Intersection Control Evaluation (ICE) Screening Evaluation

# Olive Mill Road / Coast Village Road / US 101 Interchange

Santa Barbara, California

## Draft

January 2015

KITTELSON & ASSOCIATES, INC.
TRANSPORTATION ENGINEERING/PLANNING

This Intersection Control Evaluation has been prepared under the direction of the following registered civil engineer. The registered civil engineer attests to the technical information contained herein and the engineering data upon which recommendations, conclusions, and decisions are based.

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Intersection Control Evaluation (ICE) Screening Evaluation

# Olive Mill Road / Coast Village Road / US 101 Interchange

Santa Barbara, California

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# Olive Mill Road / Coast Village Road / US 101 Interchange

## INTERSECTION CONTROL EVALUATION: SCREENING SUMMARY

Kittelson & Associates, Inc. (KAI) conducted an Intersection Control Evaluation (ICE) to objectively evaluate and screen intersection control and access alternatives at the following intersection(s):

US 101 Northbound Off-Ramp Terminal / US 101 Southbound On-Ramp Terminal / Olive Mill Road / Coast Village Road / North Jameson Road

The control options include:

- Traffic signal control
- Roundabouts
- Stop control (existing)

The City of Santa Barbara, County of Santa Barbara, and Caltrans jointly own and operate the intersection. Operationally, the roundabout configuration is the most likely, viable alternative to serve forecast traffic. The existing stop-control or, no project alternative, is a feasible traffic control alternative for the near term but will degrade over time with queues exceeding available storage capacity of the existing northbound off-ramp. Signal control is not a viable alternative considering the project constraints given for this evaluation. There may be other considerations, constraints, and project factors identified in future design evaluations that could affect the prioritization of a specific configuration.

The intersection evaluation considered year 2040 "build" condition traffic operations, geometrics, constraints, and other design considerations.

## KEY FINDINGS INCLUDE:

- The Caltrans District 5 ICE coordinator has reviewed the initial roundabout concept and agrees the project is viable to move forward into further analysis. No fatal flaws have been identified in this phase.
- Roundabout control type would provide superior AM/PM peak hour operations over either the stop controlled or the signal controlled alternatives.
- The roundabout alternative preserves the existing US 101 overpass bridge.
- The roundabout alternative would simplify the existing intersection and reduce the number of decision points.
- Traffic signal operations would not be acceptable for the existing nor 2040 design year. Stop control operations would not be acceptable for the 2040 design year.
- With stop control, queues lengths on the US-101 northbound off ramp will exceed the available storage in year 2022, and spillback would affect mainline operations.
- The roundabout alternative would not require right of way acquisition. The signal alternative is fatally flawed given the project constraints.

**Figure 1. Site Vicinity Map**

The roundabouts will provide speed control and the required sight distance, as well as accommodate traffic movements for the California Truck, Bus 45, and emergency response design vehicles. The roundabout alternative allows for less complex guide signing through the intersection. Additionally, the roundabout alternative has better expected safety performance than the traffic signal and stop control alternatives.

KAI recommends the roundabout alternative be advanced as viable intersection control and access strategies for the Olive Mill Road / Coast Village Road / US 101 Intersection.

Table 1 provides a summary of the operations comparison and Figure 2 displays the roundabout alternative concept design.

**Table 1. Year 2040 Operations Comparison**

| Year 2040 Existing Stop Control | Year 2040 Signal Control | Year 2040 Roundabout Control |
|---|---|---|
| • **Over capacity**<br>• **LOS F in the a.m. peak hour with average delay of 71 seconds**<br>• **LOS F in the p.m. peak hour with average delay of 57 seconds**<br>• **Inadequate queue storage** | • **Over capacity**<br>• **LOS F in the a.m. peak hour with average delay of 124 seconds**<br>• **LOS F in the p.m. peak hour with average delay of 209 seconds**<br>• **Inadequate queue storage** | • Under capacity<br>• LOS B in the a.m. peak hour with average delay of 10 seconds<br>• LOS B in the p.m. peak hour with average delay of 14 seconds<br>• Adequate queue storage |

**Bold** indicates unacceptable operations

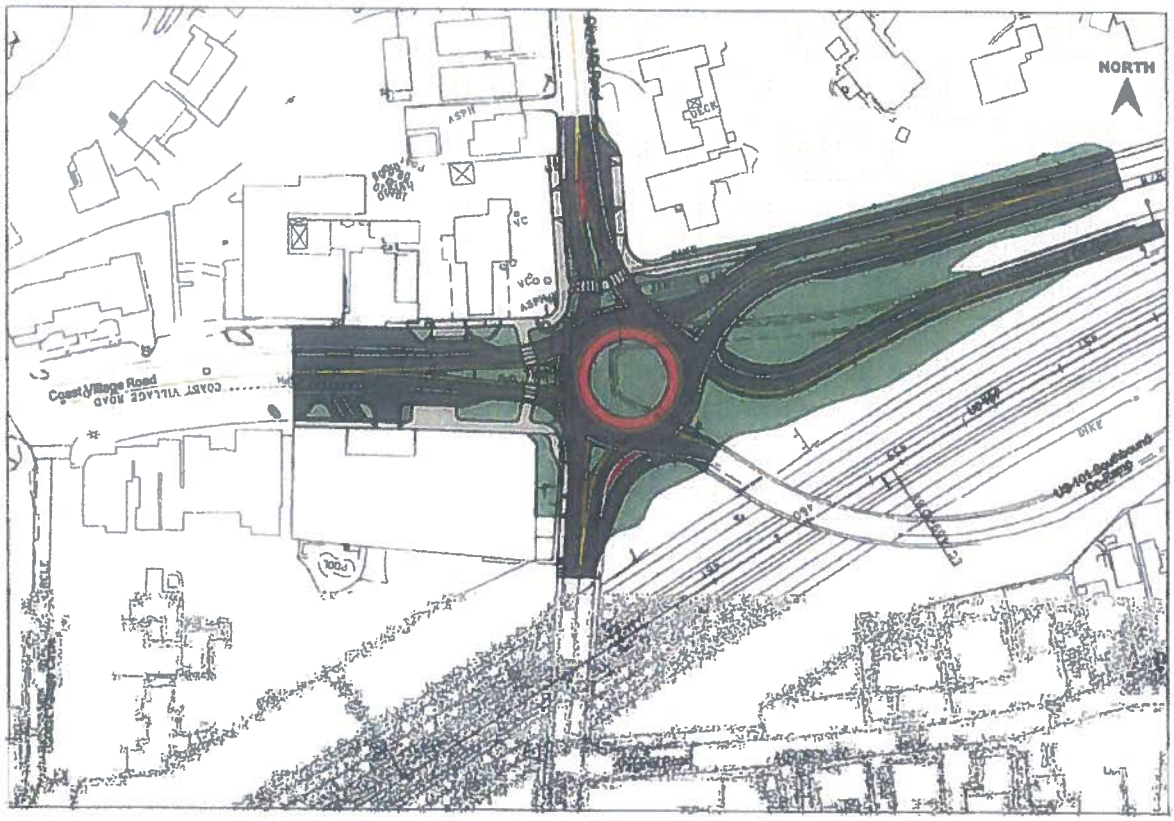


**Figure 2. Roundabout Alternative Concept Design**

# INTRODUCTION

## PROJECT OVERVIEW

This Intersection Control Evaluation (ICE) objectively evaluates alternatives for the intersection control form at the Olive Mill Road / Coast Village Road / US 101 interchange.

Figure 3 displays the site vicinity map.

This document explores intersection control alternatives at the study intersection. Three project alternatives were analyzed as described in this ICE:

- Stop Control Intersection (Existing Condition)
- Signalized Intersection
- Roundabout Intersection

## PROJECT CONTEXT

The project context identifies the transportation facilities and geometric characteristics of the roadways within the study area. Table 2 describes the study area roadways.

As seen in Figure 3, the Olive Mill Road / Coast Village Road / US 101 interchange is an interchange controlled by stop signs on all approach legs. The stop limit-lines for the southbound and northbound Olive Mill Road approach are approximately 145 feet apart. The Coast Village Road, US 101 Off-Ramp, US 101 On-Ramp, and the N. Jameson Road approaches all fall within the intersection defined by the Olive Mill Road stop limit-lines.

The Coast Village Road leg is a gateway to the City of Santa Barbara and the Coast Village Business District.

All parcels in the immediate vicinity of the project are developed.

**Table 2: Study Area Roadways**

| Roadway | Corridor Context | | | | Multimodal Transportation | | |
|---|---|---|---|---|---|---|---|
| | | | | | Transit Service | Active Transportation Links | |
| | Cross Section | Functional Classification | Speed Limit | Regional Context | | Pedestrian Considerations | Bicycle Routes |
| **Olive Mill Road**<br><br>**(City of Santa Barbara and County of Santa Barbara)** | Undivided two-lane | Local Street | 40 mph North of US Hwy 101<br><br>30 mph south of US Hwy 101 | Serves local communities to the north and south of the study area<br><br>Serves tourist and recreation destinations to the south and west of the study area | Local transit service is operated by MTD Santa Barbara in the study area. Service is provided via the Line 14 – Montecito north of the study intersection.<br><br>A bus stop is located just north of N. Jameson Road. | Sidewalks are provided along the west side of Olive Mill Road within the City of Santa Barbara.<br><br>Consistent with Montecito Association guidelines, sidewalks are not provided within the County of Santa Barbara. | Class II bicycle lanes are provided north of N. Jameson Road |

| Roadway | Corridor Context | | | | Multimodal Transportation | | |
|---|---|---|---|---|---|---|---|
| | | | | | Transit Service | Active Transportation Links | |
| | Cross Section | Functional Classification | Speed Limit | Regional Context | | Pedestrian Considerations | Bicycle Routes |
| **Coast Village Road**<br><br>**(City of Santa Barbara)** | Undivided two-lane<br><br>On-street angled parking | Commercial, shopping, entertainment. corridor | Not Posted | Serves local communities to the west.<br><br>Gateway to Santa Barbara. Serves local and tourist shopping, entertainment, professional, and lodging services to the west.<br><br>Alternate, parallel route to US 101 | Local transit service is operated by MTD Santa Barbara in the study area. Service is provided via the Line 14 – Montecito.<br><br>A bus stop is located just west of Olive Mill Road. | Sidewalks are provided along both sides | Class II bicycle lanes are provided |
| **North Jameson Road**<br><br>**(County of Santa Barbara)** | Undivided two-lane | Local Street | 40 mph | Serves local communities to the east.<br><br>Serves local and tourist shopping, entertainment, professional, and lodging services to the west.<br><br>Alternate, parallel route to US 101 | None | None.<br><br>Potential pedestrian destination limited to north of N. Jameson Road midblock.<br><br>Consistent with Montecito Association guidelines, sidewalks are not provided within the County of Santa Barbara. | Class II bicycle lanes are provided |
| **US 101** | Four-lane divided highway | Highway | | Bisects the City of Santa Barbara to provide north-south service through the City and to regional destinations | None | None | None |

**Figure 3. Study Area and Existing Study Intersection Lane Configuration**

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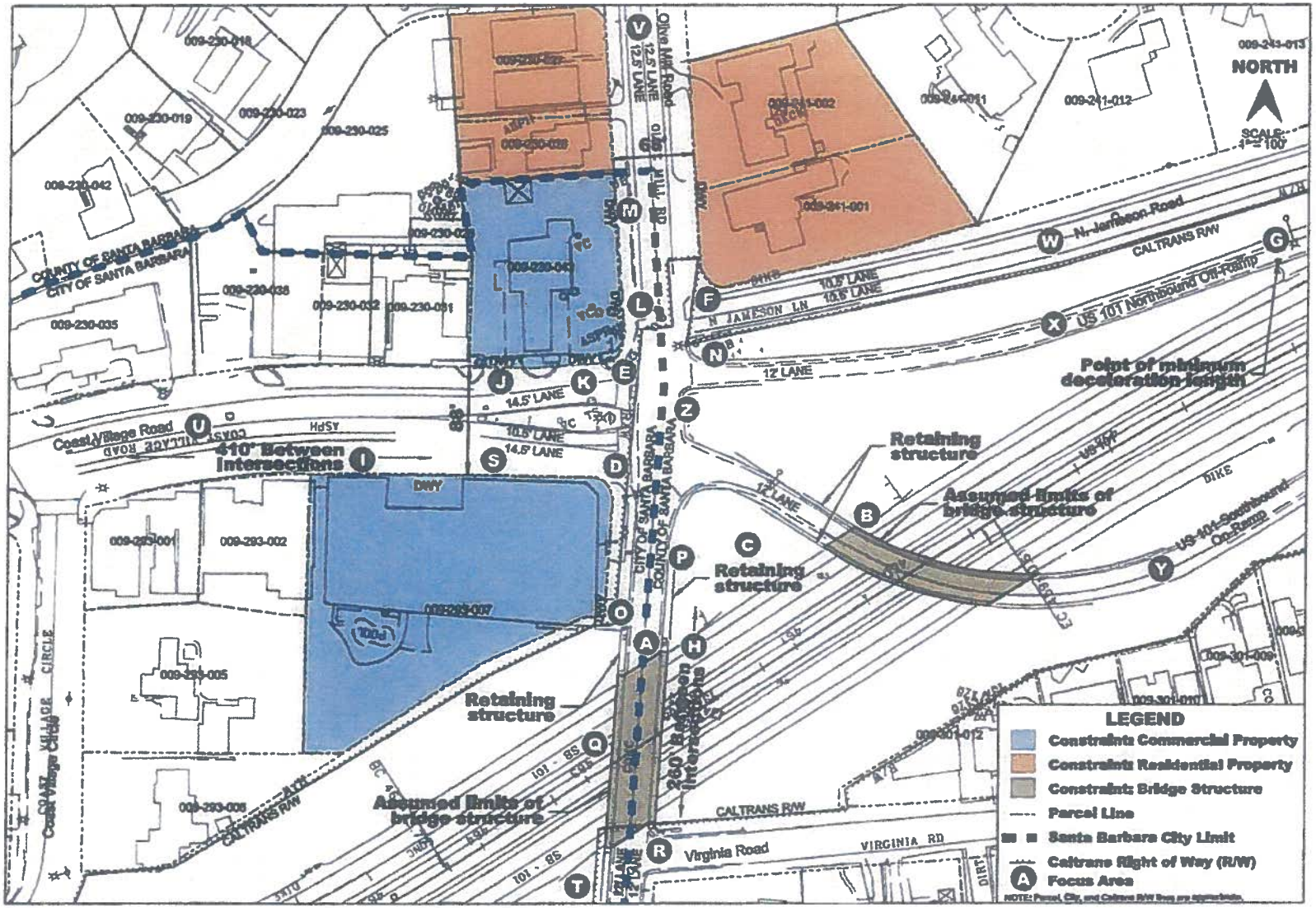


Figure 4: Existing Conditions and Constraints

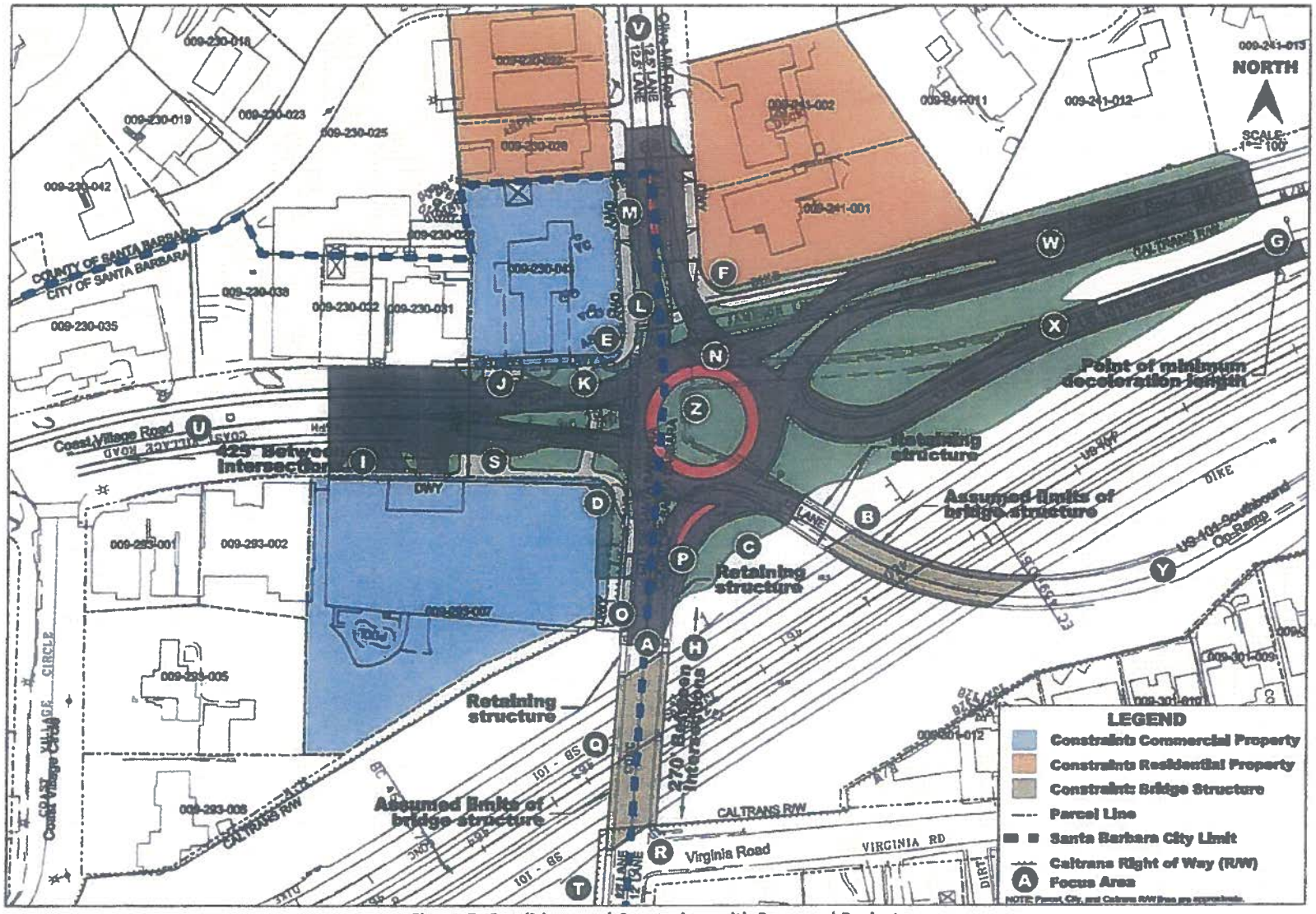


Figure 5: Conditions and Constraints with Proposed Project

# PLANNING AND DESIGN FRAMEWORK

## EXISTING CONDITIONS AND DESIGN CONSTRAINTS

The following section and Table 3 describe the existing conditions and constraints identified in Figure 4 and Figure 5.

## RIGHT OF WAY

The project intersection is bisected by the City of Santa Barbara to the west and the County of Santa Barbara to the east. The centerline of Olive Mill Road is the approximate location of the jurisdictional boundary.

Caltrans right of way generally follows the southerly fence line of N. Jameson Road and the westerly back of sidewalk of Olive Mill Road. Right of extends to a portion of Olive Mill Road north of N. Jameson Road. The existing intersection is largely within Caltrans R/W.

**Table 3: Existing Conditions and Design Constraints**

**BOLD** indicates either a fatal flaw identified by the City of Santa Barbara or a deviation from Caltrans Highway Design Manual (HDM) advisory or mandatory design standards effective September 22, 2014.

| Focus Area | Description | HDM Design Deviation Alt.1/Alt.2 | Alt. 1 Existing (Figure 4) | Alt. 2 Proposed Roundabout (Figure 5) |
|---|---|---|---|---|
| A | Olive Mill Bridge | No/No | • **Potential Design Constraint / Fatal Flaw if altered**<br>• | • No impact<br>• Preserves existing bridge |
| B | US 101 Southbound On-Ramp Bridge | No/No | • **Potential Design Constraint / Fatal Flaw if altered**<br>• | • No impact<br>• Preserves existing bridge |
| C | Retaining Structure<br>Easterly side of Olive Mill Road | No/No | • Cost consideration if modified | • New retaining structure will be required. The cost and magnitude of the structure will be influenced by Focus Area P. |
| D | Montecito Inn<br>Parcel 009-293-007 | No/No | • **Potential Right of Way Constraint / Fatal Flaw if additional Right of Way needed** | • No significant impact<br>• Landscape modifications may be needed to accommodate landscaping and sidewalk |
| E | 76 Service Station<br>Parcel 009-230-043 | No/No | • **Potential Right of Way Constraint / Fatal Flaw if additional Right of Way needed** | • No significant Right of Way impact<br>• **Significant access impact. Access for fuel trucks may be may be significantly impacted. Refer to Focus Areas K and L.**<br>• Landscape modifications may be needed to accommodate landscaping and sidewalk.<br>• Improvements will likely replace existing sidewalk within parcel. |
| F | Private Residence<br>Parcel 009-241-001 | No/No | • **Potential Right of Way Constraint / Fatal Flaw if additional Right of Way needed** | • No impact<br>• Improvements do not encroach |

| Focus Area | Description | HDM Design Deviation Alt.1/Alt.2 | Alt. 1 Existing (Figure 4) | Alt. 2 Proposed Roundabout (Figure 5) |
|---|---|---|---|---|
| G | **Northbound Off-Ramp Deceleration Length** | **No/Unlikely** | • **First curve radius = 650 feet (approx.)**<br>• Curve is approx. 420 feet from gore | • **Design Deviation Unlikely**<br>• There is sufficient length to accommodate a variety of alignments to approach the roundabout.<br>• As shown, the first curve radius is 500 feet with approx. 420 deceleration length.<br>• Future studies should evaluate horizontal and vertical approach alignments that balance superelevation requirements, retaining structure costs, roundabout geometric guidance, intersection sight line angles, and ramp deceleration length. |
| H | Distance to Virginia Road from southbound US 101 on-ramp | **Yes/Yes** | • **Existing deviation from Mandatory Design Standard** for HDM Topic 504.3 (3)<br>• Curb return to curb return distance is less than 400 feet | • **Maintains deviation from Mandatory Design Standard** with minor improvement over existing<br>• Distance from ICD to curb return, measured at Olive Mill Road centerline is 270 feet. |
| I | Distance to Coast Village Circle from Olive Mill Road | **Yes/Yes** | • **Existing deviation from Advisory Design Standard** for HDM Topic 504.3 (3)<br>• Curb return to curb return distance is less than 500 feet but greater than 400 feet. | • **Maintains deviation from Advisory Design Standard** with minor improvement over existing<br>• Distance from ICD to curb return, measured at Coast Village Road centerline is 425 feet. |
| J | Driveway<br>APN 009-230-043 | **Yes/Yes** | • **Existing deviation from Advisory Design Standard** for HDM Topic 504.8<br>• Curb return to curb return distance is less than 100 feet but greater than 50 feet | • **Maintains deviation from Advisory Design Standard**<br>• Distance from ICD to driveway, measured at Coast Village Road centerline is 80 feet. |
| K | Driveway<br>APN 009-230-043 | **Yes/No** | • **Existing deviation from Mandatory Design Standard** for HDM Topic 504.8<br>• Curb return to curb return distance is less than 50 feet | • Deviation from Mandatory Design Standard is not needed with this alternative.<br>• Driveway is removed with this concept |
| L | Driveway<br>APN 009-230-043 | **Yes/No** | • **Existing deviation from Mandatory Design Standard** for HDM Topic 504.8<br>• Curb return to curb return distance is less than 50 feet | • Deviation from Mandatory Design Standard is not needed with this alternative.<br>• Driveway is removed with this concept |
| M | Driveway<br>APN 009-230-043 | **Likely/No** | • May be an **Existing deviation from Advisory Design Standard** for HDM Topic 504.8<br>• Curb return to curb return distance may be less than 100 feet but is greater than 50 feet | • Either maintains existing deviation or a new deviation from Advisory Design Standard may be needed with this alternative.<br>• Driveway location may be 85 feet from ICD to driveway measured along the proposed Olive Mill Road centerline. |
| N | Distance to N. Jameson Road | **Yes/No** | • **Existing deviation from Mandatory Design Standard** for HDM Topic 504.3 (3)<br>• Curb return to curb return distance is less than 400 feet | • Deviation from Mandatory Design Standard is not needed with this alternative<br>• N. Jameson Road is realigned to become a part of the ramp terminal intersection |

| Focus Area | Description | HDM Design Deviation Alt.1/Alt.2 | Alt. 1 Existing (Figure 4) | Alt. 2 Proposed Roundabout (Figure 5) |
|---|---|---|---|---|
| O | Driveway<br>APN 009-293-007 | **Yes/Yes** | • **Existing deviation from Advisory Design Standard** for HDM Topic 504.8<br>• Curb return to curb return distance is less than 100 feet but is greater than 50 feet | • **Maintains deviation from Advisory Design Standard**<br>• Distance from ICD to driveway, measured at Coast Village Road centerline is approximately 90 feet. |
| P | Pedestrian access though easterly side of intersection | No/No | • Accessible pedestrian facilities are not provided along the easterly side of Olive Mill Road between the bridge and N. Jameson Road. | • No change in pedestrian route<br>• Accessible pedestrian facilities are not proposed, as illustrated.<br>• Accessible pedestrian facilities could be provided through intersection. If provided, cost of retaining structure identified in Focus Area C will likely increase.<br>• Also see Focus Areas Q and R |
| Q | Pedestrian access on Olive Mill Road bridge | No/No | • Accessible pedestrian facilities exist on both sides of bridge | • No change |
| R | Pedestrian access at intersection of Virginia Road and Olive Mill Road | No/No | • Curb ramps and crosswalks are not present | • Refer to Focus Area P<br>• Northbound pedestrians should be routed to the westerly side of Olive Mill Road if pedestrian facilities are not provided on the easterly side of the project intersection |
| S | Bus stop with turnout bay | No/No | • Consideration for all proposed improvements | • Bus stop with turnout bay is improved at existing location |
| T | Olive Mill Road, South Leg | No/No | • 12 foot lanes<br>• 2 foot shoulders<br>• 5 foot sidewalk along westerly side<br>• No crosswalk at study intersection | • No Change<br>• No Change<br>• No Change<br>• No Change<br>• Right turn lane with mountable channelization added at intersection<br>• Splitter island |
| U | Coast Village Road, West Leg | No/No | • At intersection<br>  o Eastbound 10.5 foot left turn lane<br>  o Eastbound 14.5 foot through and right turn lane<br>  o Westbound 14.5 foot lane<br>  o Crosswalk<br>  o Variable width median with pedestrian refuge<br>• 12 foot eastbound lane<br>• 17 foot westbound lane<br>• 6 foot bicycle lanes<br>• On-street, angled parking<br>• Sidewalks | • At intersection<br>  o Removed<br>  o 12 foot eastbound left-through-right lane<br>  o Westbound 12 foot lane<br>  o No change<br>  o No change<br>• No change<br>• No change<br>• No change<br>• No change<br>• No change |
| V | Olive Mill Road, North Leg | No/No | • 12.5 foot lanes<br>• 5 foot Class II bicycle lanes<br>• Sidewalk along APN 009-230-043 only<br>• No crosswalk at intersection | • 12 foot lanes<br>• No change<br>• Add 50 feet of sidewalk along easterly side, north of intersection<br>• Add crosswalk<br>• Add splitter island with mountable median at Focus Area M |
| W | N. Jameson Road, Northeast Leg | No/No | • 10.5 foot lanes<br>• 5 foot Class II bicycle lanes<br>• No sidewalks<br>• No crosswalk at intersection | • 12 foot lanes<br>• No Change<br>• 110 foot sidewalk/path along northerly side, east of intersection<br>• No Change<br>• Splitter island |

| Focus Area | Description | HDM Design Deviation Alt.1/Alt.2 | Alt. 1 Existing (Figure 4) | Alt. 2 Proposed Roundabout (Figure 5) |
|---|---|---|---|---|
| X | **US 101 Northbound Off-Ramp, East Leg** | Possible*/ No | • 12 foot lane<br>• 8 foot right shoulder<br>• 2 foot left shoulder*<br><br>* Assumes concurrence for restrictive condition per Note (2), Table 302.1 in HDM | • No change<br>• No change<br>• 4 foot left shoulder |
| Y | US 101 Southbound On-Ramp, Southeast Leg | Possible*/ Possible* | • 12 foot lane<br>• 8 foot right shoulder<br>• 2 foot left shoulder*<br><br>* Assumes concurrence for restrictive condition per Note (2), Table 302.1 in HDM | • No change<br>• No change<br>• No change* |
| Z | Design Vehicle (DV)<br>Refer to Figures in Appendix A | No/No | • DV: CA Truck<br>o Right turns: Limited - DV will encroach into oncoming traffic lane.<br>o Left turns: Possible with 1 Limitation – Left turn from southbound Olive Mill Road to N. Jameson Road, trailer will track into westbound lane.<br>o US 101 Northbound Off-Ramp to N. Jameson Road: Not Possible<br>o Eastbound Olive Mill Road to N. Jameson Road: Limited – DV will track into opposing westbound N. Jameson lane | • DV: CA Truck<br>o Right turns: Possible.<br>o Left turns: Possible.<br>o US 101 Northbound Off-Ramp to N. Jameson Road: Possible if DV circulates through roundabout.<br>o Eastbound Olive Mill Road to N. Jameson Road: Possible. |

## CRASH DATA AND OPERATING SPEEDS

Existing crash data was not reviewed as part of this effort. Vehicle speed data was not collected as part of this effort. If physical and operational constraints assessments presented herein do not inform the ICE process, these factors could be examined at a later time.

## SPECIAL EVENTS

The Santa Barbara Triathlon course goes through this intersection from Olive Mill Road (south leg) to Jameson Road.

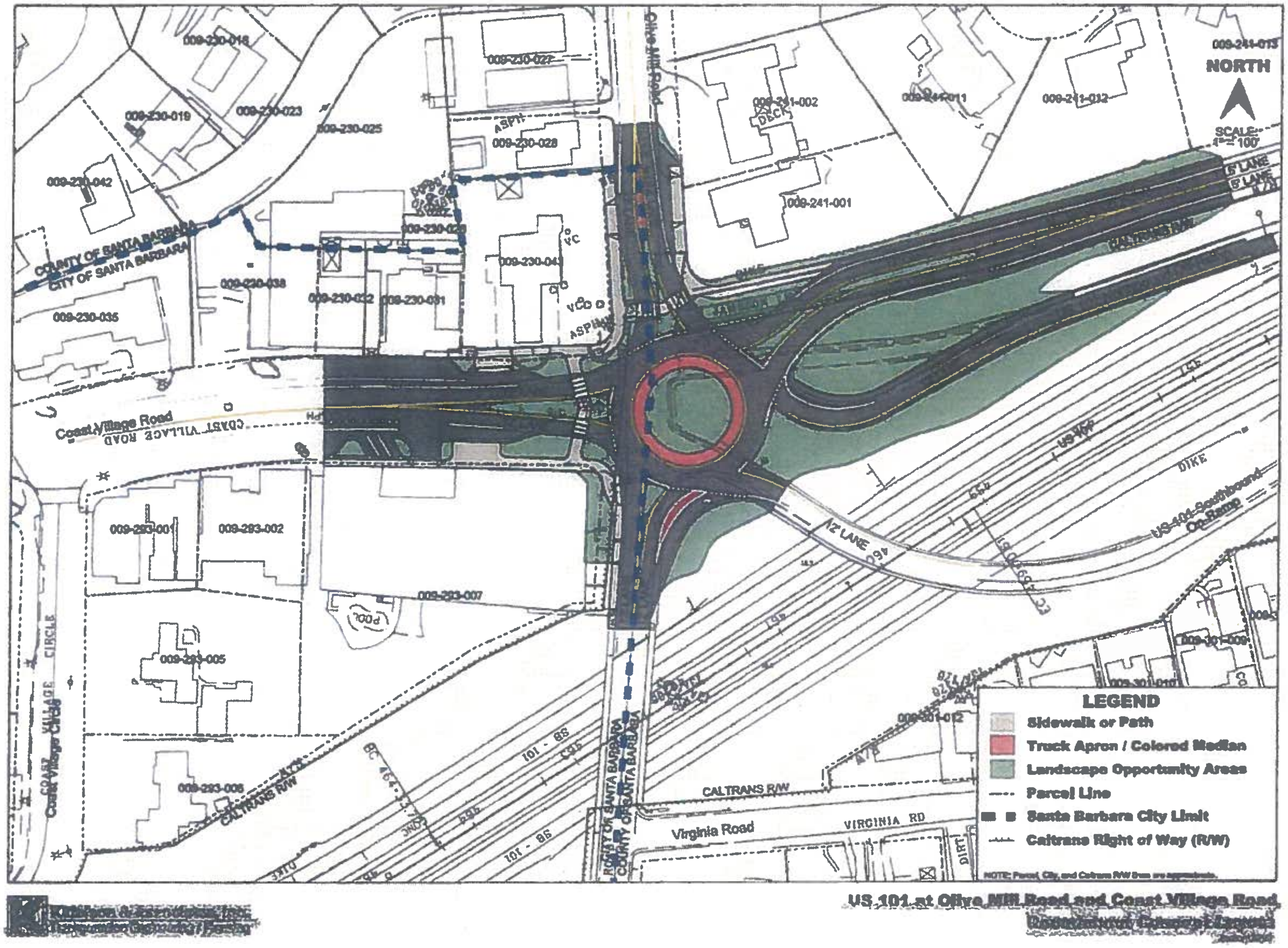


Figure 6: Proposed Roundabout Project

# TRAFFIC CONTROL STRATEGIES, CONSIDERATIONS, AND PERFORMANCE ANALYSES

Traffic control alternatives evaluated as part of this ICE include:

- Retaining the existing intersection control and geometry. This alternative would retain all-way stop control (AWSC) at the intersection.
- Converting the intersection to signal control.
- Converting the intersection to a roundabout.

AWSC and signal alternatives with new geometric configurations are not identified in this study. Geometric modifications for AWSC and signal control are not considered feasible due to the operational constraints identified as fatal flaws (i.e., queue spill-back onto the US-101 off-ramp).

Using operations methodologies consistent with the *US 101 HOV PA-ED* (dated December 2011) described in Appendix C, KAI evaluated the traffic control alternatives. The analysis results for each intersection are presented below. Supporting material, including more detailed operations results and the operations analysis worksheets can also be found in Appendix C.

## ANALYSES RESULTS

### *All-Way Stop Control with Existing Geometry*

The AWSC with existing geometry alternative assumes the existing lane configuration remains the same under year 2040 conditions. Under year 2040 conditions, the intersection is projected to operate over capacity. Queues on the US 101 Northbound Off-Ramp will exceed available storage during the weekday a.m. and p.m. peak hours.

Given the limitations of existing state-of-the-art operational software combined with the a-typical geometric design of the current interchange, two analysis approaches have been developed to analyze the AWSC conditions of the Olive Mill interchange. A static analysis using SYNCHRO was applied in the US101 HOV PA-ED study (with Modified F Configuration at Cabrillo Hot-Springs) which analyzed the Olive Mill interchange as three distinct and separate TWSC intersections (NB Off-Ramp/Olive Mill Road; North Jameson Lane/Olive Mill Road; and SB On-Ramp/Olive Mill Road). This analysis determined that the NB Off-Ramp and SB On-Ramp portions of the interchange failed (LOS E/F). For this ICE determination, a VISSIM micro-simulation model calibrated to site specific conditions with field measured flow rates and queue lengths was developed which holistically analyzed interchange operations (as one unified intersection). All capacity analysis results presented in this memo for all-way stop control were determined using the microsimulation model. Both approaches yielded similar/consistent results i.e., LOS E/F under 2040 conditions.

### *Signal Control with Existing Geometry*

The signal control alternative with existing geometry alternative assumes the existing lane configuration remains the same under year 2040 conditions. Under year 2040 conditions, the intersection is projected to operate over capacity with significant queuing during the weekday a.m. and p.m. peak hours.

### *Roundabout Control*

A roundabout configuration was evaluated to determine lane configurations needed to support the 2040 design year conditions. The proposed roundabout lane configuration is shown in Figure 7. The proposed roundabout is projected to operate with a volume to capacity (v/c) ratio of 0.77 or less on all approaches for year 2040 build conditions, with the US 101 Northbound Off-Ramp as the critical approach during the p.m. peak hour.

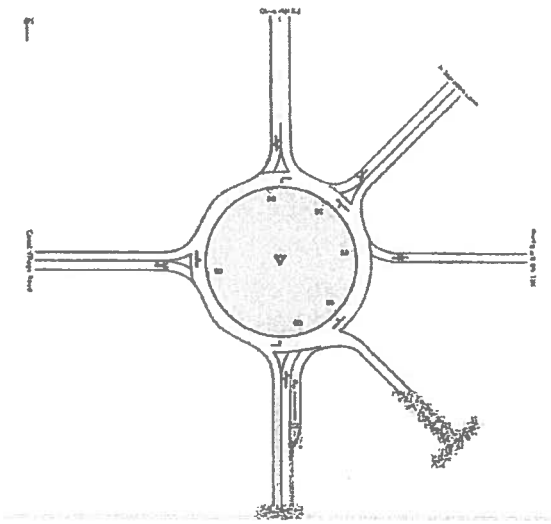

**Figure 7. Proposed Roundabout Lane Configuration**

*Roundabout vs. AWSC and Signal Comparison*

Comparing these models to the year 2040 intersection operations shows the roundabout to be the configuration with better predicted operational performance and no identified fatal flaws. Under AWSC and signalized conditions, the intersection is expected to exceed capacity and experience significantly greater delays than under the roundabout alternative. Further, any mitigated geometry alternatives to the AWSC and signal control options would exceed given right of way constraints and would be considered fatally flawed.

**Table 4: Existing (2014) Operations**

| Approach | Movement* | Delay (seconds/vehicle) | | 95th % Queue (feet)[1] | | Storage (feet)[2] | Adequate Storage (Yes/No) |
|---|---|---|---|---|---|---|---|
| | | AM | PM | AM | PM | | |
| Northbound – Olive Mill Road | L/T/R | **29.1 (D)** | **31.2 (D)** | 150 | 225 | 275 | Yes |
| Westbound – US-101 NB-Off Ramp | L/T/R | **58.9 (F)** | **30.8 (D)** | 325 | 125 | 750 | Yes |
| Westbound – Jameson Lane | L/T/R | 22.4 (C) | 14.4 (B) | 100 | 75 | 710 | Yes |
| Southbound – Olive Mill Road | L/T/R | **29.1 (D)** | **31.2 (D)** | 150 | 225 | 720 | Yes |
| Eastbound – Coast Village Road | Left | 17.4 (C) | **58.6 (F)** | 100 | 1425 | 410 | **No** |
| | T/R | 23.0 (C) | **35.1 (E)** | 150 | 1600 | 150 | **No** |

*Movement Key: L=Left turn, T=Through, R=Right turn.
1. Rounded up to the nearest 25 feet
2. Storage = Available storage
**Bold and shaded indicates inadequate condition**

**Table 5. Year 2040 Operations Comparison**

| | Existing All Way Stop Control* | | | Signal Control* | | | Roundabout Control** | | |
|---|---|---|---|---|---|---|---|---|---|
| Time Period | Volume to Capacity Ratio | Delay (seconds/ vehicle) | Queue Length (feet) | Volume to Capacity Ratio | Delay (seconds/ vehicle) | Queue Length (feet)) | Volume to Capacity Ratio | Delay (seconds/ vehicle) | Queue Length (feet)) |
| AM | 0.542 | 71.6 (LOS F) | > 1000 (E) | >1.00 | 112.5 (LOS F) | 700 (S) | 0.421 | 9.6 (LOS A) | 100 (E) |
| PM | 0.676 | 58.3 (LOS F) | > 1000 (E) | > 1.00 | 162.3 (LOS F) | 775 (S) | 0.555 | 13.7 (LOS B) | 250 (W) |

*Overall intersection operations shown for the all way stop control and signalized alternatives
**Critical movement volume to capacity ratio and overall intersection average delay shown for each alternative

# SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

## SUMMARY

Kittelson & Associates, Inc. (KAI) conducted an Intersection Control Evaluation (ICE) to objectively evaluate and screen intersection control and access alternatives at the following intersection(s):

- US 101 Northbound Off-Ramp Terminal / US 101 Southbound On-Ramp Terminal / Olive Mill Road / Coast Village Road / North Jameson Road

The control options include:

- Traffic signal control
- Roundabouts
- Stop control (existing)

The intersection evaluations considered year 2040 traffic operations, geometrics, constraints, and other design considerations.

## INTERAGENCY COORDINATION

Review of the project concept geometry and operations were conducted with project stakeholders and KAI. Project stakeholders include City of Santa Barbara, County of Santa Barbara, Santa Barbara County Association of Governments (SBCAG), and Caltrans. The following reviews were conducted:

1. Meeting 1, July 9, 2014. Santa Barbara North County Public Works Conference Room, Orcutt, CA.
2. Meeting 2, November 12, 2014. City of Santa Barbara Public Works Main Conference Room, Santa Barbara, CA.
3. Draft ICE document review, January 2015.

## CONCLUSIONS

Key findings include:

- The Caltrans District 5 ICE coordinator has reviewed the initial roundabout concept and agrees the project is viable to move forward into further analysis. No fatal flaws have been identified in this phase.
- Roundabout control type would provide superior AM/PM peak hour operations over either the stop controlled or the signal controlled alternatives.
- The roundabout alternative preserves the existing US 101 overpass bridge.
- The roundabout alternative would simplify the existing intersection and reduce the number of decision points.
- Traffic signal operations would not be acceptable for the existing nor 2040 design year. Stop control operations would not be acceptable for the 2040 design year.
- With stop control, queue lengths on the US-101 northbound off ramp will exceed the available storage in year 2022, and spillback would affect mainline operations. The roundabout alternative would not require right of way acquisition. The signal alternative is fatally flawed given the project constraints.

## RECOMMENDATIONS

KAI recommends the roundabout alternatives be advanced as viable intersection control and access strategies for the Olive Mill Road/Coast Village Road/US-101 Interchange intersection.

# REFERENCES

1. Dowling Associates. SC101 HOV PA-ED Traffic Study. December 2011.
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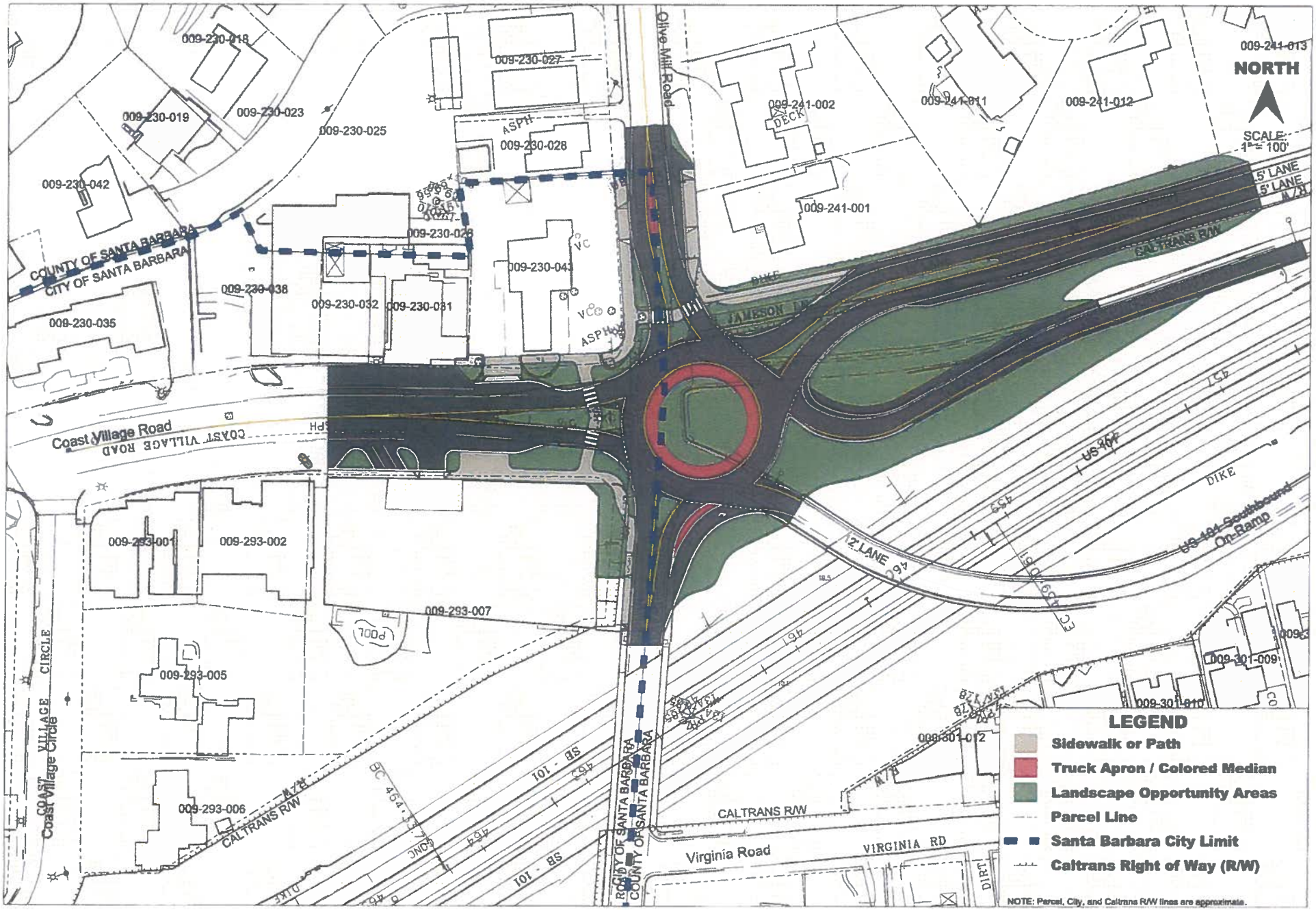
7. Federal Highway Administration, Crash Modification Factors Clearinghouse. <http://www.cmfclearinghouse.org/>. Accessed July 23, 2013.

# Appendix A
# Conceptual Roundabout Layouts




Kittelson & Associates, Inc.
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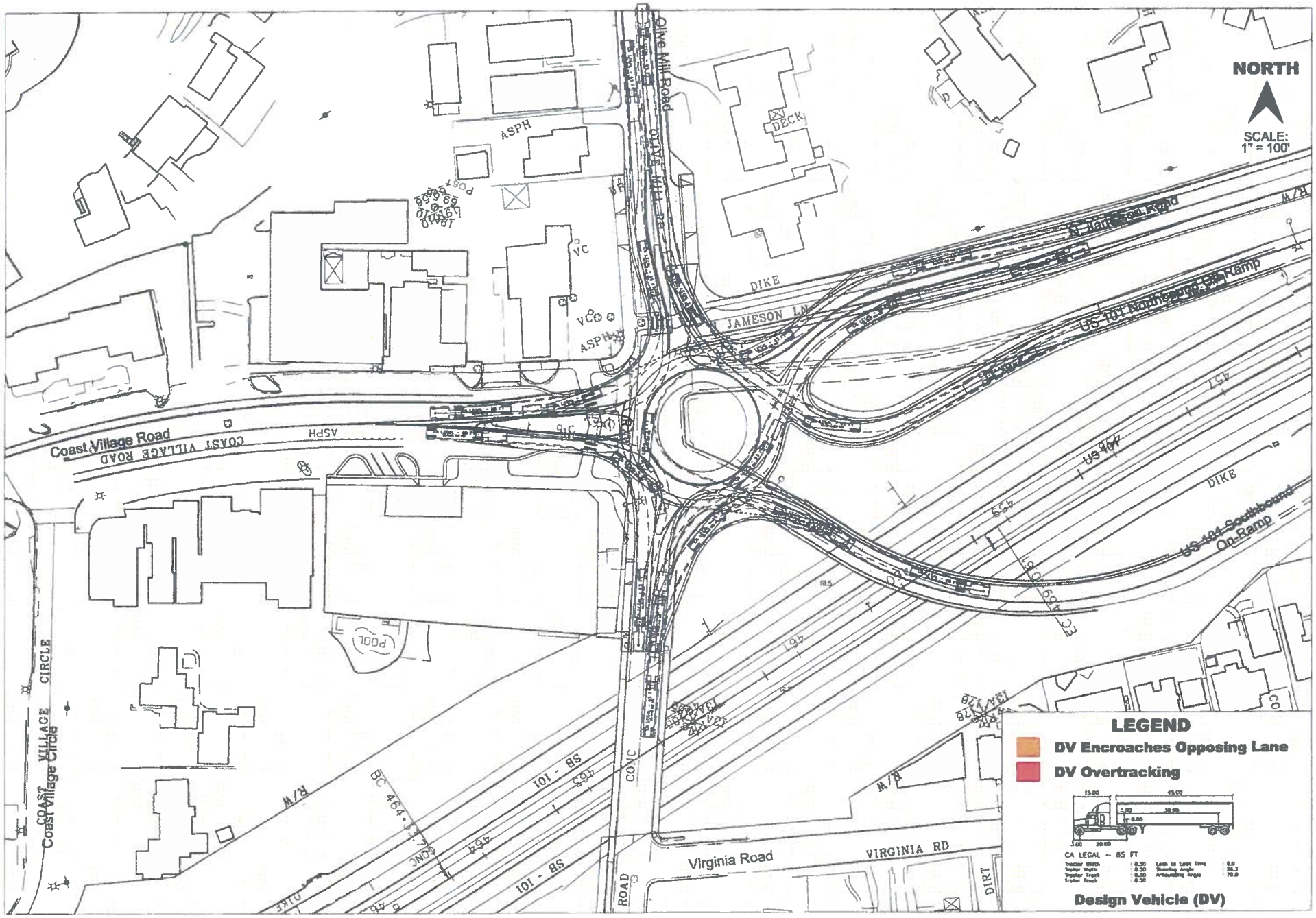
**US 101 at Olive Mill Road and Coast Village Road**
**Roundabout Concept Layout**
January 2015

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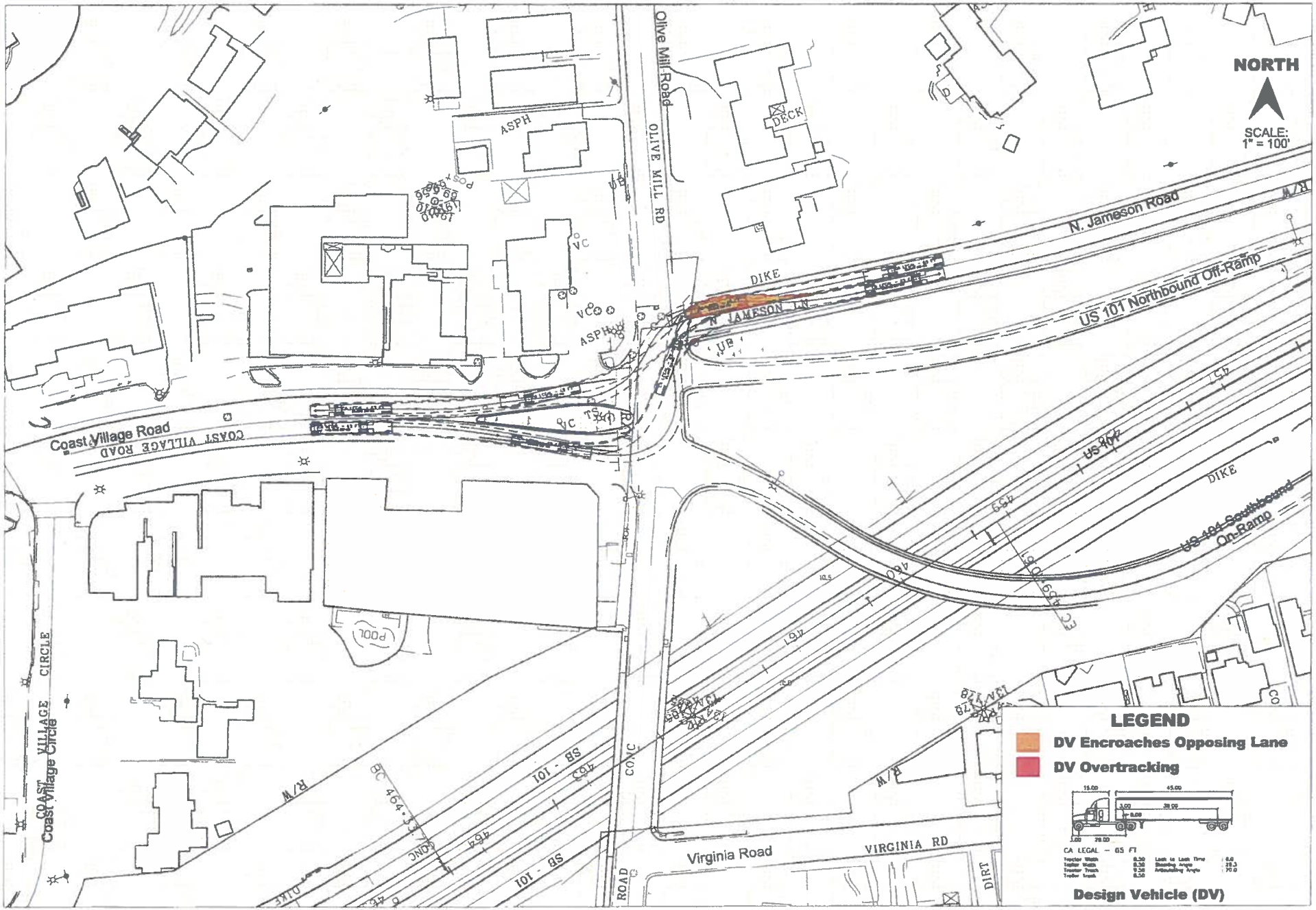
**US 101 at Olive Mill Road and Coast Village Road**
**Design Vehicle Path - Roundabout Concept**
January 2015

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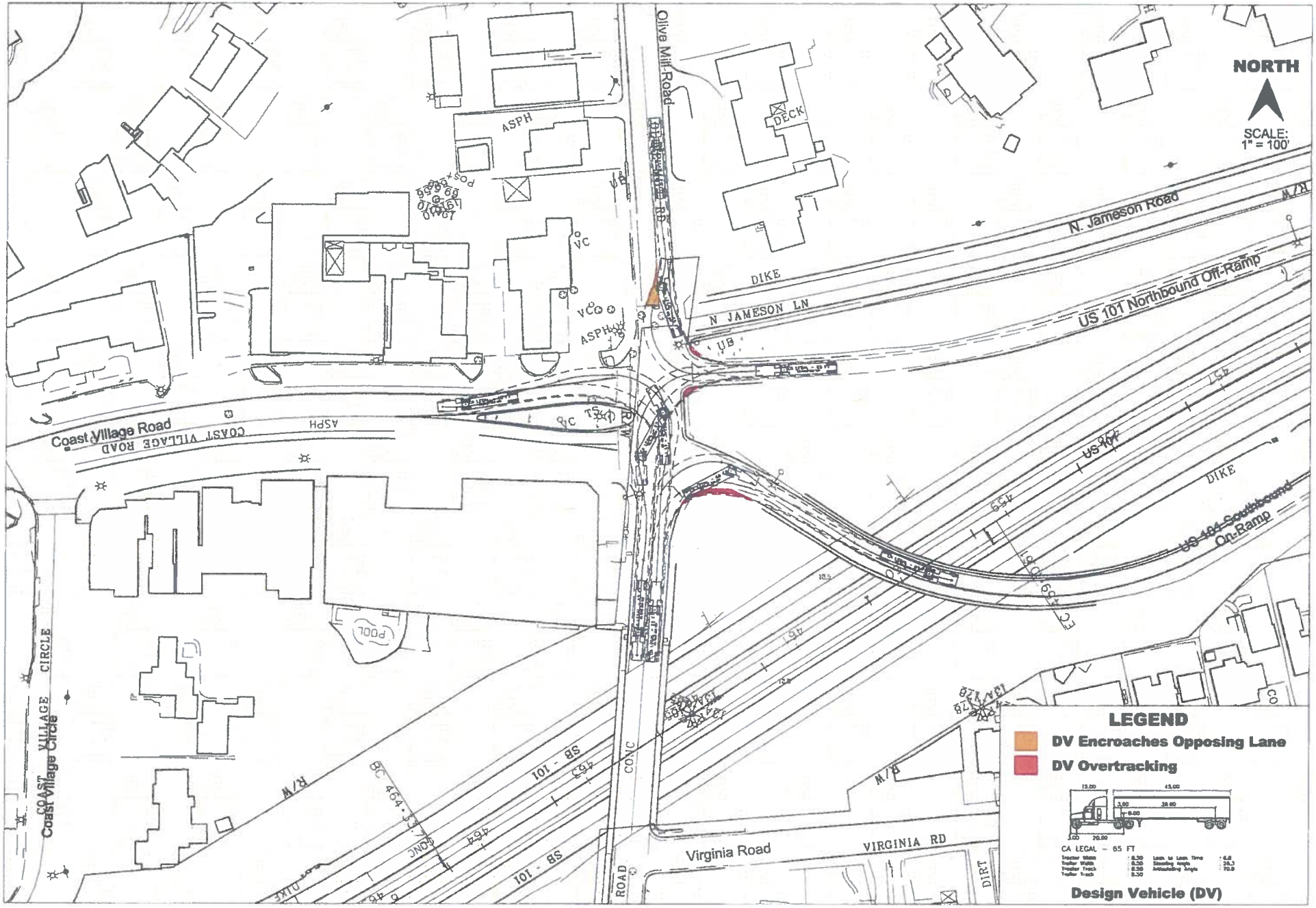
**US 101 at Olive Mill Road and Coast Village Road**
**Design Vehicle Path - Exsiting East - West**
January 2015

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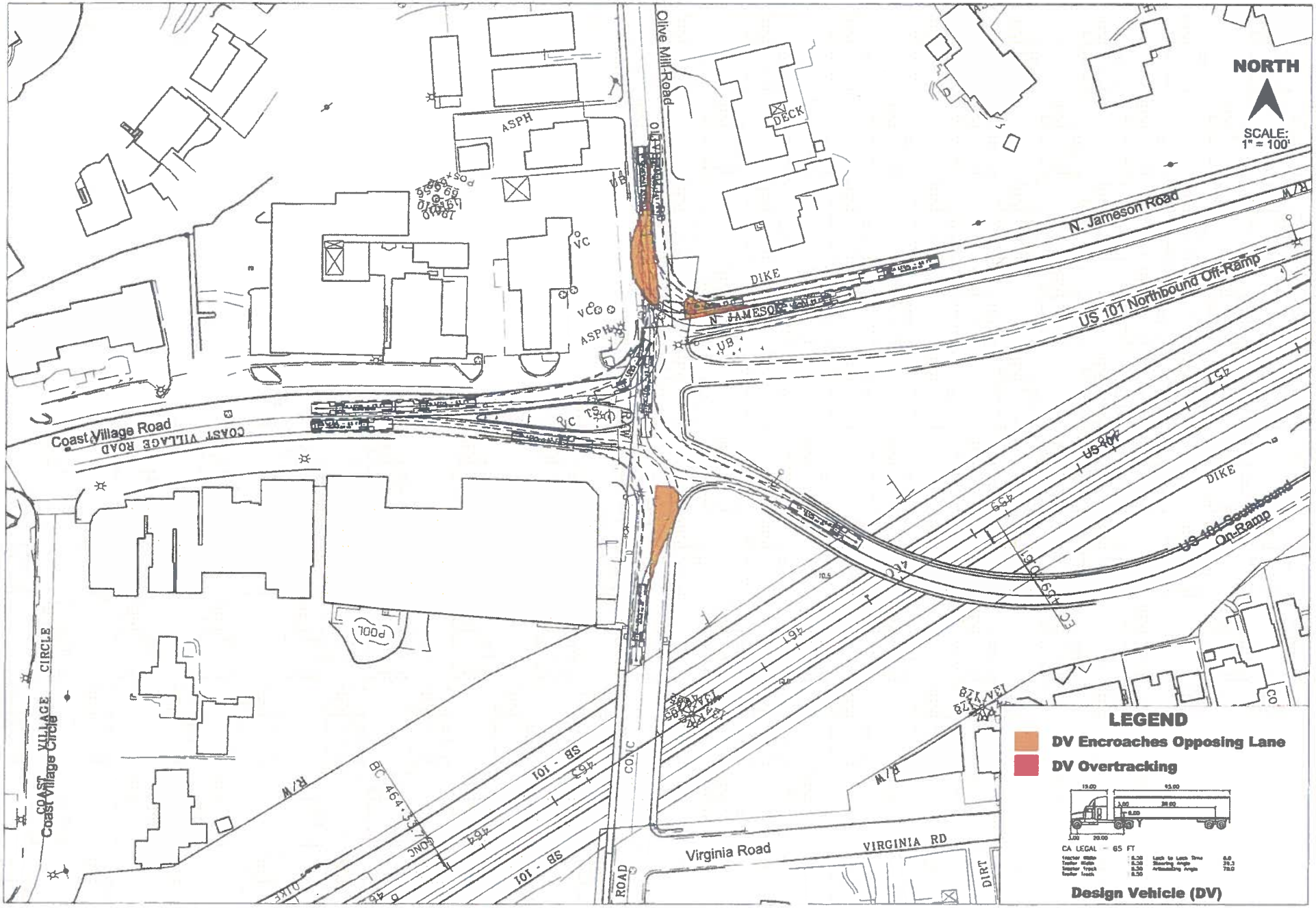
**US 101 at Olive Mill Road and Coast Village Road**
**Design Vehicle Path - Exsiting NB - WB**
January 2015

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Transportation Engineering / Planning

**US 101 at Olive Mill Road and Coast Village Road**
**Design Vehicle Path - Exsiting NB - WB**
January 2015

# Appendix B
# Level-of-Service Concept

# APPENDIX B LEVEL-OF-SERVICE CONCEPT

Level of service (LOS) is a concept developed to quantify the degree of comfort (including such elements as travel time, number of stops, total amount of stopped delay, and impediments caused by other vehicles) afforded to drivers as they travel through an intersection or roadway segment. Six grades are used to denote the various level of service from "A" to "F".

## SIGNALIZED INTERSECTIONS

The six level-of-service grades are described qualitatively for signalized intersections in Table B1. Additionally, Table B2 identifies the relationship between level of service and average control delay per vehicle. Control delay is defined to include initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. Using this definition, Level of Service "D" is generally considered to represent the minimum acceptable design standard.

**Table B-1: Level-of-Service Definitions (Signalized Intersections)**

| Level of Service | Average Delay per Vehicle |
|---|---|
| A | Very low average control delay, less than 10 seconds per vehicle. This occurs when progression is extremely favorable, and most vehicles arrive during the green phase. Most vehicles do not stop at all. Short cycle lengths may also contribute to low delay. |
| B | Average control delay is greater than 10 seconds per vehicle and less than or equal to 20 seconds per vehicle. This generally occurs with good progression and/or short cycle lengths. More vehicles stop than for a level of service A, causing higher levels of average delay. |
| C | Average control delay is greater than 20 seconds per vehicle and less than or equal to 35 seconds per vehicle. These higher delays may result from fair progression and/or longer cycle lengths. Individual cycle failures may begin to appear at this level. The number of vehicles stopping is significant at this level, although many still pass through the intersection without stopping. |
| D | Average control delay is greater than 35 seconds per vehicle and less than or equal to 55 seconds per vehicle. The influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle length, or high volume/capacity ratios. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable. |
| E | Average control delay is greater than 55 seconds per vehicle and less than or equal to 80 seconds per vehicle. This is usually considered to be the limit of acceptable delay. These high delay values generally (but not always) indicate poor progression, long cycle lengths, and high volume/capacity ratios. Individual cycle failures are frequent occurrences. |
| F | Average control delay is in excess of 80 seconds per vehicle. This is considered to be unacceptable to most drivers. This condition often occurs with oversaturation. It may also occur at high volume/capacity ratios below 1.0 with many individual cycle failures. Poor progression and long cycle lengths may also contribute to such high delay values. |

1 Most of the material in this appendix is adapted from the Transportation Research Board, Highway Capacity Manual, (2000).

**Table B-2: Level-of-Service Criteria for Signalized Intersections**

| Level of Service | Average Control Delay per Vehicle (Seconds) |
|---|---|
| A | <10.0 |
| B | >10 and ≤20 |
| C | >20 and ≤35 |
| D | >35 and ≤55 |
| E | >55 and ≤80 |
| F | >80 |

## UNSIGNALIZED INTERSECTIONS

Unsignalized intersections include two-way stop-controlled (TWSC) and all-way stop-controlled (AWSC) intersections. The 2000 Highway Capacity Manual (HCM) provides models for estimating control delay at both TWSC and AWSC intersections. A qualitative description of the various service levels associated with an unsignalized intersection is presented in Table B3. A quantitative definition of level of service for unsignalized intersections is presented in Table B4. Using this definition, Level of Service "E" is generally considered to represent the minimum acceptable design standard.

**Table B3: Level-of-Service Criteria for Unsignalized Intersections**

| Level of Service | Average Delay per Vehicle to Minor Street |
|---|---|
| A | • Nearly all drivers find freedom of operation.<br>• Very seldom is there more than one vehicle in queue. |
| B | • Some drivers begin to consider the delay an inconvenience.<br>• Occasionally there is more than one vehicle in queue. |
| C | • Many times there is more than one vehicle in queue.<br>• Most drivers feel restricted, but not objectionably so. |
| D | • Often there is more than one vehicle in queue.<br>• Drivers feel quite restricted. |
| E | • Represents a condition in which the demand is near or equal to the probable maximum number of vehicles that can be accommodated by the movement.<br>• There is almost always more than one vehicle in queue.<br>• Drivers find the delays approaching intolerable levels. |
| F | • Forced flow.<br>• Represents an intersection failure condition that is caused by geometric and/or operational constraints external to the intersection. |

**Table B-4: Level-of-Service Criteria for Unsignalized Intersections**

| Level of Service | Average Control Delay per Vehicle (Seconds) |
|---|---|
| A | <10.0 |
| B | >10.0 and ≤ 15.0 |
| C | >15.0 and ≤ 25.0 |
| D | >25.0 and ≤ 35.0 |
| E | >35.0 and ≤ 50.0 |
| F | >50.0 |

The level-of-service criteria for unsignalized intersections are somewhat different than the criteria used for signalized intersections. The primary reason for this difference is that drivers expect different levels of performance from different kinds of transportation facilities. The expectation is that a signalized intersection is designed to carry higher traffic volumes than an unsignalized intersection. Additionally, there are a number of driver behavior considerations that combine to make delays at signalized intersections less galling than at unsignalized intersections. For example, drivers at signalized intersections are able to relax during the red interval, while drivers on the minor street approaches to TWSC intersections must remain attentive to the task of identifying acceptable gaps and vehicle conflicts. Also, there is often much more variability in the amount of delay experienced by individual drivers at unsignalized intersections than signalized intersections. For these reasons, it is considered that the control delay threshold for any given level of service is less for an unsignalized intersection than for a signalized intersection. While overall intersection level of service is calculated for AWSC intersections, level of service is only calculated for the minor approaches and the major street left turn movements at TWSC intersections. No delay is assumed to the major street through movements. For TWSC intersections, the overall intersection level of service remains undefined: level of service is only calculated for each minor street lane.

In the performance evaluation of TWSC intersections, other measures of effectiveness (MOEs) in addition to delay, such as v/c ratios for individual movements, average queue lengths, and 95th-percentile queue lengths should be considered because of their impacts on the operational and safety performance of the intersection. By focusing on a single MOE for the worst movement only, such as delay for the minor-street left turn, users may make inappropriate traffic control decisions. The potential for making such inappropriate decisions is likely to be particularly pronounced when the HCM level-of-service thresholds are adopted as legal standards, as is the case in many public agencies.

## ROUNDABOUT INTERSECTIONS

The levels of service (LOS) criteria for automobiles in roundabouts are given in Table B-5. As the table notes, LOS F is assigned if the volume-to-capacity ratio of a lane exceeds 1.0 regardless of the control delay. For assessment of LOS at the approach and intersection levels, LOS is based solely on control delay. The thresholds in Table B-5 are based on the considered judgment of the Transportation Research Board Committee on Highway Capacity and Quality of Service.

**Table B-5: Level-of-Service Criteria for Roundabout Intersections**

| Control Delay (s/veh) | Level of Service by Volume-to-Capacity Ratio* | |
|---|---|---|
| | v/c ≤ 1.0 | v/c > 1.0 |
| 0-10 | A | F |
| >10-15 | B | F |
| >15-25 | C | F |
| >25-35 | D | F |
| >35-50 | E | F |
| >50 | F | F |

*For approaches and intersection-wide assessment, LOS is defined solely by control delay

Roundabouts share the same basic control delay formulation with two-way and all-way STOP-controlled intersections, adjusting for the effect of YIELD control. However, at the time of publication of 2010 edition of the Highway Capacity Manual (HCM), no research was available on traveler perception of quality of service at roundabouts. In the absence of such research, the service measure and thresholds have been made consistent with those for other unsignalized intersections, primarily on the basis of this similar control delay formulation.

# Appendix C
# Operations Methodology and Analysis Results

## INTRODUCTION

Kittelson & Associates, Inc. (KAI) has completed an evaluation of the performance of existing and proposed intersection control alternatives at the intersection of US 101 and Olive Mill Road. The purpose of this analysis is to summarize the design year operations at this interchange assuming the following intersection control options: 1) stop control; 2) signal control; and, 3) roundabout. This analysis was conducted in support of, and in accordance with, the Caltrans Traffic Operations Policy Directive 13-02 (TOPD 13-02) for Intersection Control Evaluations (ICE) effective August 30, 2013. The purpose of TOPD 13-02 is to apply a performance based assessment to test the full range of intersection control options to identify the most cost-effective solution.

The analysis tools and methodologies described herein were based on and are consistent with those documented in the *SC101 HOV PA-ED Traffic Study (Kittelson & Associates (formally Dowling Associates) December 2011).*

The analysis for the *SC101 HOV PA-ED Traffic Study* reflected a 2008 baseline and a 2040 design year. Hence, this intersection control analysis of the Olive Mill interchange at US 101 was also based on a 2040 design year.

## RESULTS SUMMARY

Based on the 2040 design year operations, this intersection control evaluation of the Olive Mill interchange with US 101 in the City of Santa Barbara has determined that a roundabout control type would provide superior AM/PM peak hour operations over either an all way stop controlled or signalized control alternative.

A modern roundabout achieves the best level of service (i.e., delay) for the entire intersection, including the US-101 NB off-ramp approach. If the existing all way stop control is maintained through year 2040, the average delay during the AM peak will be 72 seconds (level of service F), and the average delay during the PM peak will be 58 seconds (level of service F). A signalized intersection would result in a - 113 second average delay (level of service F) in the AM peak period and a 162 second average delay (level of service F) in the PM peak period. A roundabout would result in a 9 second average delay (level of service A) in the AM peak period and an 14 second delay in the PM peak period.

For the US-101 NB off-ramp in year 2040, all way stop control will result in XX seconds of delay (level of service X) during the AM peak, and XX seconds of delay (level of service X) during the PM peak. Signalized control would result in 124 seconds of delay (level of service F), and 209 seconds of delay level of service F) during the PM peak. A roundabout would result in 6.9 seconds of delay (level of service A) during the AM peak, and 18.1 seconds of delay (level of service C) during the PM peak.

In addition to superior delay based performance, a roundabout will achieve the shortest 95$^{th}$ percentile queues for the intersection. For the all-way stop alternative, it was determined using VISSIM analysis that the US 101 NB Off-ramp's maximum queue will be over 1000-feet by year 2040, which exceeds the available ramp storage of 750-feet, and will cause spill back onto the US-101 mainline. The off-ramp queue at the existing stop controled intersection is projected to exceed the available storage in the AM

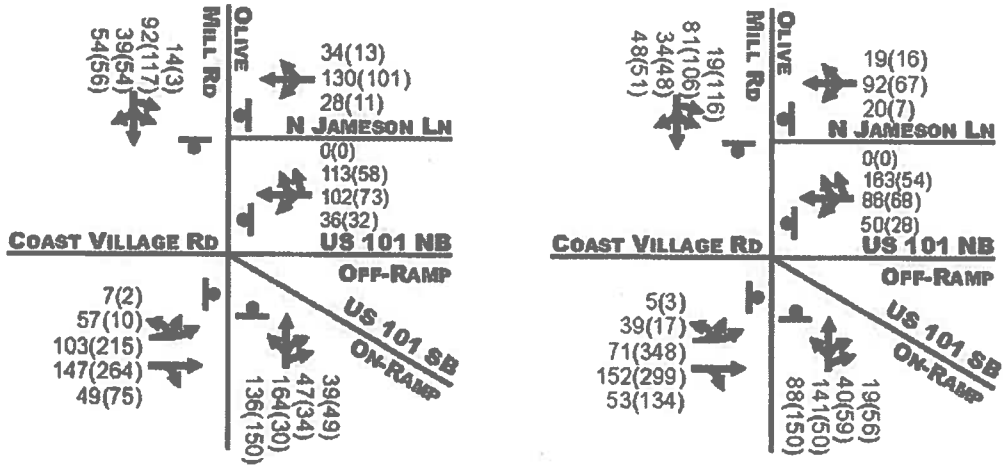
peak period by year 2022 and in the PM peak period by year 2036. For the signalized alternative, queues on the off-ramp will reach 680-feet in the AM peak period and 633 feet in the PM peak period by year 2040. Conversely, the proposed roundabout will result in a 92-foot queue in the AM peak period and a 59-foot queue in the PM peak period under 2040 conditions.

## BASELINE CONDITION

Traffic counts performed as part of the *SC101 HOV PA-ED Traffic Study* were examined. These turning movement counts were collected in April 2008. Given that six years had transpired since this count was taken, a more recent 2014 turning movement count was performed for this analysis. Similar to the 2008 traffic count, the 2014 count was performed during the 7:00 AM – 9:00 AM and 4:00 PM – 6:00 PM peak periods. The true AM/PM peak hour volumes were identified from this four hour count.

A graphical comparison between the 2008 and 2014 AM/PM peak hour turning movement counts is provided below in Figure 8.

**Figure 8: 2008 Traffic Counts (left) and 2014 Traffic Counts (right)**




LEGEND: XX (YY) – AM (PM) Peak Hour

From 2008 to 2014, an overall reduction of 2% was experienced at this interchange in the AM peak hour and 0.69% increase was experienced in the PM peak hour.

Although holistically traffic demand at this interchange has not significantly changed, inspection of specific movements show several significant differences. Of note, in the AM peak period, Olive Mill Road coming from Coast Village Road experienced 18 and 32 reduction in vehicle counts traveling left onto Olive Mill Road and left onto North Jameson Lane respectively. Additionally, in the AM peak period, vehicles traveling northbound right from Olive Mill onto the US-101 SB on-ramp experienced a 20 vehicle count reduction from 2008 volumes. Conversely, in the PM peak period, there were an additional 25 vehicles traveling northbound right from Olive Mill onto North Jameson Lane. Also in the

PM peak period, there were approximately 100 additional vehicles traveling southbound on Olive Mill Road onto Coast Village Road.

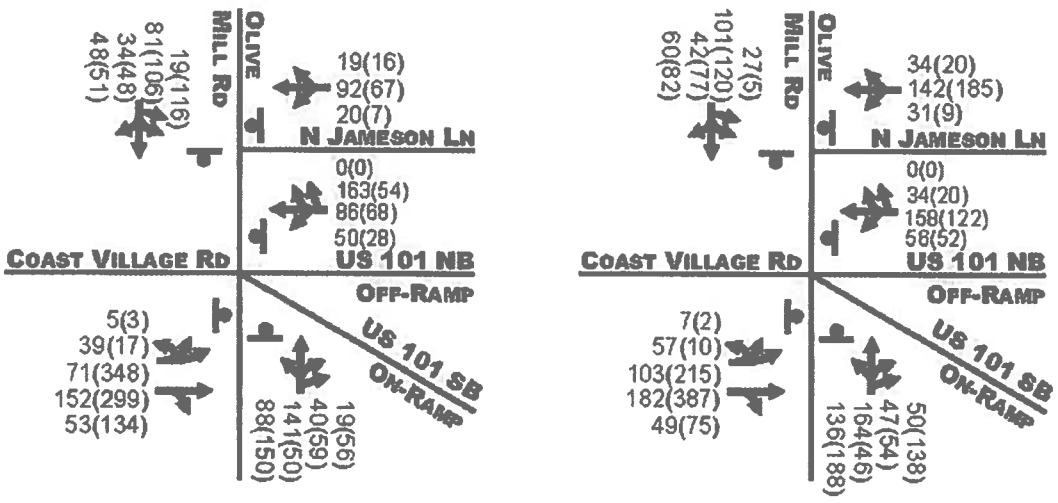
## DESIGN YEAR CONDITION

The basis for the design year volume set were the traffic projections developed for the *SC101 HOV PA-ED Traffic Study (December 2011)* which were generated using the Santa Barbara County Association of Governments (SBCAG) travel demand model. The AM/PM peak hour models were used to forecast 2040 year volumes appropriate for peak hour operational analysis as seen in Figure 9.

To ensure reasonable intersection turn movement forecasts, a refinement process called the Furness Method was applied. This post-processing adjustment is needed given that travel models are calibrated to produce more accurate results on road segments than for individual turn movements. The Furness Method iteratively adjusts the 2014 turning movement counts until the directional sum of the movements balance to the adjusted future link volumes. This factoring process produces forecast turn distributions that resemble the count distribution, but turn movement proportions change in response to different growth rates on different legs as produced by the AM/PM peak hour travel demand model. Additional "spot" adjustments were performed to ensure that no future volume for a given turn movement was less than the 2014 traffic count.

Given that the Olive Mill Interchange is be affected by operations at near-by adjacent interchanges, planned modifications to the Cabrillo-Hot Springs interchange are reflected in this analysis. Kittelson & Associates, Inc. (as Dowling and Associates, Inc.) prepared the Cabrillo Boulevard I/C Modified Configurations Analysis (July 19, 2011) included as part of the Cabrillo/Hot Springs Interchange Configuration Analysis Technical Memorandums (December 11, 2011). Based on these technical studies, the "Modified F" configuration has been advanced as the preferred configuration for the Cabrillo-Host Springs interchange. This configuration is assumed as part of this US 101/Olive Mill interchange analysis.

**Figure 9: 2014 Traffic Counts (left) and 2040 Forecast Traffic Counts (right)**



LEGEND: XX (YY) – AM (PM) Peak Hour

As seen in **Error! Reference source not found.** above, from 2014 to 2040, a 1% compound growth in the AM peak period and 0.65% in the PM peak period is projected. There is an increase in 31 vehicles traveling northbound turning right onto the US-101 SB on-ramp and 72 additional vehicles traveling westbound thru in the AM peak period. In the PM peak period, there are over 100 vehicles traveling westbound right on Jameson movements, 83 additional vehicles traveling westbound right from US-101 NB onto Olive Mill Road, and 82 additional vehicles traveling northbound right from Olive Mill Road onto US-101 SB on-ramp.

## TRAFFIC OPERATIONS ANALYSIS

This subsection summarizes operational analysis methodology and results at the study location.

### Analysis Methodology

Site visits were performed and aerial imagery was also used to document the physical, geometric and operational characteristics of each of the study area intersections and roadway approach segments. This included observed queue lengths and back of queue distances at each approach.

The adjusted 2040 turn movement forecasts were input into the operational software SYNCHRO 8.0 and Sidra. Further volume balancing adjustments were performed to ensure that conservation of traffic flow was maintained at adjacent intersections. For stop controlled and signalized intersection analysis, SYNCHRO analysis was performed to yield the intersection LOS and queue lengths results. Sidra analysis was performed for the roundabout option.

Given that micro-simulation can better capture the interaction of closely spaced intersections, a simulation analysis using the VISSIM software was developed to better determine queues and delays at the study intersection. The model was developed and calibrated to existing conditions using field measured queue lengths delays to ensure an accurate reflection of this a-typical intersection. Given that queue spill-back onto the freeway mainline is a major safety concern, this check of future queue lengths on the off-ramp is considered a fatal flaw assessment. VISSIM simulation runs were based on a minimum 10 minute seeding time, 60 minute analysis time (divided into four 15 minute intervals), and reflect an average of 5 multiple runs. VISSIM simulation for this analysis was validated for existing queue spillback by the *FHWA Traffic Analysis Toolbox Volume III: Guidelines for Applying Traffic Microsimulation Modeling Software* prepared by Dowling Associates, Inc. (now Kittelson & Associates, Inc.) in July 2004.

#### Stop Controlled and Signalized Intersections

Roadway operations are typically governed by, and most constrained at, intersections. The measure of effectiveness commonly used to determine the quality or level of service (LOS) experienced by motorists at intersections is average control delay. The methodology used to analyze intersection LOS is outlined in the Transportation Research Board's Highway Capacity Manual, 2010 version (HCM 2010).

LOS is a qualitative measure of driver satisfaction and is quantitatively expressed by the level of delay and congestion experienced by motorists using an intersection. LOS is designated by the letters A through F, with A being the best condition and F being the worst (high delay and congestion). A summary of LOS criteria for signalized and unsignalized intersections can be found in Table 5 below.

**Table 6: LOS Criteria for Signalized and Unsignalized Intersections**

| | Average Delay (sec/veh) | | |
|---|---|---|---|
| **LOS** | **Signalized** | **Unsignalized** | **Description** |
| A | ≤10.0 | ≤10.0 | Very Low Delay: This occurs when progression is extremely favorable and most vehicles arrive during a green phase. Most vehicles do not stop at all. |
| B | >10.0 & ≤20.0 | >10.0 & ≤15.0 | Minimal Delays: This generally occurs with good progression, short cycle lengths, or both. More vehicles stop than at LOS A, causing higher levels of average delay. |
| C | >20.0 & ≤35.0 | >15.0 & ≤25.0 | Acceptable Delay: Delay increases due to only fair progression, longer cycle lengths, or both. Individual cycle failures (*to service all waiting vehicles*) may begin to appear at this level of service. The number of vehicles stopping is significant, though many still pass through the intersection without stopping. |
| D | >35.0 & ≤55.0 | >25.0 & ≤35.0 | Approaching Unstable/Tolerable Delays: The influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle lengths, or high v/c ratios. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable. |
| E | >55.0 & ≤80.0 | >35.0 & ≤50.0 | Unstable Operation/Significant Delays: These high delay values generally indicate poor progression, long cycle lengths, and high v/c ratios. Individual cycle failures are frequent occurrences. |
| F | >80.0 | >50.0 | Excessive Delays: This level, considered to be unacceptable to most drivers, often occurs with oversaturation (i.e., when arrival flow rates exceed the capacity of the intersection). It may also occur at high v/c ratios below 1.00 with many individual cycle failures. Poor progression and long cycle lengths may also be major contributing causes to such delay levels. |
| Source: | *Highway Capacity Manual,* Transportation Research Board, Washington D.C, 2010 | | |

This analysis includes stop control and signal controlled alternatives. For all-way stop intersections, Chapter 20 of the HCM 2010 outlines the operational methodology to analyze this type of control. Signal-controlled intersections were analyzed using the operational methodology outlined in the HCM 2010, Chapter 18. This procedure calculates the average control delay per vehicle at a signalized intersection, and assigns a LOS designation based upon the delay. The SYNCHRO 8.0 software package was used to perform LOS analysis. Intersection geometrics were based on aerial imagery and field observations. Bicycle and pedestrian counts were not used.

Roundabouts

Roundabout operations were evaluated using Sidra Intersection 6 software using the 2010 Highway Capacity Manual (HCM) capacity model. The 2010 HCM capacity model was calibrated to better reflect gap acceptance behavior of California drivers for critical headway and follow-up headway. The calibration factors, or HCM Parameters A and B, used in this analysis are recommended in the Caltrans document "Roundabout Geometric Design Guidance" dated June 2007. The A and B parameters were derived based on field observations to more accurately reflect operational performance of California

roundabouts. The differences among the default parameters used in the 2010 HCM methodology and identified for California roundabouts are shown below in Table 6.

**Table 7: Roundabout Model Parameters for Entry Capacity**

| | Default 2010 HCM Parameters | | Modified HCM Parameters based on Caltrans guidance | |
|---|---|---|---|---|
| | A | B | A | B |
| **Single-lane circulating stream ($n_c$=1)** | | | | |
| Single-lane entry ($n_e$=1, $n_c$=1) | 1130 | 0.00100 | 1440 | 0.00100 |
| Multi-lane entry ($n_e$> 1, $n_c$=1): apply to all lanes | 1130 | 0.00100 | 1440 | 0.0010 |
| **Multi-lane circulating stream ($n_c$>1)** | | | | |
| Single-lane entry ($n_e$=1, $n_c$=1) | 1130 | 0.00070 | | |
| Multi-lane entry ($n_e$> 1, $n_c$=1) | | | | |
| Dominate lane (right lane) | 1130 | 0.00070 | 1640 | .00090 |
| Subdominate lane (left lane) | 1130 | 0.00075 | 1640 | .00100 |

LOS criteria specified in the 2010 HCM was used to establish the quality of service for the roundabout from a user's perspective. The 2010 HCM uses the average control delay (s/veh) and volume-to-capacity ratio (v/c) to establish thresholds for intersection LOS. These thresholds are shown in Table 7.

**Table 8: Level of Service Criteria**

| Control Delay (s/veh) | Level of Service by Volume-to-Capacity Ratio* | |
|---|---|---|
| | v/c ≤ 1.0 | v/c > 1.0 |
| 0-10 | A | F |
| >10-15 | B | F |
| >15-25 | C | F |
| >25-35 | D | F |
| >35-50 | E | F |
| >50 | F | F |

*For approaches and intersection-wide assessment, LOS is defined solely by control delay

For roundabouts, v/c ratios in the range of 0.85 to 0.90 represent an approximate threshold for satisfactory operations. Individual lanes with v/c ratios near this threshold should be evaluated to determine the sensitivity of the lane to varying traffic conditions and/or driver behavior.

## DESIGN YEAR ANALYSIS RESULTS

Level of Service (LOS) and 95$^{th}$ percentile queue (feet) results for each control type are provided in this section.

Operations for the roundabout were calculated using the 2010 HCM with California Calibration capacity model (HCM-CA) according to the methodology above. As shown, the proposed roundabout is expected to perform at an acceptable LOS through the 2040 forecast year.

The VISSIM model was run for a number of different years to determine the approximate year when queue lengths for the off-ramp will exceed the available storage length of 750-feet. It was assumed that the project is built by year 2020, as the 2020 "build" traffic volumes from the *SC101 HOV PA-ED Traffic Study (December 2011)* report were used. Traffic volumes were assumed to have straight line growth between 2020 and 2040. As seen in Table 8 below, the queue during AM peak period is projection to exceed the available storage in year 2022, and the PM peak period queue length for the off-ramp will exceed available storage in year 2036.

**Table 9: Maximum Queue Results for East (Northbound US-101 Off-Ramp) Approach**

| Max Queue (ft.) | | | Simulated | |
|---|---|---|---|---|
| **Year** | **Approach Lane** | **Location** | **AM** | **PM** |
| 2014 | East | 101 NB Off-Ramp | 104.05 | 14.13 |
| 2020 | East | 101 NB Off-Ramp | 530.80 | 134.70 |
| 2021 | East | 101 NB Off-Ramp | 634.50 | 137.40 |
| 2022 | East | 101 NB Off-Ramp | 827.70* | 101.00 |
| 2030 | East | 101 NB Off-Ramp | 1560.20 | 242.90 |
| 2034 | East | 101 NB Off-Ramp | 1664.50 | 440.20 |
| 2036 | East | 102 NB Off-Ramp | 1666.80 | 784.50* |
| 2040 | East | 101 NB Off-Ramp | 1672.40 | 1616.20 |

* Projected queue length exceeds available storage on off-ramp (750-feet)

## ANALYSIS RESULTS

**Table 10. Year 2040 US 101 at Olive Mill Road All Way Stop Control with Existing Lane Configuration**

| Approach | Movement | Level of Service (LOS) | | Volume to Capacity Ratio | | Delay (seconds/vehicle) | | 95th % Queue (feet)[1] | | Storage (feet)[2] | Adequate Storage (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | AM | PM | AM | PM | AM | PM | AM | PM | | |
| Northbound – Olive Mill Road | L/T/R | F | F | 0.47 | 0.45 | 101.7 | 97.3 | 160.4 | 235.6 | 275 | No |
| Westbound – US-101 NB-Off Ramp | L/T/R | F | F | 1.02 | 1.03 | 195.6 | 228.0 | 1,672.4 | 1,616.2 | 750 | Yes |
| Westbound – Jameson Lane | L/T/R | E | C | 0.49 | 0.50 | 36.8 | 19.2 | 148.9 | 131.5 | 710 | No |
| Southbound – Olive Mill Road | L/T/R | F | F | 0.50 | 0.61 | 101.7 | 97.3 | 160.4 | 235.6 | 720 | No |
| Eastbound – Coast Village Road | Left | D | F | 0.40 | 0.61 | 22.0 | 69.6 | 112.3 | 365.9 | 410 | No |
| | T/R | F | F | 0.36 | 0.86 | 28.0 | 95.7 | 206.9 | 1,603 | 150 | Yes |

1. Rounded up to the nearest 25 feet
2. Storage = Available storage to the nearest local street intersection or distance to ramp gore point
**Bold and shaded indicates inadequate condition**

**Table 11. Year 2040 US 101 at Olive Mill Road Signalized Intersection Control with Existing Lane Configuration**

| Approach | Movement | Level of Service (LOS) | | Volume to Capacity Ratio | | Delay (seconds/vehicle) | | 95th % Queue (feet)[1] | | Storage (feet)[2] | Adequate Storage (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | AM | PM | AM | PM | AM | PM | AM | PM | | |
| **Northbound – Olive Mill Road** | L/T/R | F | F | 1.07 | 1.22 | 117 | 169 | 681 | 775 | 275 | Yes |
| **Westbound – US-101 NB-Off Ramp** | L/T/R | F | F | 0.93 | 1.35 | 121 | 228.3 | 221 | 633 | 750 | No |
| **Westbound – Jameson Lane** | L/T/R | E | F | 1.08 | 1.10 | 62 | 111.1 | 680 | 286 | 710 | No |
| **Southbound – Olive Mill Road** | L/T/R | F | F | 1.06 | 1.16 | 135 | 155 | 448 | 626 | 720 | No |
| **Eastbound – Coast Village Road** | Left | F | E | 0.88 | 0.70 | 101 | 68.2 | 321 | 330 | 410 | No |
| | T/R | F | F | 1.08 | 1.41 | 139 | 242.2 | 451 | 889 | 150 | Yes |

1. Rounded up to the nearest 25 feet
2. Storage = Available storage to the nearest local street intersection or distance to ramp gore point

**Table 12. Year 2040 US 101 at Olive Mill Road Proposed Roundabout Alternative**

| Approach | Movement | Level of Service (LOS) | | Volume to Capacity Ratio | | Delay (seconds/vehicle) | | 95th % Queue (feet)[1] | | Storage (feet)[2] | Adequate Storage (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | AM | PM | AM | PM | AM | PM | AM | PM | | |
| **Northbound – Olive Mill Road** | L/T | B | C | 0.463 | 0.546 | 10.5 | 16.3 | 68.2 | 79.1 | 275 | Yes |
| | R | A | A | 0.066 | 0.259 | 5.0 | 9.7 | 6.7 | 26.8 | 85 | No |
| **Westbound – US-101 NB-Off Ramp** | L/T/R | B | A | 0.548 | 0.425 | 12.8 | 9.9 | 92 | 59 | 700 | No |
| **Westbound – Jameson Lane** | L/T/R | B | A | 0.363 | 0.315 | 10.9 | 8.3 | 43 | 37 | 670 | No |
| **Southbound – Olive Mill Road** | L/T/R | A | B | 0.327 | 0.497 | 8.6 | 12.2 | 38 | 74 | 735 | No |
| Coast Village Road | LT/R | A | C | 0.411 | 0.772 | 7.8 | 18.9 | 60 | 239 | 425 | No |

1. Rounded up to the nearest 25 feet
2. Storage = Available storage to the nearest local street intersection or distance to ramp gore point
*Italics and shaded represent mitigated lane configuration changes*