaluated using the TWSC intersection analysis method in the HCM as implemented in Synchro. The J-Turn configuration samples in Synchro are shown in Exhibit 5 and the Synchro sample report is shown in Exhibit 6.

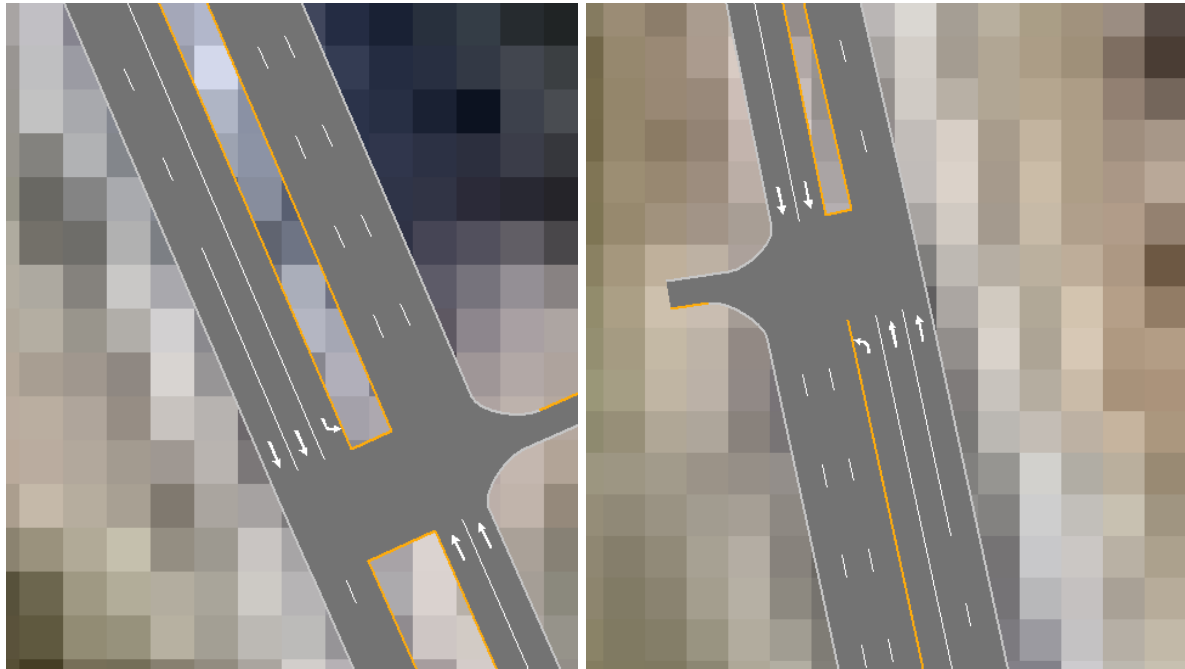


Exhibit 5 – WSDOT Synchro J-Turn Configuration Sample (South MUT - Left & North MUT - Right)

HCM 6th TWSC
16: Hwy 195 & South J-Turn

2026 AM w/ Project (Figure 13)
03/18/2022

Intersection						
Int Delay, s/veh	1.8					
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations		↗	↗↗		↘	↘↘
Traffic Vol, veh/h	0	130	2010	0	130	738
Future Vol, veh/h	0	130	2010	0	130	738
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	None
Storage Length	-	0	-	-	600	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	0	3	2	0	3	12
Mvmt Flow	0	141	2185	0	141	802
Minor Lane/Major Mvmt	NBTWBLn1		SBL	SBT		
Capacity (veh/h)	-		-	236	-	
HCM Lane V/C Ratio	-		-	0.599	-	
HCM Control Delay (s)	-		0	40.7	-	
HCM Lane LOS	-		A	E	-	
HCM 95th %tile Q(veh)	-		-	3.5	-	

Exhibit 6 – WSDOT Synchro Report Sample (South MUT at Thorpe Road & SR 195)

As shown in Exhibit 5, the 3-leg TWSC Configuration in Synchro reflects the left turn movement from the left-in lane on SR 195 into the truck loon for the J-Turn intersections at Thorpe Road and Meadowlane Road. With the 3-leg TWSC Configuration, the results in the Synchro report includes Control Delay, Level of Service (LOS), and the 95th Percentile Queue of the left turn lane as shown in Exhibit 6.

Synchro Results

Based upon the recommendations provided, the Levels of Service at the J-turn intersections at Thorpe Road & SR 195 were calculated using the TWSC and Freeway Merge methods from the 6th Edition Highway Capacity Manual (HCM) as implemented in Synchro and HCS. The Levels of Service for the J-turn intersections at Thorpe Road & SR 195 are summarized on the following tables.

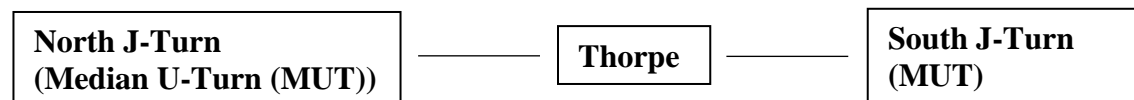


Table 2 – Synchro Analysis at Thorpe & SR 195

INTERSECTION			AM Peak Hour			PM Peak Hour		
(S)ignalized (U)nsignalized			Delay (sec)	LOS	95 th % Q (veh)	Delay (sec)	LOS	95 th % Q (veh)
2021 Existing	North MUT • (Merge)	U (U)	9.1 (8.5 pc/mi/ln)	A (A)	0.2	16.7 (19.7 pc/mi/ln)	C (B)	1.1
	Thorpe & SR 195	U	12.5	B	1.2	19.4	C	1.2
	South MUT • (Merge)	U (U)	20.8 (21.9 pc/mi/ln)	C (B)	1.7	9.9 (10.5 pc/mi/ln)	A (A)	0.4
2026 w/ BK Growth Rate	North MUT • (Merge)	U (U)	9.2 (9.0 pc/h/ln)	A (A)	0.2	18.2 (20.7 pc/h/ln)	C (B)	1.3
	Thorpe & SR 195	U	13.0	B	1.3	21.0	C	1.4
	South MUT • (Merge)	U (U)	23.5 (23.1 pc/mi/ln)	C (B)	2.0	10.1 (11.1 pc/mi/ln)	B (A)	0.4
2026 w/ Projects	North MUT • (Merge)	U (U)	9.7 (10.8 pc/mi/ln)	A (A)	0.3	31.8 (25.4 pc/mi/ln)	D (B)	3.1
	Thorpe & SR 195	U	14.5	B	1.7	40.0	E	3.6
	South MUT • (Merge)	U (U)	40.7 (27.6 pc/mi/ln)	E (C)	3.5	11.6 (14.1 pc/mi/ln)	B (B)	0.5

*Delay, LOS, and Queue Length based on critical movement – NBL @ N. MUT, EBR @ Thorpe & SR 195, SBL @ S. MUT

** 2026 w/ Project scenario includes Eagle Ridge 13th Addition, The Summit, Tangle Ridge, Wheatland Estates, Latah Glen, Marshall Creek, The Greens at Meadowlane, and Qualchan View Estates based upon the Qualchan View Estates Traffic Impact Analysis (TIA) report.

The City of Spokane and WSDOT have adopted level of service E as the minimum acceptable level for unsignalized intersections.

As shown in Table 2, the J-turn intersections at Thorpe Road & SR 195 are anticipated to operate at an acceptable level of service for 2026 with the Projects scenario.

Synchro TWSC uses left turn movement as a complete maneuver. Acceleration and merge are separated.

A comparison between the HCS RCUT and Synchro TWSC are summarized in Table 3.

Table 3 – Comparison HCS RCUT vs Synchro TWSC with HCS Merge (2026 w/ Project)

INTERSECTION (S)ignalized (U)nsignalized			AM Peak Hour			PM Peak Hour		
			Delay (sec)	LOS	95 th % Q (veh)	Delay (sec)	LOS	95 th % Q (veh)
HCS	N. MUT	U	10.6	B	0.4	47.4	E	4.3
	Thorpe & SR 195	U	41.2	E	1.6	39.8	E	3.6
	S. MUT	U	64.0	F	4.8	13.1	B	0.6
Synchro with Merge	North MUT • (Merge)	U (U)	9.7 (10.8 pc/mi/ln)	A (A)	0.3	31.8 (25.4 pc/mi/ln)	D (B)	3.1
	Thorpe & SR 195	U	14.5	B	1.7	40.0	E	3.6
	South MUT • (Merge)	U (U)	40.7 (27.6 pc/mi/ln)	E (C)	3.5	11.6 (14.1 pc/mi/ln)	B (B)	0.5

Conclusion

Based upon the analysis and the information provided, we recommend that the J-turn intersections at Thorpe Road and Meadowlane Road on SR 195 be calculated using the TWSC and Freeway Merge methods from HCM 6th Edition as implemented in Synchro.