VISION THAT MOVES YOUR COMMUNITY

TECHNICAL MEMORANDUM

Date: February 5, 2021

To: Jodi Ketelsen
TY Lin International
Email: jodi.ketelsen@tylin.com

Project No.: 117-121

From: Phong Vo
Project Manager

Praveena Samaleti
Project Engineer

Jurisdiction: Sonoma County, California

Subject: ***Traffic Management Technical Memorandum for Todd Road and Standish Avenue intersection Realignment in Sonoma County, CA***

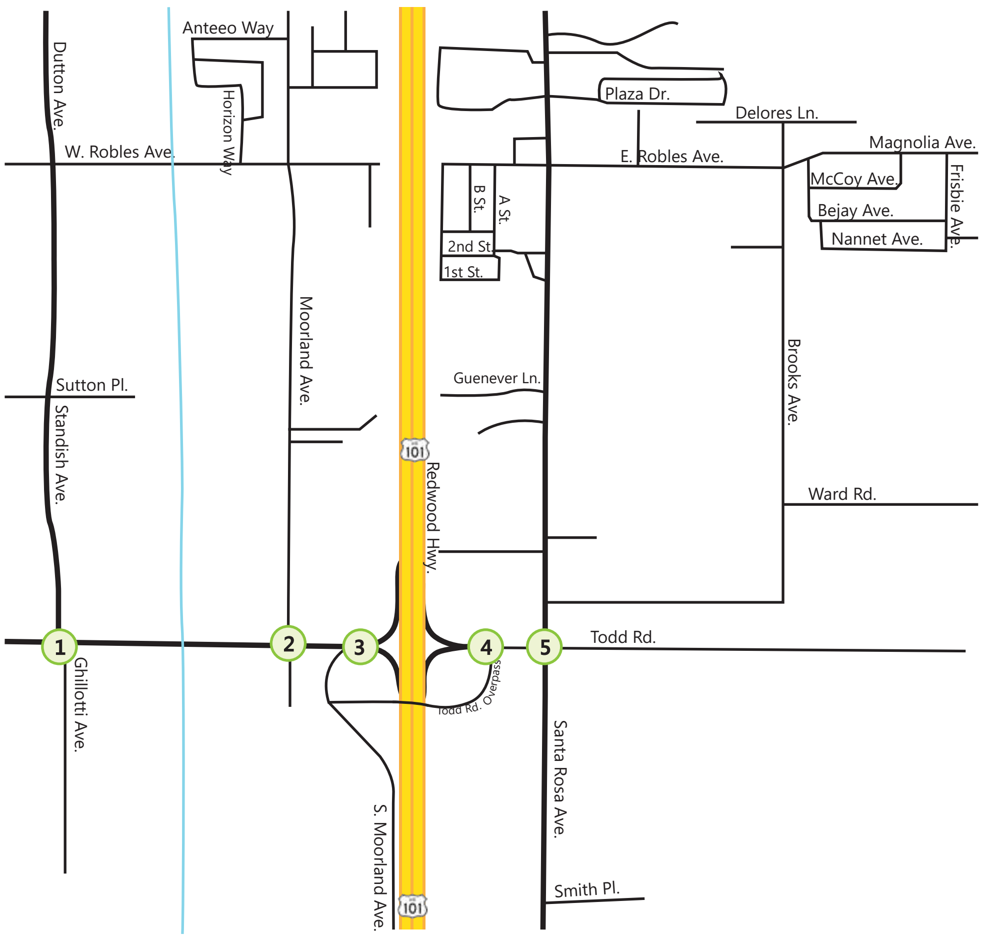
Introduction

The purpose of this memorandum is to evaluate potential traffic impacts and provide congestion relief during construction of the proposed Todd Road Realignment Project located at the intersection of Todd Road and Standish Avenue in Sonoma County, California. The proposed project consists of converting an existing 3-leg, stop-controlled intersection, at Todd Road and Standish Avenue into a 4-leg, signalized intersection, incorporating the private driveway at Ghilotti Avenue.

Project Description

The Sonoma County Transportation Authority (SCTA) proposes to realign the 3-leg, stop-controlled intersection of Todd Road and Standish Avenue with the private driveway of Ghilotti Avenue to form a 4-leg signalized intersection to improve traffic operations at Todd Road and Standish Avenue. In 2018, W-Trans prepared a traffic impact study for the Ghilotti Construction Yard for the County of Sonoma. From this study, potential traffic impacts associated with development of a construction yard at 304 Todd Road were identified at the intersection of Todd Road/Standish Avenue-Ghilotti Avenue. Based on the recommendations that were listed in report, the county is planning to install traffic signal at Todd Road/Standish Avenue-Ghilotti Avenue to achieve acceptable operations. The purpose of this memorandum is to present traffic evaluation and transportation management during the construction phase in 2021.TJKM conducted a Level of Service Analysis at the study intersections for the year of 2021 during a.m., and p.m. peak hours. Traffic analysis to identify impacts due to construction and improvements to mitigate the impacts was conducted. **Figure 1** shows the vicinity map.

Figure 1: Vicinity Map



LEGEND

X Study Intersection

TJKM

STUDY INTERSECTIONS

TJKM evaluated traffic conditions at 5 study intersections during the weekday a.m., and p.m. peak hours. The peak periods evaluated were between 7:00-9:00 a.m., and 4:00-6:00 p.m. The study intersections and associated traffic controls are as follows:

1. Todd Road/Standish Avenue-Ghilotti Avenue (Two-Way Stop)
2. Todd Road/Moorland Avenue (One-Way Stop)
3. Todd Road/US 101 South Ramps (Signal)
4. Todd Road/US 101 North Ramps (Signal)
5. Todd Road/ Santa Rosa Avenue (Signal)

PEAK HOUR TRAFFIC VOLUMES

The study intersections were evaluated for the highest one-hour volumes during weekday morning and evening peak periods. The intersection turning movement counts from "Final Traffic Impact Study for the Ghilotti Construction Yard, March 7, 2018" document prepared by W-Trans were used to project 2021 volumes by applying one percent growth per year to existing 2017 volumes during a.m., and p.m. peak hours. Annual growth rate at the study intersections was calculated from 2017 volumes and 2040 volumes from W-Trans study. **Figure 2** illustrates the projected Year 2021 weekday a.m., and p.m. peak hour vehicle turning movement volumes at the study intersections.

LEVEL OF SERVICE ANALYSIS METHODOLOGY

LOS in this study describes the motor vehicle operating conditions for unsignalized and signalized intersections. LOS is a qualitative index of the performance of an element of the transportation system. It is a rating scale running from A to F, with LOS A indicating no congestion, and LOS F indicating unacceptable congestion and delays. The Highway Capacity Manual (HCM) is the standard reference published by the Transportation Research Board, and contains the specific criteria and methods to be used in assessing LOS. Synchro software was used to calculate the LOS at the study intersections. The study intersections with stop signs on side-street approaches were analyzed using the "Two-Way Stop-Controlled Intersection" methodology from the HCM. **Tables 1** and **2** provide LOS definitions for both signalized and stop-controlled study intersections. Average stopped delay per vehicle in seconds is used as the basis for evaluation in this methodology.

Table 1: intersection Level of Service Definitions for Signalized Intersections

LOS	Description
A	Very low control delay, up to 10 seconds per vehicle. Progression is extremely favorable, and most vehicles arrive during the green phase. Many vehicles do not stop at all. Short cycle lengths may tend to contribute to low delay values.
B	Control delay greater than 10 and up to 20 seconds per vehicle. There is good progression or short cycle lengths or both. More vehicles stop causing higher levels of delay.
C	Control delay greater than 20 and up to 35 seconds per vehicle. Higher delays are caused by fair progression or longer cycle lengths or both. Individual cycle failures may begin to appear. Cycle failure occurs when a given green phase does not serve queued vehicles, and overflow occurs. The number of vehicles stopping is significant, though many still pass through the intersection without stopping.
D	Control delay greater than 35 and up to 55 seconds per vehicle. The influence of congestions becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle lengths, or high volumes. Many vehicles stop, the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.
E	Control delay greater than 55 and up to 80 seconds per vehicle. The limit of acceptable delay. High delays usually indicate poor progression, long cycle lengths, and high volumes. Individual cycle failures are frequent.
F	Control delay in excess of 80 seconds per vehicle. Unacceptable to most drivers. Oversaturation, arrival flow rates exceed the capacity of the intersection. Many individual cycle failures. Poor progression and long cycle lengths may also be contributing factors to higher delay.

Source: Highway Capacity Manual, 2000.

Table 2: Level of Service Definitions for Stop-controlled Intersections

LOS	Description
A	Very low control delay less than 10 seconds per vehicle for each movement subject to delay.
B	Low control delay greater than 10 and up to 15 seconds per vehicle for each movement subject to delay.
C	Acceptable control delay greater than 15 and up to 25 seconds per vehicle for each movement subject to delay.
D	Tolerable control delay greater than 25 and up to 35 seconds per vehicle for each movement subject to delay.
E	Limit of tolerable control delay greater than 35 and up to 50 seconds per vehicle for each movement subject to delay.
F	Unacceptable control delay in excess of 50 seconds per vehicle for each movement subject to delay.

Source: Highway Capacity Manual, 2000.

INTERSECTION LEVEL OF SERVICE ANALYSIS – YEAR 2021 CONDITIONS

Existing intersection lane configurations, signal timings, and 2021 turning movement volumes were used to calculate the level of service at the study intersections during each peak hour. The peak hour factor is used to account for variations in flow within the peak hour. The HCM 2000 recommends defaults of 0.92 for urban facilities, was used to all study intersections for the analysis. The results of the LOS analysis using the Synchro 10 software program for Year 2021 Conditions are summarized in **Table 3**. HCM Methodology was followed to analyze the study intersections that was discussed earlier.

Under this scenario, all of the study intersections operate at acceptable service levels (LOS D or better for SCTA's intersections) during both peak hours, except the intersection of Todd Road/Standish Avenue-Ghilotti Avenue (intersection#1), which operates at LOS F during a.m. peak hour and LOS E during p.m. peak hour. This results are consistent with the result presented in W-Trans report (Table 4, page 12). It should be noted that the proposed project proposes to install traffic signal at the intersection. With the installation of traffic signal, the intersection is projected to operate at acceptable LOS B during a.m., and p.m. peak hour (Ref: W-Trans report – Table 4, page 12). LOS worksheets are provided in **Appendix A**.

Table 3: Intersection Levels of Service – Year 2021 Conditions

#	Intersection	Control	Peak Hour[1]	Existing Conditions	
				Average Delay[2]	LOS[3]
1	Todd Road/Standish Avenue-Ghilotti Avenue	Two-Way Stop	AM	**78.1**	**F**
			PM	**35.0**	**E**
2	Todd Road/Moorland Avenue	One-Way Stop	AM	19.2	C
			PM	24.3	C
3	Todd Road/US 101 South Ramps	Signal	AM	41.6	D
			PM	38.5	D
4	Todd Road/US 101 North Ramps	Signal	AM	10.6	B
			PM	9.2	A
5	Todd Road/Santa Rosa Avenue	Signal	AM	19.7	B
			PM	27.7	C

Notes:

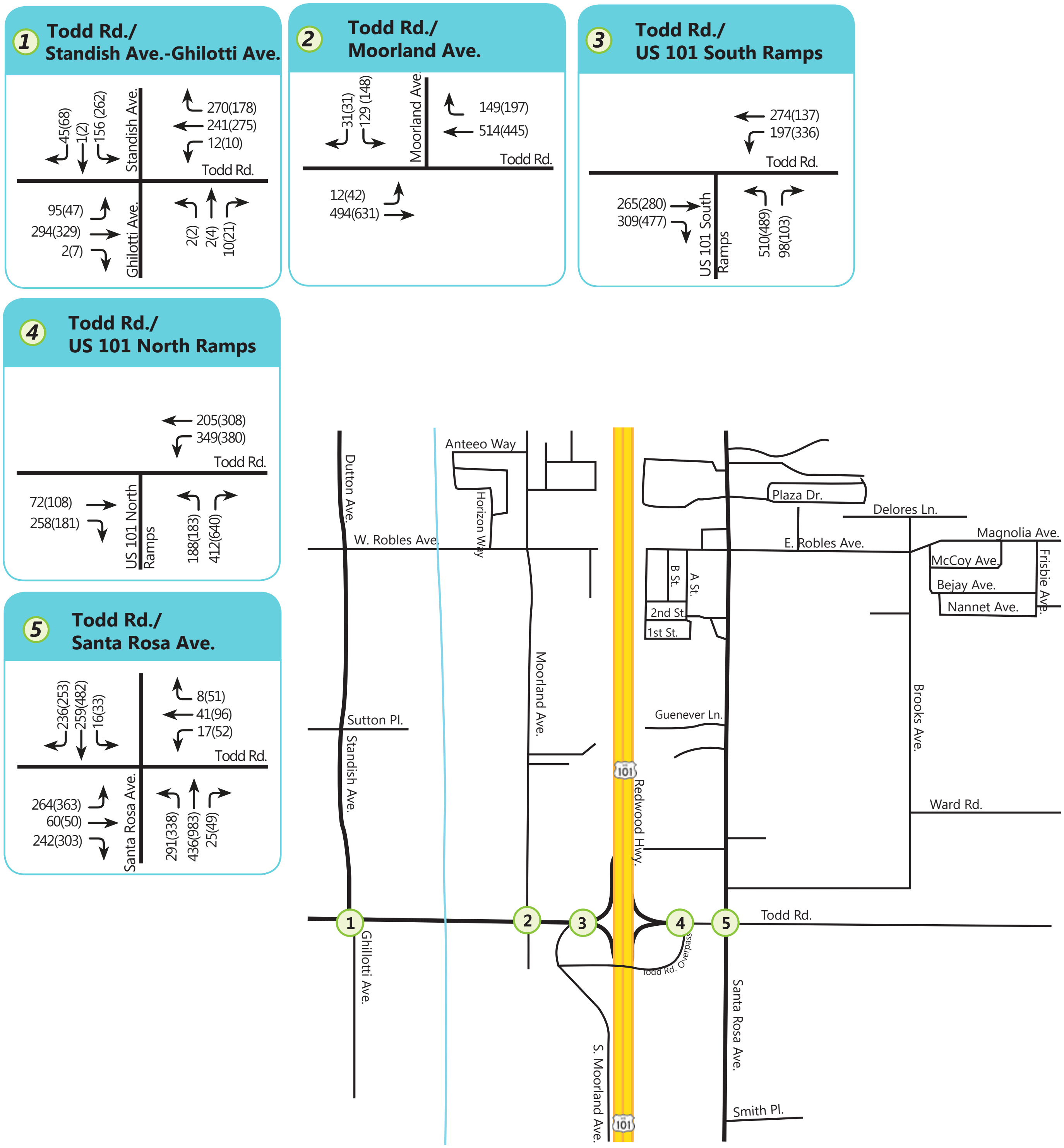
Bold indicates unacceptable LOS E or F.

[1] AM – Morning peak period; PM – Evening peak period

[2] Control delay for the worst movement is presented for side-street stop controlled intersections.

[3] LOS = Level of Service.

Figure 2: Year 2021 Peak Hour Traffic Volumes



LEGEND

X Study Intersection

XX Weekday AM Peak Hour Traffic Volumes

(XX) Weekday PM Peak Hour Traffic Volumes

TRANSPORTATION MANAGEMENT PLAN

In order to prevent unreasonable traffic delays resulting from planned construction work, Transportation Management Plans (TMPs) must be carefully developed and implemented to maintain current levels of service and safety during all work activities.

A Transportation Management Plan (TMP) is a specialized program tailored to prevent and mitigate the impacts of a construction project by applying a variety of techniques including Public Information and Construction Strategies. The major objectives of the TMP are to maintain efficient and safe movement of vehicles through the construction zone maintaining safety of the construction workers; and to provide intensive public awareness of potential impacts on Todd Road, local roadways, and US 101. The TMP proposes a program of public information. The public information program consist of media notification, telephone hotline, press release, and traveler information system (Internet).

Existing bus stop (Stop ID: 7766700) located east side of Todd Road/ Standish Avenue-Ghilotti Avenue intersection and bus stop would need to be temporarily relocated during construction. This would require an advanced coordination with SC Transit prior to construction regarding the temporary relocation, notification in advance of construction for transit riders, and the establishment of a temporary bus stop near the closed stop to reduce/minimize distance that passengers need to walk. The bus stop would be relocated during the entire construction duration given the work required in the immediate area to upgrade the sidewalk and the utility work as well as the shifting of travel lanes during construction.

CONSTRUCTION STAGING AND OPERATIONAL HOURS

The project is proposed to be constructed in five stages. The staging sequence has been developed in a way that impacts are minimized to the traffic. There are four legs to the Todd Road and Standish Road intersection, including the Ghilotti Avenue private road. As illustrated in the Conceptual Construction plan, traffic operations through the intersection would be maintained at all times with the assistance of flaggers as necessary to facilitate movements through narrowed lanes. Construction phasing for the project is identified in quadrants or one-half of each travel way and shift traffic onto the opposite side. The project is expected to require approximately 40 – 50 working days to complete the construction, dependent on variables such as weather and availability of materials needed. Due to heavy day-time traffic, contractor may be permitted to conduct night-time construction activities to reduce construction duration. Also, it should be noted that narrow lanes and lack of shoulders would reduce travel speeds and thus short-term minor delays are inevitable. Therefore some night work may provide an expediting of the construction work to reduce the duration of construction and thus reduce the inconvenience of construction. Advanced notification of construction would be provided to property owners via signage postings a minimum of 2 weeks in advance of starting construction. Construction would occur within a dry season (from late spring through early fall). The proposed construction staging is summarized in **Figure 3**.

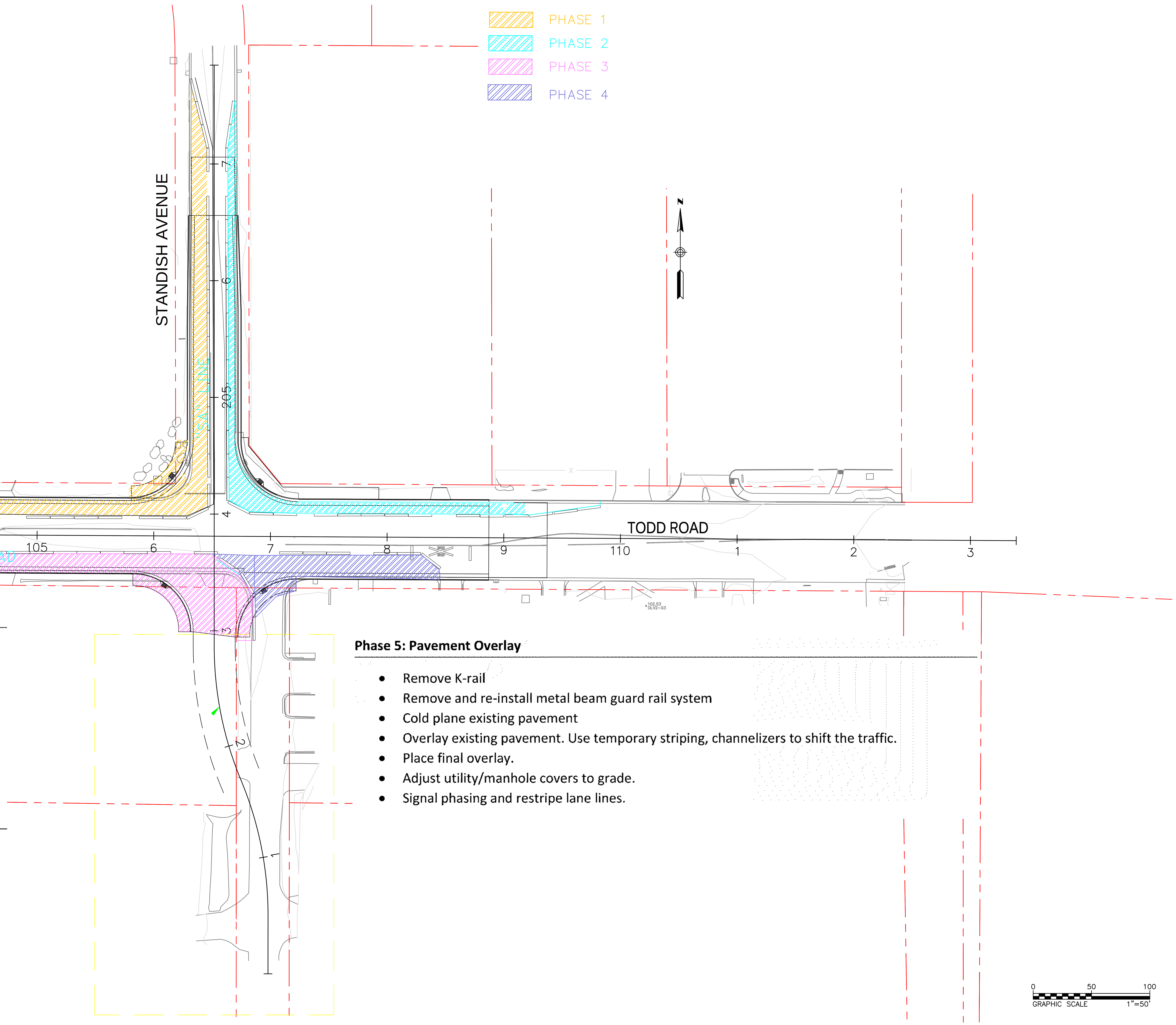
Figure 3: Construction Phasing Plan

Phase 1: NW Quadrant (Standish Avenue SB Direction & Todd Rd WB Direction)_

- Close the Standish Avenue SB lane between intersection and the first driveway. Shift SB traffic towards NB Lane. Re-stripe the lanes to provide atleast 2- 12 ft lanes.
- Close a portion of the WB lane along Todd RD between intersection and end of project limits.
- Provide access to any properties.
- Place K-rail.
- Sawcut and remove existing curb and gutter.
- Trench and excavate for the proposed storm drain. Install new storm drainpipe.
- Install the signal
- Construct proposed Curb and gutter, curb ramp to the finished grade.

Phase 2: NE Quadrant (Standish Avenue NB Direction & Todd Rd EB Direction)_

- Close the Standish Avenue NB lane between intersection and the first driveway. Shift NB traffic towards SB Lane. Re-stripe the lanes to provide atleast 2- 12 ft lanes.
- Close a portion of the WB lane along Todd RD between intersection and end of project limits.
- Provide access to any properties.
- Place K-rail.
- Sawcut and remove existing curb and gutter.
- Remove existing Catch basin at the curb return.
- Install the signal
- Construct proposed Curb and gutter, Sidewalk and curb ramp to the finished grade.



Phase 3: SW Quadrant (Todd Rd EB Direction)

- Close a portion of the Todd Rd EB lane between end of the project limits and existing Ghillotti Avenue
- Place K-rail.
- Sawcut and remove existing curb and gutter.
- Clean the existing Culverts, Regrade the ditch.
- Install the signal
- Construct proposed curb ramp, curb and gutter to the finished grade.

Phase 4: SE Quadrant (Todd Rd EB Direction)

- Close a portion of the Todd Rd EB lane between Ghillotte Avenue and end of project limits
- Place K-rail.
- Sawcut and remove existing curb and gutter.
- Install Signal
- Construct proposed curb ramp, curb and gutter to the finished grade.

Phase 5: Pavement Overlay

- Remove K-rail
- Remove and re-install metal beam guard rail system
- Cold plane existing pavement
- Overlay existing pavement. Use temporary striping, channelizers to shift the traffic.
- Place final overlay.
- Adjust utility/manhole covers to grade.
- Signal phasing and restripe lane lines.

DESIGN BY	XXX
DRAWING BY	XXX
CHECKED BY	XXX

REGISTERED CIVIL ENGINEER

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER No. Exp. CIVIL STATE OF CALIFORNIA

"RECORD DRAWING" INFORMATION TO BE COMPLETED AFTER CONSTRUCTION

CONSTRUCTION COMPLETED:

RESIDENT ENGINEER AS BUILT DRAWINGS BY:

DATE	REVISION	BY	APPROVED

TRANSPORTATION & PUBLIC WORKS Getting you there! SONOMA COUNTY

COUNTY OF SONOMA
DEPARTMENT OF TRANSPORTATION & PUBLIC WORKS
JOHANNES J. HOEVERTSZ, P.E., DIRECTOR

CONSTRUCTION PHASING

TASK ORDER #15 TODD ROAD AT STANDISH AVENUE

ROAD NUMBER	9999A
BUDGET NUMBER	C09999
FISCAL YEAR	20XX–XX
SHEET NUMBER	XX
TOTAL SHEETS	XX

Construction of the proposed project is to be undertaken in five stages summarized as follows:

Phase 1: Construction – Northwest Quadrant (Standish Avenue SB Direction & Todd Road WB Direction)

- Realign north leg (Standish Avenue) at Todd Road/Standish Avenue intersection.
- Construct new pavement sections and curb and gutter on west side of Standish Avenue.
- Construct new curb at northwest corner of Todd Road/Standish Avenue intersection.
- Construct new curb and gutter sections on north side of Todd Road on west leg of the Todd Road/Standish Avenue intersection.
- Install lighting and signal equipment needed at northwest corner of Todd Road/Standish Avenue intersection.

Phase 1: Traffic Management

- Close Standish Avenue southbound lane between the intersection and the first driveway. Shift the southbound traffic towards the northbound lane. Re-stripe the lanes to provide at least two 12ft lanes (one in each direction).
- Close a portion of westbound lane along Todd Road between the intersection and end of project limits.
- Place K-rail.
- Shift traffic to east side of Standish Avenue to allow realignment of the roadway for construction on west side of roadway. Provide one northbound lane and one southbound lane 12 feet wide. Close shoulder on the north side of Todd Road on the west leg of the Todd Road/Standish Avenue intersection to allow construction of curb and gutter.

Phase 2: Construction – Northeast Quadrant (Standish Avenue NB Direction & Todd Road EB Direction)

- Close Standish Avenue northbound lane between the intersection and the first driveway. Shift northbound traffic towards southbound lane. Re-stripe the lanes to provide at least two 12ft lanes.
- Existing bus stop (Stop ID: 7766700) located east side of Todd Road/ Standish Avenue-Ghilotti Avenue intersection and bus stop would need to be temporarily relocated during construction.
- Construct new curb and gutter and pavement sections on east side of Standish Avenue, as needed.
- Construct new curb at northeast corner of Todd Road/Standish Avenue intersection.

- Construct new curb and gutter sections on north side of Todd Road on east leg of the Todd Road/Standish Avenue intersection.
- Install lighting and signal equipment needed at northeast corner of Todd Road/Standish Avenue.

Phase 2: Traffic Management

- Shift traffic to west side on Standish Avenue to make room for any soil cement treatment work to be done on the east side. Provide one northbound lane and one southbound lane at 12 feet wide.
- Close a portion of the westbound lane along Todd Road between intersection and end of project limits.
- Place K-rail.
- Close shoulder on north side of Todd Road on the east leg of the Todd Road/Standish Avenue intersection.
- Pavement markings and striping to be done on Standish Avenue and Todd Road during off-peak hours with minimal traffic (i.e. night-time).
- Re-open Todd Road & Standish Avenue bus stop (Stop ID: 7766700). Close temporary bus stop on east side of Todd Road/ Standish Avenue-Ghilotti Avenue intersection.

Phase 3: Construction – Southwest Quadrant (Todd Road EB direction)

- Construct new pavement sections on the south leg, Ghilotti Avenue.
- Construct new curbs at southwest corner of Todd Road/Standish Avenue/Ghilotti Avenue intersection.
- Construct new curb and gutter sections on the south side of Todd Road as needed.
- Install lighting and signal equipment needed at southwest corners of Todd Road/Standish Avenue/Ghilotti Avenue intersection.

Phase 3: Traffic Management

- Close Ghilotti Avenue. Reroute traffic through Ghilotti Construction Lots on Todd Road and Ghilotti Avenue. Prohibit westbound left-turn and eastbound right-turn movements from Todd Road, and southbound through movement from Standish Avenue.
- Place K-rail.
- Close shoulder on south side of Todd Road for approximately 450 feet west of Ghilotti Avenue.

Phase 4: Construction – Southeast Quadrant (Todd Road EB direction)

- Construct new pavement sections at south leg, Ghilotti Avenue.
- Construct new curbs at southeast corner of Todd Road/Standish Avenue/Ghilotti Avenue intersection.
- Construct new curb and gutter sections on the south side of Todd Road as needed.
- Install lighting and signal equipment needed at southeast corners of Todd Road/Standish Avenue/Ghilotti Avenue intersection.

Phase 4: Traffic Management

- Close Ghilotti Avenue. Reroute traffic through Ghilotti Construction Lots on Todd Road and Ghilotti Avenue. Prohibit northbound traffic from Ghilotti Avenue.
- Place K-rail.
- Close shoulder on south side of Todd Road for approximately 100 feet east of Ghilotti Avenue.
- Pavement markings and striping to be done on Ghilotti Avenue during off-peak hours with minimal traffic (i.e. night-time).
- Install additional signal pole equipment and necessary signage as needed at Todd Road/Standish Avenue intersection.

Phase 5: Pavement Overlay

- Remove K-rail.
- Remove and re-install metal beam guard rail system.
- Cold plane existing pavement. Overlay existing payment. Use temporary striping, channelizers to shift the traffic.
- Place final overlay.
- Adjust utility/manhole covers to grade.
- Signal phasing and restripe lane lines.

Based on the staging plans, no-turn lanes or through lanes are proposed to be closed during the construction of the project. Operational hours for construction phasing is shown in **Table 4.**

Table 4: Construction Phasing and Operational Hours

Phasing	Description	Operational Hours
Phase 1	Northwest Quadrant (Standish Avenue SB Direction & Todd Road WB Direction)	Work Hours: Weekdays: **7:00 am – 7:00 pm** Evening Hours (Fri-Sat): **9:00 pm – 5:00 am** K-rail to change work area, with flagging one lane only: **9:00 pm – 2:00 am**
Phase 2	Northeast Quadrant (Standish Avenue NB Direction & Todd Road EB Direction)	
Phase 3	Southwest Quadrant (Todd Road EB Direction)	
Phase 4	Southeast Quadrant (Todd Road EB Direction)	
Phase 5	Pavement Overlay	

TRAFFIC IMPACTS DURING CONSTRUCTION

Since no lane closures are proposed on Todd Road and Standish Avenue throughout the construction as per the proposed staging plans, no major impacts to the traffic operations is projected during construction. However, narrow lanes and lack of shoulders will reduce vehicle travel speed and short-term minor delays are inevitable. Therefore, some night work may provide an expediting of the construction work to reduce the duration of construction time and thus reduce the inconvenience of construction.

Construction would not result in impacts associated with the Sonoma-Marin Area Rail Transit (SMART) crossing of Todd Road and vehicle delays. The crossing is located about 600 east of the project area and the train service is infrequent with 26 weekday trains (13 southbound and 13 northbound) over an approximate 17 hour time frame generally between the hours of 5AM and 10PM. There is at least 30 minutes between trains and more frequently closer to 60 minutes. The trains are relatively short in length, and long queues of traffic that would extend into the construction area are not anticipated because of distance between the crossing and the construction area, the length of trains and associated delays, and the frequency of the trains.

Also, there is an existing bus stop (Stop ID: 7766700) located east side of Todd Road/ Standish Avenue-Ghilotti Avenue intersection and bus stop would need to be temporarily relocated during construction. This will have a minimal impact to passengers during construction period. It is recommended that a public information program be developed and implemented upon approval from the County.

Appendix A – Level of Service Analysis Worksheets

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	95	294	2	12	241	270	2	2	10	156	1	45
Future Volume (Veh/h)	95	294	2	12	241	270	2	2	10	156	1	45
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	103	320	2	13	262	293	2	2	11	170	1	49
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	555			322			864	1108	321	972	962	408
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	555			322			864	1108	321	972	962	408
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	90			99			99	99	98	18	100	92
cM capacity (veh/h)	1015			1238			231	187	720	207	227	643

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	103	322	13	555	15	220
Volume Left	103	0	13	0	2	170
Volume Right	0	2	0	293	11	49
cSH	1015	1700	1238	1700	433	244
Volume to Capacity	0.10	0.19	0.01	0.33	0.03	0.90
Queue Length 95th (ft)	8	0	1	0	3	193
Control Delay (s)	8.9	0.0	7.9	0.0	13.6	78.1
Lane LOS	A		A		B	F
Approach Delay (s)	2.2		0.2		13.6	78.1
Approach LOS					B	F

Intersection Summary			
Average Delay	15.0		
Intersection Capacity Utilization	62.6%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	12	494	514	149	129	31
Future Volume (Veh/h)	12	494	514	149	129	31
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	13	537	559	162	140	34
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		TWLTL	TWLTL			
Median storage veh)		2	2			
Upstream signal (ft)			224			
pX, platoon unblocked	0.89				0.89	0.89
vC, conflicting volume	721				1203	640
vC1, stage 1 conf vol					640	
vC2, stage 2 conf vol					563	
vCu, unblocked vol	624				1166	533
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)					5.4	
tF (s)	2.2				3.5	3.3
p0 queue free %	98				66	93
cM capacity (veh/h)	851				413	486

Direction, Lane #	EB 1	EB 2	WB 1	SB 1
Volume Total	13	537	721	174
Volume Left	13	0	0	140
Volume Right	0	0	162	34
cSH	851	1700	1700	426
Volume to Capacity	0.02	0.32	0.42	0.41
Queue Length 95th (ft)	1	0	0	49
Control Delay (s)	9.3	0.0	0.0	19.2
Lane LOS	A			C
Approach Delay (s)	0.2		0.0	19.2
Approach LOS				C

Intersection Summary			
Average Delay	2.4		
Intersection Capacity Utilization	51.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	265	309	197	274	510	98
Future Volume (vph)	265	309	197	274	510	98
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.2	3.2	3.0	3.0	3.5	3.5
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	0.95
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	1863	1583	1770	1863	1771	1504
Flt Permitted	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (perm)	1863	1583	1770	1863	1771	1504
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	288	336	214	298	554	107
RTOR Reduction (vph)	0	270	0	0	1	66
Lane Group Flow (vph)	288	66	214	298	564	30
Turn Type	NA	Perm	Split	NA	Prot	Perm
Protected Phases	4		3	3	6	
Permitted Phases		4				6
Actuated Green, G (s)	16.0	16.0	30.1	30.1	25.1	25.1
Effective Green, g (s)	16.0	16.0	30.1	30.1	25.1	25.1
Actuated g/C Ratio	0.20	0.20	0.37	0.37	0.31	0.31
Clearance Time (s)	3.2	3.2	3.0	3.0	3.5	3.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	3.5	3.5
Lane Grp Cap (vph)	368	313	658	693	549	466
v/s Ratio Prot	c0.15		0.12	c0.16	c0.32	
v/s Ratio Perm		0.04				0.02
v/c Ratio	0.78	0.21	0.33	0.43	1.03	0.06
Uniform Delay, d1	30.8	27.2	18.1	19.0	27.9	19.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	9.6	0.1	1.3	1.9	45.7	0.1
Delay (s)	40.4	27.3	19.5	20.9	73.6	19.7
Level of Service	D	C	B	C	E	B
Approach Delay (s)	33.4			20.3	65.8	
Approach LOS	C			C	E	

Intersection Summary			
HCM 2000 Control Delay	41.6	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	80.9	Sum of lost time (s)	9.7
Intersection Capacity Utilization	65.1%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	72	258	349	205	188	412
Future Volume (vph)	72	258	349	205	188	412
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.5	3.5	3.5	3.5	3.5	3.5
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	0.88
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3539	1583	1770	3539	1770	2787
Flt Permitted	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (perm)	3539	1583	1770	3539	1770	2787
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	78	280	379	223	204	448
RTOR Reduction (vph)	0	235	0	0	0	192
Lane Group Flow (vph)	78	45	379	223	204	256
Turn Type	NA	Perm	Split	NA	Prot	pm+ov
Protected Phases	5		6	6	8	6
Permitted Phases		5				8
Actuated Green, G (s)	6.3	6.3	15.5	15.5	6.8	22.3
Effective Green, g (s)	6.3	6.3	15.5	15.5	6.8	22.3
Actuated g/C Ratio	0.16	0.16	0.40	0.40	0.17	0.57
Clearance Time (s)	3.5	3.5	3.5	3.5	3.5	3.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	570	255	701	1402	307	1838
v/s Ratio Prot	0.02		c0.21	0.06	c0.12	0.06
v/s Ratio Perm		c0.03				0.04
v/c Ratio	0.14	0.18	0.54	0.16	0.66	0.14
Uniform Delay, d1	14.1	14.2	9.1	7.6	15.1	3.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.0	0.1	3.0	0.2	4.2	0.0
Delay (s)	14.1	14.3	12.0	7.8	19.2	3.9
Level of Service	B	B	B	A	B	A
Approach Delay (s)	14.2			10.5	8.7	
Approach LOS	B			B	A	

Intersection Summary			
HCM 2000 Control Delay	10.6	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	39.1	Sum of lost time (s)	10.5
Intersection Capacity Utilization	43.1%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	264	60	242	17	41	8	291	436	25	16	259	236
Future Volume (vph)	264	60	242	17	41	8	291	436	25	16	259	236
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5		4.0	4.5	4.5	4.5	4.5	4.5
Lane Util. Factor	0.95	0.95	1.00	1.00	1.00		1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.97		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.97	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1715	1583	1770	1816		1770	3539	1583	1770	3539	1583
Flt Permitted	0.95	0.97	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1715	1583	1770	1816		1770	3539	1583	1770	3539	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	287	65	263	18	45	9	316	474	27	17	282	257
RTOR Reduction (vph)	0	0	216	0	8	0	0	0	15	0	0	199
Lane Group Flow (vph)	175	177	47	18	46	0	316	474	12	17	282	58
Turn Type	Split	NA	Perm	Split	NA		Prot	NA	Perm	Prot	NA	Perm
Protected Phases	2	2		6	6		3	8		7	4	
Permitted Phases			2						8			4
Actuated Green, G (s)	10.5	10.5	10.5	3.3	3.3		14.1	25.9	25.9	0.9	13.2	13.2
Effective Green, g (s)	10.5	10.5	10.5	3.3	3.3		14.1	25.9	25.9	0.9	13.2	13.2
Actuated g/C Ratio	0.18	0.18	0.18	0.06	0.06		0.24	0.44	0.44	0.02	0.23	0.23
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5		4.0	4.5	4.5	4.5	4.5	4.5
Vehicle Extension (s)	1.5	1.5	1.5	1.5	1.5		1.5	1.5	1.5	1.5	1.5	1.5
Lane Grp Cap (vph)	301	307	283	99	102		425	1564	699	27	797	356
v/s Ratio Prot	c0.10	0.10		0.01	c0.03		c0.18	c0.13		0.01	0.08	
v/s Ratio Perm			0.03						0.01			0.04
v/c Ratio	0.58	0.58	0.17	0.18	0.45		0.74	0.30	0.02	0.63	0.35	0.16
Uniform Delay, d1	22.0	22.0	20.3	26.4	26.8		20.6	10.5	9.2	28.7	19.1	18.3
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.8	1.6	0.1	0.3	1.1		6.1	0.0	0.0	28.6	0.1	0.1
Delay (s)	23.9	23.6	20.4	26.7	27.9		26.6	10.6	9.2	57.3	19.2	18.3
Level of Service	C	C	C	C	C		C	B	A	E	B	B
Approach Delay (s)		22.3			27.6			16.7			20.0	
Approach LOS		C			C			B			B	

Intersection Summary			
HCM 2000 Control Delay	19.7	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	58.6	Sum of lost time (s)	18.0
Intersection Capacity Utilization	49.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	47	329	7	10	275	178	2	4	21	262	2	68
Future Volume (Veh/h)	47	329	7	10	275	178	2	4	21	262	2	68
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	51	358	8	11	299	193	2	4	23	285	2	74
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		TWLTL			TWLTL							
Median storage veh)		2			2							
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	492			366			860	978	362	902	886	396
vC1, stage 1 conf vol							464	464		418	418	
vC2, stage 2 conf vol							396	514		485	468	
vCu, unblocked vol	492			366			860	978	362	902	886	396
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)							6.1	5.5		6.1	5.5	
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	95			99			100	99	97	34	100	89
cM capacity (veh/h)	1071			1193			416	405	683	431	445	654

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	51	366	11	492	29	361
Volume Left	51	0	11	0	2	285
Volume Right	0	8	0	193	23	74
cSH	1071	1700	1193	1700	599	464
Volume to Capacity	0.05	0.22	0.01	0.29	0.05	0.78
Queue Length 95th (ft)	4	0	1	0	4	172
Control Delay (s)	8.5	0.0	8.0	0.0	11.3	35.0
Lane LOS	A		A		B	E
Approach Delay (s)	1.0		0.2		11.3	35.0
Approach LOS					B	E

Intersection Summary			
Average Delay	10.3		
Intersection Capacity Utilization	64.1%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	42	631	445	197	148	31
Future Volume (Veh/h)	42	631	445	197	148	31
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	46	686	484	214	161	34
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		TWLTL	TWLTL			
Median storage veh)		2	2			
Upstream signal (ft)			224			
pX, platoon unblocked	0.95				0.95	0.95
vC, conflicting volume	698				1369	591
vC1, stage 1 conf vol					591	
vC2, stage 2 conf vol					778	
vCu, unblocked vol	654				1362	542
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)					5.4	
tF (s)	2.2				3.5	3.3
p0 queue free %	95				55	93
cM capacity (veh/h)	885				358	513

Direction, Lane #	EB 1	EB 2	WB 1	SB 1
Volume Total	46	686	698	195
Volume Left	46	0	0	161
Volume Right	0	0	214	34
cSH	885	1700	1700	378
Volume to Capacity	0.05	0.40	0.41	0.52
Queue Length 95th (ft)	4	0	0	71
Control Delay (s)	9.3	0.0	0.0	24.3
Lane LOS	A			C
Approach Delay (s)	0.6		0.0	24.3
Approach LOS				C

Intersection Summary			
Average Delay	3.2		
Intersection Capacity Utilization	Err%	ICU Level of Service	H
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	280	477	336	137	489	103
Future Volume (vph)	280	477	336	137	489	103
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.2	3.2	3.0	3.0	3.5	3.5
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	0.95
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	1863	1583	1770	1863	1770	1504
Flt Permitted	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (perm)	1863	1583	1770	1863	1770	1504
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	304	518	365	149	532	112
RTOR Reduction (vph)	0	413	0	0	1	70
Lane Group Flow (vph)	304	105	365	149	542	31
Turn Type	NA	Perm	Split	NA	Prot	Perm
Protected Phases	4		3	3	6	
Permitted Phases		4				6
Actuated Green, G (s)	16.5	16.5	30.1	30.1	25.0	25.0
Effective Green, g (s)	16.5	16.5	30.1	30.1	25.0	25.0
Actuated g/C Ratio	0.20	0.20	0.37	0.37	0.31	0.31
Clearance Time (s)	3.2	3.2	3.0	3.0	3.5	3.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	3.5	3.5
Lane Grp Cap (vph)	378	321	655	689	544	462
v/s Ratio Prot	c0.16		c0.21	0.08	c0.31	
v/s Ratio Perm		0.07				0.02
v/c Ratio	0.80	0.33	0.56	0.22	1.00	0.07
Uniform Delay, d1	30.9	27.7	20.3	17.5	28.1	19.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	11.1	0.2	3.4	0.7	37.6	0.1
Delay (s)	42.0	27.9	23.7	18.2	65.7	20.0
Level of Service	D	C	C	B	E	B
Approach Delay (s)	33.1			22.1	58.5	
Approach LOS	C			C	E	

Intersection Summary			
HCM 2000 Control Delay	38.5	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	81.3	Sum of lost time (s)	9.7
Intersection Capacity Utilization	72.5%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
4: Todd Rd Overpass & US 101 NB Ramps/Todd Rd

Year 2021 Conditions
Timing Plan: P.M. Peak

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	108	181	380	308	183	640
Future Volume (vph)	108	181	380	308	183	640
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.5	3.5	3.5	3.5	3.5	3.5
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	0.88
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3539	1583	1770	3539	1770	2787
Flt Permitted	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (perm)	3539	1583	1770	3539	1770	2787
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	117	197	413	335	199	696
RTOR Reduction (vph)	0	173	0	0	0	268
Lane Group Flow (vph)	117	24	413	335	199	428
Turn Type	NA	Perm	Split	NA	Prot	pm+ov
Protected Phases	5		6	6	8	6
Permitted Phases		5				8
Actuated Green, G (s)	4.8	4.8	17.7	17.7	6.7	24.4
Effective Green, g (s)	4.8	4.8	17.7	17.7	6.7	24.4
Actuated g/C Ratio	0.12	0.12	0.45	0.45	0.17	0.61
Clearance Time (s)	3.5	3.5	3.5	3.5	3.5	3.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	427	191	789	1577	298	1958
v/s Ratio Prot	c0.03		c0.23	0.09	c0.11	0.10
v/s Ratio Perm		0.02				0.06
v/c Ratio	0.27	0.12	0.52	0.21	0.67	0.22
Uniform Delay, d1	15.9	15.6	8.0	6.7	15.5	3.4
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.1	0.1	2.5	0.3	4.3	0.0
Delay (s)	16.0	15.7	10.4	7.0	19.8	3.4
Level of Service	B	B	B	A	B	A
Approach Delay (s)	15.8			8.9	7.1	
Approach LOS	B			A	A	

Intersection Summary			
HCM 2000 Control Delay	9.2	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	39.7	Sum of lost time (s)	10.5
Intersection Capacity Utilization	44.5%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	363	50	303	52	96	51	338	983	49	33	482	253
Future Volume (vph)	363	50	303	52	96	51	338	983	49	33	482	253
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5		4.0	4.5	4.5	4.5	4.5	4.5
Lane Util. Factor	0.95	0.95	1.00	1.00	1.00		1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.95		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1705	1583	1770	1766		1770	3539	1583	1770	3539	1583
Flt Permitted	0.95	0.96	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1705	1583	1770	1766		1770	3539	1583	1770	3539	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	395	54	329	57	104	55	367	1068	53	36	524	275
RTOR Reduction (vph)	0	0	268	0	24	0	0	0	32	0	0	215
Lane Group Flow (vph)	225	224	61	57	135	0	367	1068	21	36	524	60
Turn Type	Split	NA	Perm	Split	NA		Prot	NA	Perm	Prot	NA	Perm
Protected Phases	2	2		6	6		3	8		7	4	
Permitted Phases			2						8			4
Actuated Green, G (s)	13.4	13.4	13.4	8.3	8.3		17.1	28.8	28.8	3.6	15.8	15.8
Effective Green, g (s)	13.4	13.4	13.4	8.3	8.3		17.1	28.8	28.8	3.6	15.8	15.8
Actuated g/C Ratio	0.19	0.19	0.19	0.12	0.12		0.24	0.40	0.40	0.05	0.22	0.22
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5		4.0	4.5	4.5	4.5	4.5	4.5
Vehicle Extension (s)	1.5	1.5	1.5	1.5	1.5		1.5	1.5	1.5	1.5	1.5	1.5
Lane Grp Cap (vph)	312	316	294	203	203		419	1413	632	88	775	346
v/s Ratio Prot	c0.13	0.13		0.03	c0.08		c0.21	c0.30		0.02	0.15	
v/s Ratio Perm			0.04						0.01			0.04
v/c Ratio	0.72	0.71	0.21	0.28	0.67		0.88	0.76	0.03	0.41	0.68	0.17
Uniform Delay, d1	27.6	27.5	24.9	29.2	30.6		26.5	18.6	13.2	33.2	25.8	22.9
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	6.8	5.8	0.1	0.3	6.2		17.6	2.1	0.0	1.1	1.8	0.1
Delay (s)	34.4	33.4	25.0	29.4	36.8		44.1	20.7	13.2	34.3	27.7	22.9
Level of Service	C	C	C	C	D		D	C	B	C	C	C
Approach Delay (s)		30.1			34.9			26.2			26.4	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM 2000 Control Delay	27.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	72.1	Sum of lost time (s)	18.0
Intersection Capacity Utilization	66.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group