Appendix G: Railroad Crossing Traffic Effect Analysis at C and D Streets

Final Technical Memorandum

To:	**WSDOT Rail Office**	**Date:**	**February 14, 2013**
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Subject:	**Railroad Crossing Traffic Effect Analysis at C and D Streets**		

1. Introduction

The purpose of this technical memorandum is to review the potential level of effect caused by the future blocking of East C Street and East D Street two times per day for the six minutes the Amtrak Coast Starlight train is stopped at the Tacoma Dome Station. Additionally, this memo is to identify alternate routes for detours and measures for identifying these routes to drivers. The analysis of the street network operation outside of this area is not part of the scope of this memorandum

The Point Defiance Bypass Project proposes to relocate the Tacoma Amtrak station to the Freighthouse Square Building on East 25th Street in the City of Tacoma. The Tacoma Dome Station will be served by Sound Transit, Pierce Transit, Intercity Transit and Amtrak upon completion of the Point Defiance Bypass Project. A parking structure is located across East 25th Street and two outdoor overflow parking lots are off East C Street and East D Street.

The Tacoma Dome is an indoor arena for sporting events, expos and concerts, and has a seating capacity of up to 23,000 depending on the type of event. Two of the main access points for the Tacoma Dome and its parking areas are located on East C Street and East D Street. The Tacoma Dome is roughly 1000 feet southeast of the proposed location of the Tacoma Dome Station.

Amtrak will operate two passenger services, the Cascades service and the Coast Starlight long distance train on the rail line that serves the Tacoma Dome Station. Additionally, Sound Transit operates one commuter service, Sounder service, which currently serves the Tacoma Dome Station. All three services are scheduled to stop at the station for up to six minutes to allow passengers to disembark or board the trains. The Cascades and Sounder trains are typically about 700 feet long or less, which is shorter than the length of the station and its platform. The Cascades and Sounder trains do not block East C Street and East D Street while in the station. The operational intent is that the gates on East D Street will remain up while the Cascades and Sounder trains are stopped in the station. The Coast Starlight train is 1235 feet long, which is longer than the station and its platform. While stopped at the station, the Coast Starlight will extend out of the station and across East C Street and East D Street. This means that surface traffic will be affected during the time the Coast Starlight is at the station. Infrequently, the Coast Starlight stop may coincide with an event at the Tacoma Dome. **Table 1** shows the proposed Coast Starlight train schedule. These times are outside of the typical weekday peak hours, 5:00AM to 6:00AM and 5:00PM to 6:00PM, for these streets.

Table 1: Coast Starlight Tacoma Dome Station Schedule

Train	Arrive	Depart
Southbound	10:25 AM	10:31 AM
Northbound	7:05 PM	7:11 PM

2. Study Scope

The length of the Coast Starlight causes it to block East C Street and East D Street at the roadway grade crossing for six minutes while it is stopped at the station. Infrequently, the two times per day these two trains blocking the streets can coincide with events at the Tacoma Dome. This traffic study identifies the possible effect this has on this short-term increase in vehicle and pedestrian traffic on East C Street and East D Street during a Coast Starlight stop. This event is the worst-case scenario in which the maximum anticipated surface traffic will coincide with a blockage of East C and East D Streets. Minimization measures will be provided if the Coast Starlight dwell times degrade the Level of Service (LOS) on East C and D Streets to an unacceptable LOS (LOS E or F).

The scope of this study is to analyze the effect of this localized, short-term static event on traffic using East C Street and East D Street during increased traffic before Tacoma Dome events. The analysis results being used to show this effect are the change in average vehicle delay in seconds and the length of the queue in feet that develops during this six minute period. No operational analyses looking at optimizing signal timing, signal coordination and/or intersections beyond the four identified are part of this study. More detailed analysis will occur during the design of the actual improvements. This study is to identify the magnitude of this effect and identify potential minimizations for this effect.

Temporary street blockages of the projects crossings due to a moving train event, were already analyzed as part of the Traffic and Transportation Discipline Report, presented as Appendix E of the Point Defiance Bypass Project Environmental Assessment (FRA, 2013).

3. Data Collection

The City of Tacoma provided an event schedule for upcoming Tacoma Dome events. Manual turning movement and pedestrian counts were collected for two hours prior to the starting of several events over the January 4th 2013 weekend. A list of events, schedule and time periods selected for data collection are shown in **Table 2**. The Advanced Auto Parts Monster Jam monster truck event is typical of the bigger events that occur at the Tacoma Dome. All of the monster truck events were very well attended. Additionally, another all-day event was occurring on the same Saturday and Sunday making these days good worst case examples. Most of the Tacoma dome events are on weekends. During February and March 2013 there are 9 events on 15 days, all on a Friday, Saturday and/or Sunday.

Table 2: Tacoma Dome Event and Data Collection Schedule

Date	Event	Starting Time	Data Collection Period
Friday, January 4th	Advanced Auto Parts Monster Jam	7:30 PM	5:30 PM – 7:30 PM
Saturday, January 5th	Tacoma Wedding Expo	9:30 AM	Not selected – Ongoing event
Saturday, January 5th	Advanced Auto Parts Monster Jam	2:00 PM	12:00 PM – 2:00 PM
Saturday, January 5th	Advanced Auto Parts Monster Jam	7:30 PM	5:30 PM – 7:30 PM
Sunday, January 6th	Tacoma Wedding Expo	10:30 AM	Not selected – Ongoing event
Sunday, January 6th	Advanced Auto Parts Monster Jam	1:00 PM	11:00 AM – 1:00 PM

Machine tube counters were set up mid-blocks to collect 24-hour traffic counts, recorded in 15 minute intervals, for the entire days on Friday, January 4th; Saturday, January 5th; and Sunday, January 6th. **Figure 1** shows the study area and the various count locations, including machine counts in mid-blocks, manual turning movement counts at the intersections, and pedestrian counts near the railroad crossings. Printouts of all traffic counts are included in the **Appendix A**.

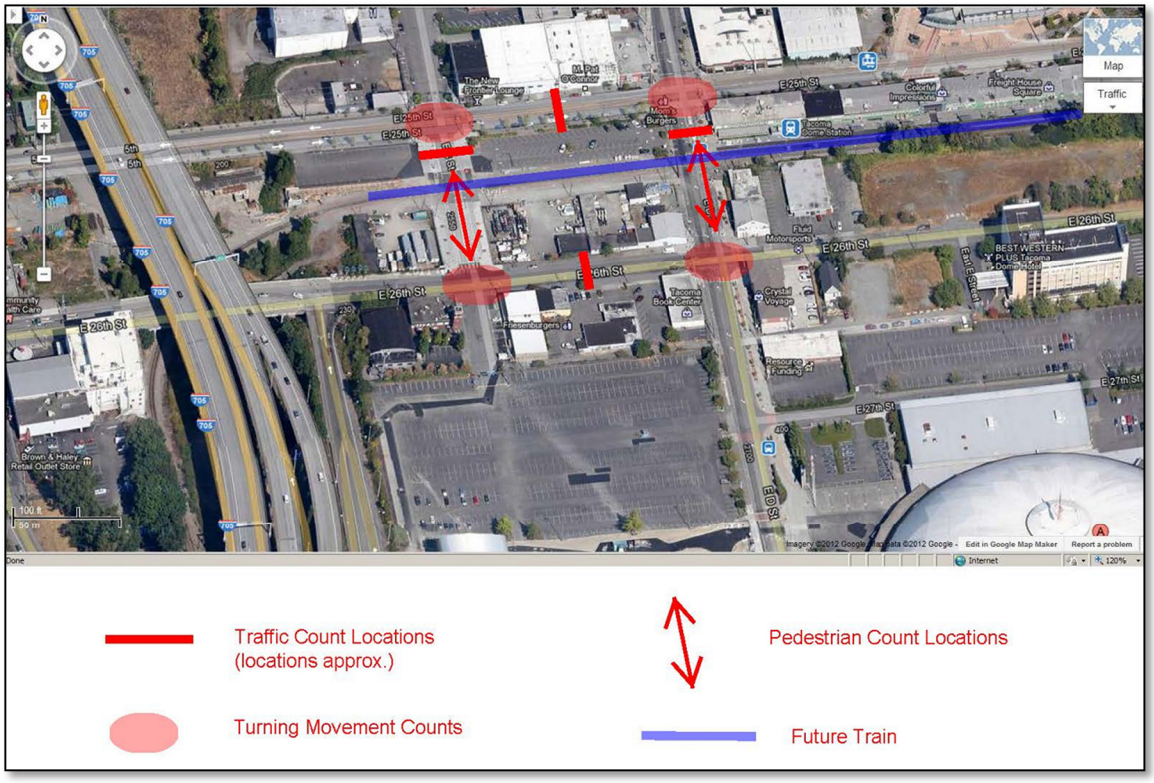

Figure 1: Study Area and Data Collection Map

4. Vehicle and Pedestrian Analysis Methodology

The capacity analysis was performed using the methodology outlined in the Highway Capacity Manual 2000 (HCM 2000). In particular, vehicular Level of Service (LOS) was the primary measure of effectiveness used to identify intersection operation. LOS refers to the degree of congestion on a roadway or at an intersection, measured in average vehicle delay. LOS A represents free flow conditions (motorists experience little or no delay and traffic levels are well below roadway capacity). LOS F represents force-flow conditions (motorists experience very long delays and traffic levels exceed roadway capacity). In other words, when demand volumes exceed the capacity of the lane, extreme delays occur. Queuing may cause severe congestion, affecting multiple movements through the intersection. LOS A represents better operating conditions than LOS F.

The vehicle delay calculated by HCM 2000 for unsignalized intersections is determined for each minor or controlled movement at an individual intersection. **Table 3** shows the LOS criteria for unsignalized intersections. For signalized intersections, the average delay per vehicle calculated by HCM 2000 is estimated for each lane group and aggregated for each approach and for the intersection as a whole. **Table 4** shows the LOS criteria for signalized intersections.

For pedestrians HCM uses pedestrian space as the primary measure of effectiveness, with mean speed and flow rates as secondary measures. **Table 5** shows the LOS criteria for pedestrians.

Table 3: Vehicle Level of Service Criteria for Unsignalized Intersections

Control Delay (d) (seconds/vehicle) [1]	Level of Service
$d \leq 10$	A
$10 < d \leq 15$	B
$15 < d \leq 25$	C
$25 < d \leq 35$	D
$35 < d \leq 50$	E
$d > 50$	F

1. Delay is usually measured in seconds per vehicle on average.

Table 4: Vehicle Level of Service Criteria for Signalized Intersections

Control Delay (d) (seconds/vehicle) [1]	Level of Service
$d \leq 10$	A
$10 < d \leq 20$	B
$20 < d \leq 35$	C
$35 < d \leq 55$	D
$55 < d \leq 80$	E
$d > 80$	F

1. Delay is usually measured in seconds per vehicle on average.

Table 5: Recommended HCM Walkway Level of Service (LOS) Criteria

LOS	Space (ft^2/ped)	Flow Rate (ped/min/ft)	Average Speed (ft/min)
A	>60	<5	>255
B	40 – 60	5 – 7	250 – 255
C	24 – 40	7 – 10	240 – 255
D	15 – 24	10 – 15	225 – 240
E	15 – 8	15 – 23	150 – 225
F	<8	>23	<150

Since this was a localized, macroscopic event, the traffic analysis software program Synchro/SimTraffic (version 7.0) was selected to analyze the street network and intersections in the study area. Synchro is a macroscopic modeling program that uses the methodology in the HCM 2000.

5. Analyses and Effect Review

The following two scenarios were analyzed in this study.

- Existing scenario - before Tacoma Dome event without Coast Starlight train blocking the East C Street and East D Street
- With train scenario – before Tacoma Dome event with Coast Starlight train blocking the East C Street and East D Street for six minutes

Pedestrian and vehicle counts collected two hours prior to the event capturing event pedestrian and vehicle traffic in the study area. The highest 15-minute volumes were used in the analyses for each event observed. This study evaluates how the intersections performed prior to the Tacoma Dome events when there is no train blockage involved, which considers the existing scenario. The result is then used as a base to compare to the blocking scenario of East C Street and East D Street for six minutes. The differences are the indications of the potential effect from the Amtrak Coast Starlight train.

The following four intersections are identified as the study intersections based on their close proximity to the Tacoma Dome Station and Tacoma Dome.

1. East C Street & East 25th Street (Signal control)
2. East D Street & East 25th Street (Signal control)
3. East C Street & East 26th Street (Two-way stop control)
4. East D Street & East 26th Street (Signal control)

Signal timing for the signalized intersections were provided by City of Tacoma and are included in **Appendix B**. The volumes used in the Synchro/SimTraffic model were manually balanced before simulating the intersections and rail-crossing operations before the Tacoma Dome events. The balancing process employed the higher values of the unbalanced counts and these higher values were then used to account for a more conservative effect caused by the train on an event day. The following four weekend events were observed and analyzed. During these events the highest hourly volume before an event was as high or higher than the PM peak hour. This analysis assumes that driver behavior will allow these four intersections to continue to function. Since these are two lane streets, there is a possibility that an

improperly formed queue near the intersections, right-turn vehicles not staying close to the curb and/or left-turn vehicles not staying close to the centerline, could block the lane they are in. If this occurs the longest delay will be more than six minutes.

1. Friday PM event
2. Saturday Midday event
3. Saturday PM event
4. Sunday Midday event

The results from the Synchro/SimTraffic analyses are shown in **Table 6** and **Table 7**. The numbers recorded in **Table 6** represent the total delay per vehicle at each intersection. An average of 5 simulation runs was done to derive these results. Both the existing scenario and the with train scenario use exactly the same variables, except for the train blockage. In other words, a simple comparison between the two only yields the effect from the train blockage. The Synchro/SimTraffic reports for the existing scenario and the with train scenario are included in **Appendix C**.

Table 6: Levels of Services of the Study Intersections for Highest 15 Minute Period Before an Event Starting Without Detour

Event	Intersection	Delay/Veh[2] (LOS)[4]		Delay/Veh Difference (sec)
		Existing W/O Train – C&D Open	With Train – C&D Blocked	
Friday PM Event	East C Street & East 25th Street	8.0 (A)	136.4 (F)	128.4
	East D Street & East 25th Street	8.8 (A)	108.2 (F)	99.4
	East C Street & East 26th Street[1,3]	38.1 (E)	82.5 (F)	44.4
	East D Street & East 26th Street	12.8 (B)	47.5 (D)	34.7
Saturday Midday Event	East C Street & East 25th Street	7.9 (A)	175.5 (F)	167.6
	East D Street & East 25th Street	9.3 (A)	98.9 (F)	89.6
	East C Street & East 26th Street[1,3]	26.0 (D)	76.5 (F)	50.5
	East D Street & East 26th Street	15.4 (B)	99.3 (F)	83.9
Saturday PM Event	East C Street & East 25th Street	6.9 (A)	108.1 (F)	101.2
	East D Street & East 25th Street	7.1 (A)	45.0 (D)	37.9
	East C Street & East 26th Street[1,3]	28.1 (D)	92.8 (F)	64.7
	East D Street & East 26th Street	9.7 (A)	30.8 (C)	21.1
Sunday Midday Event	East C Street & East 25th Street	7.4 (A)	59.0 (E)	51.6
	East D Street & East 25th Street	9.0 (A)	56.7 (E)	47.7
	East C Street & East 26th Street[1,3]	16.6 (C)	126.0 (F)	109.4
	East D Street & East 26th Street	15.1 (B)	35.0 (C)	19.9

Notes:
1. Two-way stop controlled intersection.

2. Delay, measured in seconds per vehicle, is a measure of all the delay contributable to traffic control measures, such as traffic signals or stop signs. At signalized intersections and all-way stop controlled intersections, the delay reported is the average of all the delay experienced for all the movements. At one-way or two-way stop controlled intersections, the reported delay is for only one movement: the movement experiencing the worst delay, which is typically one of the stop controlled side street approaches.
3. Delay reported at two-way stop controlled intersections is not a valid indication of the operations at the entire intersection.
4. LOS is the level of service, a concept based on the 2000 *Highway Capacity Manual* for unsignalized and signalized intersections.

The results of the analysis for vehicles indicated that all four study intersections are operating under an acceptable LOS of D or better before the existing events, except for the SB through movement at East C Street and East 26th Street before the Friday PM event. When a train blocks the streets for six minutes, the overall intersection level of service will decline by a minimum of two LOS levels at most study locations. The effect from the train could be as high as an average of 167.6 seconds (under 3 minutes) per vehicle at the intersection of East C Street and East 25th Street before a Saturday midday event, or as low as average of 19.9 seconds per vehicle at the intersection of East D Street and East 26th Street before a Sunday midday event. The total number of vehicles delayed during a Coast Starlight event dwelling at the Tacoma Dome Station is approximately 116 vehicles at East C Street/East 25th Street and approximately 109 vehicles at East D Street/East 25th Street if no detour or other minimization measure was provided. On East 26th Street at the intersections with East C Street and East D Street the total vehicles delayed would be 40 and 168 respectively.

Queue length is also a good indication of the effect on intersection performance. The 95th-percentile queue is defined to be the queue length (in vehicles) that has only a 5-percent probability of being exceeded during the analysis time period. It is a useful parameter for representing the worst condition, but it is not typical of what an average driver would experience. The 95th-percentile queue lengths computed by the Synchro/SimTraffic results are shown in **Table 7**.

Table 7: 95th-Percentile Queue Lengths of the Study Intersections (in feet) for Highest 15 Minute Period Before an Event Starting Without Detour

Event	Intersection	Existing				With Train			
		EB	WB	NB	SB	EB	WB	NB	SB
Friday PM Event	East C Street & East 25th Street	83	99	66	93	550	385	105	747
	East D Street & East 25th Street	98	124	81	111	197	885	161	720
	East C Street & East 26th Street	42	41	62	141	335	46	109	190
	East D Street & East 26th Street	218	117	114	162	363	568	429	201
	East C Street Railroad Crossing	-	-	0	57	-	-	143	134
	East D Street Railroad Crossing	-	-	0	47	-	-	218	147
Saturday Midday Event	East C Street & East 25th Street	109	97	82	98	999	375	114	837
	East D Street & East 25th Street	133	89	122	107	308	944	166	566
	East C Street & East 26th Street	46	30	75	148	194	67	141	194
	East D Street & East 26th Street	276	91	249	164	372	507	1600	208
	East C Street Railroad Crossing	-	-	7	40	-	-	160	128

	East D Street Railroad Crossing	-	-	76	50	-	-	214	152
Saturday PM Event	East C Street & East 25th Street	103	81	58	86	562	281	72	674
	East D Street & East 25th Street	90	77	90	89	203	254	134	556
	East C Street & East 26th Street	44	22	34	144	35	30	34	196
	East D Street & East 26th Street	130	96	109	143	204	305	428	181
	East C Street Railroad Crossing	-	-	0	64	-	-	116	121
	East D Street Railroad Crossing	-	-	16	33	-	-	203	147
Sunday Midday Event	East C Street & East 25th Street	115	86	80	84	518	216	123	399
	East D Street & East 25th Street	138	86	99	99	371	345	131	475
	East C Street & East 26th Street	53	27	45	105	464	101	106	175
	East D Street & East 26th Street	219	104	158	160	314	233	529	220
	East C Street Railroad Crossing	-	-	0	0	-	-	175	133
	East D Street Railroad Crossing	-	-	22	35	-	-	196	157

The 95th-percentile queue lengths of the existing scenario are shorter than the streets can accommodate. The queue length does not spill back to the upstream intersection on any approaches of the study intersections. However, when a train blocks the streets for six minutes, the queue length could be as high as 1600 feet on northbound of East D Street and East 26th Street before a Saturday midday event. It is estimated that it will take 7 to 9 minutes after the train leaves the station before the traffic signals return to normal function. Vehicles on southbound East C Street and East D Street tend to back up beyond Puyallup Avenue for all events analyzed, which without minimization measures could break down other intersections.

The diagrams showing the 95th-percentile queue lengths are included in **Appendix D**. The blue lines represent the 95th-percentile queue lengths of the existing scenario, and the orange lines represent the blocking scenario.

No analysis was completed for pedestrians because if the Flow Rate and Average Speed is zero, then the LOS is F. Also, as additional pedestrians arrive at East D Street the LOS is F based on Space criteria. In a developing pedestrian queue the HCM assumes 2 sq. ft. for each pedestrian. There is adequate sidewalk to store these pedestrians. Pedestrians are arriving the railroad crossing at a continuous flow rate, the ones who arrive right after the train arrives will have to wait for six minutes. The next ones to arrive will wait less than six minutes depending on when they reach the crossing. Assuming a fraction of the pedestrians recorded on East C Street and East D Street between 7:00 pm and 7:15 pm during the data collection were blocked by a train for 6 minutes, the total numbers of pedestrian affected by train blockage are identified in **Table 8**.

Table 8: Numbers of Pedestrian Affected by 6-Minute Train Blockage

Event	East C Street		East D Street	
	No. of Pedestrian	LOS	No. of Pedestrian	LOS
Friday PM Event	13	F	52	F
Saturday PM Event	17	F	146	F

6. Minimizations

Based on all the aspects analyzed above, the effect from the train blockage would degrade the intersection vehicle LOS from an acceptable level to unacceptable (below LOS D) in most locations. It would cause queues that exceed 300 feet backing up to the upstream intersections.

The pedestrian LOS is F at both East C Street and East D Street. The LOS is based on a pedestrian's ability to continue along their route and total number of pedestrians delayed. It is not reasonable to direct pedestrians to use designated detour routes as it will take them longer than six minutes along any available detour routes. There are not any reasonably feasible improvements that would assist the pedestrians in getting past the stopped train.

To minimize the vehicle effects, this study evaluated the option of detour routes during the train blockage period. **Figure 2** shows the existing routes and the proposed detour routes. The proposed detour routes advise traffic turning off East 25th Street earlier to avoid using East C Street and East D Street.

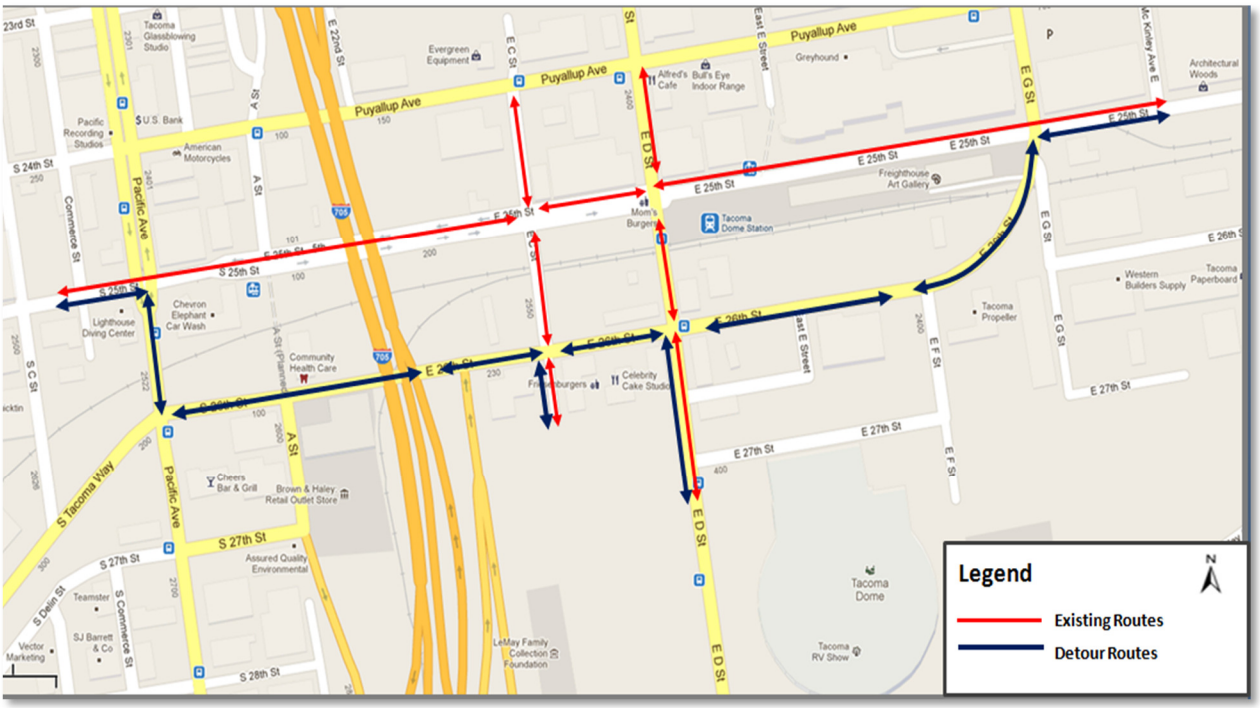

Figure 2: Existing Routes and Proposed Detour Routes

The results of detour routes from the Synchro/SimTraffic analyses are shown in **Table 9** and **Table 10**. With the detour plan in place, all intersections will operate at LOS D or better as shown in **Table 9**. The Synchro/SimTraffic reports for detour route analyses are included in **Appendix E**. This scenario assumes 100% of the vehicles on East 25th Street and East 26th Street either take the Pacific Avenue or G Street detours or continue through the East C Street and East D Street intersections to take the opposite detour.

Table 9: Levels of Services of the Study Intersections for Highest 15 Minute Period Before an Event Starting

Event	Intersection	Delay/Veh[2] (LOS)[3]	
		Existing W/O Train – C&D Open	With Train – C&D Blocked w/Detour[4]
Friday PM Event	East C Street & East 25th Street	8.0 (A)	8.0 (A)
	East D Street & East 25th Street	8.8 (A)	8.8 (A)
	East C Street & East 26th Street[1]	38.1 (E)	38.1 (E)
	East D Street & East 26th Street	12.8 (B)	12.8 (B)
Saturday Midday Event	East C Street & East 25th Street	7.9 (A)	8.1 (A)
	East D Street & East 25th Street	9.3 (A)	9.9 (A)
	East C Street & East 26th Street[1]	26.0 (D)	26.0 (D)
	East D Street & East 26th Street	15.4 (B)	15.4 (B)
Saturday PM Event	East C Street & East 25th Street	6.9 (A)	6.9 (A)
	East D Street & East 25th Street	7.1 (A)	7.9 (A)
	East C Street & East 26th Street[1]	28.1 (D)	28.1 (D)
	East D Street & East 26th Street	9.7 (A)	9.7 (A)
Sunday Midday Event	East C Street & East 25th Street	7.4 (A)	7.4 (A)
	East D Street & East 25th Street	9.0 (A)	9.3 (A)
	East C Street & East 26th Street[1]	16.6 (C)	16.6 (C)
	East D Street & East 26th Street	15.1 (B)	16.4 (B)

Notes:

1. Two-way stop controlled intersection.
2. Delay, measured in seconds per vehicle, is a measure of all the delay contributable to traffic control measures, such as traffic signals or stop signs. At signalized intersections and all-way stop controlled intersections, the delay reported is the average of all the delay experienced for all the movements. At one-way or two-way stop controlled intersections, the reported delay is for only one movement: the movement experiencing the worst delay, which is typically one of the stop controlled side street approaches. The delay reported at two-way stop controlled intersections is not a valid indication of the operations at the entire intersection.
3. LOS is the level of service, a concept based on the 2000 *Highway Capacity Manual* for unsignalized and signalized intersections.
4. This scenario is best case assuming all of the traffic on 25th St and 26th St going to the Tacoma Dome either take the detour or continue straight with the queue not blocking the lanes.

The 95th-percentile queue lengths computed by the Synchro/SimTraffic results are shown in **Table 10.** When the detour routes are in place, the queue length could be similar to the existing condition or better in some cases, even with the train blockage of six minutes. Vehicles on southbound East C Street and East D Street will no longer back up beyond Puyallup Avenue for all events analyzed.

The cause of the additional delays and LOS failure of the intersections on East C Street and East D Street is due to the inability for vehicles to move towards the intersections while the queues exist. No count data was collected along the detour, i.e. Pacific Avenue at East 26th Street and East G Street and East 25th Street. These intersections were reviewed by evaluating how much traffic was diverted to these streets. None of these volumes were significant enough to change the LOS at these intersections.

Table 10: 95th-Percentile Queue Lengths of the Study Intersections with Detour Route (in feet)

Event	Intersection	Existing				Detour			
		EB	WB	NB	SB	EB	WB	NB	SB
Friday PM Event	East C Street & East 25th Street	83	99	66	93	88	91	66	102
	East D Street & East 25th Street	98	124	81	111	92	107	83	86
	East C Street & East 26th Street	42	41	62	141	38	40	55	130
	East D Street & East 26th Street	218	117	114	162	195	152	118	151
	East C Street Railroad Crossing	-	-	0	57	-	-	33	37
	East D Street Railroad Crossing	-	-	0	47	-	-	45	50
Saturday Midday Event	East C Street & East 25th Street	109	97	82	98	131	119	78	77
	East D Street & East 25th Street	133	89	122	107	147	107	90	99
	East C Street & East 26th Street	46	30	75	148	43	46	68	133
	East D Street & East 26th Street	276	91	249	164	265	104	188	125
	East C Street Railroad Crossing	-	-	7	40	-	-	85	80
	East D Street Railroad Crossing	-	-	76	50	-	-	0	0
Saturday PM Event	East C Street & East 25th Street	103	81	58	86	104	89	59	94
	East D Street & East 25th Street	90	77	90	89	97	90	85	121
	East C Street & East 26th Street	44	22	34	144	25	36	48	157
	East D Street & East 26th Street	130	96	109	143	120	102	114	110
	East C Street Railroad Crossing	-	-	0	64	-	-	29	61
	East D Street Railroad Crossing	-	-	16	33	-	-	0	0
Sunday Midday Event	East C Street & East 25th Street	115	86	80	84	133	74	91	75
	East D Street & East 25th Street	138	86	99	99	152	91	82	107
	East C Street & East 26th Street	53	27	45	105	60	31	46	101
	East D Street & East 26th Street	219	104	158	160	235	153	177	126
	East C Street Railroad Crossing	-	-	0	0	-	-	54	43
	East D Street Railroad Crossing	-	-	22	35	-	-	0	0

7. Conclusion

Since no reasonably feasible improvements can be provided for pedestrians, informational signage is recommended to minimize the effect from blockage of their path by the Amtrak Coast Starlight train. The information on the signs will provide info on what is occurring and how long their wait will be.

A detour plan is recommended to minimize the effect on vehicle traffic for when the start or finish of a Tacoma Dome event coincides with the Amtrak Coast Starlight train schedule. Two recommended measures for providing a detour for Tacoma Dome traffic during a Coast Starlight event include:

1. Static signs identifying the detour routes.
2. Dynamic message signs that only identify the detour routes during a train blockage.

The detour routes identified in **Figure 2** are Pacific Avenue at East 25th Street to East 26th Street and East G Street at East 25th Street to East 26th Street. Static signs placed on East 25th Street would direct vehicle traffic down Pacific Avenue and East G Street. The one issue with static signs is drivers don't know if they need to detour until they see a train is blocking East C Street and East D Street. The vehicles on East 25th Street heading towards East G Street will likely detour then for every train since they will be unable to determine whether the streets ahead of the are blocked. The vehicles on East 25th Street heading towards Pacific Avenue will not know whether they need to detour or not because of not being able to see the trains.

Flashing blankout signs on East 25th Street and East 26th Street before Pacific Avenue and East G Street that only come on when East C Street and East D Street are blocked would eliminate driver confusion. A message such as "TRAIN EVENT – DETOUR LEFT (or RIGHT)" would prepare drivers to detour before they reach the beginning of the detour. These signs can run through a controller connected to the railroad signaling equipment so that they could potentially be used for all northbound trains and the Coast Starlight trains and operate similar to a preemption event.

Upon review of the data and the subsequent analysis our opinion is that the blankout signs will be the best solution to minimize the effect of train blockage of East C Street and East D Street. Connecting these signs to the railroad signaling equipment will allow them to come on shortly before the streets are blocked to give all vehicles the opportunity to take the detour.