1. CALL TO ORDER

2. ROLL CALL
   Chair Patz
   Vice Chair Biri
   Commissioner Emerson
   Commissioner Mejia
   Commissioner Seaman
   Commissioner Wilhelm
3. PLEDGE OF ALLEGIANCE

4. ORAL COMMUNICATION
   At this time any individual in the audience may address the Traffic Commission
   and speak on any item within the subject matter jurisdiction of the Commission.
   Please state if you wish to speak on an item on the Agenda. Remarks are to be
   limited to not more than five minutes.

5. APPROVAL OF MINUTES
   A. Approve the Minutes for the Regular Meeting of June 8, 2016.

6. STAFF REPORTS
   A. Consideration of a Signal Modification at Los Alamitos Boulevard at
      Rossmoor Way and Bradbury Road
      A request has been received by the Traffic Commission to look at
      changing the left-turn signal phases at Los Alamitos Boulevard @
      Rossmoor Way and Bradbury Road going into the Highlands
      Neighborhood.

      Recommendation: Based on the findings of Staff’s analysis, the
      installation of protected-permissive left-turn phasing is not recommended.

7. ITEMS FROM THE PUBLIC WORKS DEPARTMENT
   A. Traffic Commission Status Log.

8. TRAFFIC COMMISSION INITIATED BUSINESS
   At this time, Commissioners may report on items not included on the agenda, but
   no such matter may be discussed, nor may any action be taken in which there is
   interest to the community, except as to provide Staff direction to report back or to
   place the item on a future agenda.

9. ADJOURNMENT

I hereby certify, under penalty of perjury under the laws of the State of California that the foregoing
Agenda was posted at the Community Center, Museum, and City Hall not less than 72 hours prior to the
meeting. Dated this 7th day of July, 2016.

Dawn Sallade, Department Secretary
MINUTES OF TRAFFIC COMMISSION MEETING
OF THE CITY OF LOS ALAMITOS

REGULAR MEETING – June 8, 2016

1. CALL TO ORDER

A Regular meeting of the Traffic Commission was called to order at 7:06 PM on June 8, 2016, in the Council Chambers, 3191 Katella Avenue, Los Alamitos, California, Chair Patz presiding.

2. ROLL CALL

Present: Commissioners: Chair Daniel Patz
Vice Chair Gina Biri
Commissioner Dave Emerson
Commissioner Javier Mejia
Commissioner James Wilhelm

Absent: Commissioner Jason Seaman

Chair Patz reported that Commissioner Seaman notified both he and the Department Secretary via email a few weeks ago that he would be out of town on business and would be absent from this meeting. This will be counted as an excused absence.

Present: Staff: Steven Mendoza, Development Services Director
Vanessa Munoz, Traffic Engineer
Sergeant Gallagher, Police Department
Dawn Sallade, Department Secretary

3. PLEDGE OF ALLEGIANCE

The Pledge of Allegiance was led by Vice Chair Biri.

4. ORAL COMMUNICATIONS

Chair Patz opened the meeting for Oral Communications. There being no speakers, the Chair closed Oral Communications.

5. INTRODUCTION

Introduction of Vanessa Munoz as Traffic Engineer, Ruth Smith’s temporary replacement.

Development Services Director Steven Mendoza introduced Ms. Munoz and gave a brief overview of her qualifications and her duties at Willdan Engineering.

Ms. Munoz indicated she’ll be handling the Traffic Commission meetings until another employee of Willdan Engineering takes the Traffic Engineer duties. She expanded on her experience.
6. **APPROVAL OF MINUTES**

A. **Approve the Minutes for the Regular Meeting of May 11, 2016.**

Chair Patz pointed out a correction on:

- Page 7, Section 8, second line, "...need to come before the Commission...".

Commissioner Wilhelm pointed out a correction on:

- Pages 5, second line from the bottom, "...stipulate that a business must provide the sufficient parking...".

Commissioner Emerson pointed out the following corrections:

- Page 5, fifth paragraph, fifth sentence, "...anything necessary on the right (south) of each exit. He reported that from his own...".

- And on Page 4, fifth paragraph, first line, "...read into record a letter from Ralph Vardabedian...". He said he felt that that letter should be attached to the back of the official Minutes or summarized or something since they were read into record. He said he would like to have it added as it's an important piece of the discussion.

- Page 7, fourth paragraph, third line, "Following discussion, it was determined that the "Limit Lines" and "Keep Clear" on F-9 (Farquhar & Pine) would remain but the "Limit Lines" and "Keep Clear" lines on F-10 (Farquhar & Cherry) will be removed."

Chair Patz pointed out a correction:

- Page 7, second paragraph, first line, "Chair Patz asked what the status...".

Motion/Second: Biri/Mejia

Unanimously Carried 5/0/0 (Seaman absent): The Traffic Commission approved the minutes of the Regular meeting of May 11, 2016, with corrections as noted above.

7. **STAFF REPORTS**

A. **Continuing Education – “Setting Speed Limits”**

Staff will present the Commission with a PowerPoint presentation on setting speed limits.

Traffic Engineer Vanessa Munoz summarized the Staff report and educated the Traffic Commission and Staff on the process of setting speed limits.
Following a long discussion, the Traffic Commission thanked Ms. Munoz for her most informative presentation.

8. TRAFFIC COMMISSION INITIATED BUSINESS

Commissioner Mejia
- Asked about the parking signs that were put up at Laurel Park as they still have the blank spot where the Municipal Code section should be and wondered if this is a necessity.

Ms. Munoz indicated that Ruth Smith had followed up with the City Attorney regarding this and he indicated that the Municipal Code section does not need to be on the sign.

Commissioner Emerson
- Bloomfield and Cerritos intersection – Would be a logical place for a protected/permission traffic light.

Mr. Mendoza indicated this is on the 7-year CIP list but it won’t be in the first year of that 7-year plan.

Officer Gallagher interjected that from a law enforcement standpoint, it would be an incredibly dangerous situation for this to occur. This is due to the proximity of the school as this tends to be where the greatest threat is due to the driver watching for traffic instead of pedestrians crossing the road.

Commissioner Emerson withdrew his request.

- Protected/permission traffic light at the two entrances to Rossmoor Highlands which is Rossmoor Way and Bradbury Way. It is a protected light currently.

Officer Gallagher indicated he sees no safety issue with this request.

Chair Patz inquired as to the cost of conversion.

Ms. Munoz answered that the cost would vary depending on what size pole there is currently. She would have to do some research before giving cost information.

Ms. Munoz indicated that from a traffic engineering standpoint, she would have to research the history of why this intersection was fully protected instead of protected/permission. For liability purposes, Staff would have to document it very clearly before downgrading.

Traffic Commission Meeting Minutes
June 8, 2016
Page 3 of 4
Motion/Second: Emerson/Mejia
Carried 5/0/0 (Seaman absent): The Traffic Commission approved the request to agendize the proposed Protected/Permissive traffic light at the two entrances to Rossmoor Highlands on Rossmoor Way and Bradbury Way (south bound left turns only) and also include a rough pricing estimate in the information as well.

Commissioner Mejia asked on a study such as this, wouldn’t it be more common to do both north bound and south bound?

Ms. Munoz answered that that is correct. There are some cities that do use the mix of operation and she feels that that kind of operation is such that it confuses the drivers. Most municipalities tend to be consistent (both protected and protected/permissive).

Following discussion, Commission Emerson wanted to amend his motion as follows:

Motion/Second: Emerson/Mejia
Carried 5/0/0 (Seaman absent): The Traffic Commission approved the request to agendize the proposed Protected/Permissive traffic light at the two entrances to Rossmoor Highlands on Rossmoor Way and Bradbury Way (south bound and north bound) and also include a rough pricing estimate in the information as well.

- Reported he would not be present at the July Traffic Commission meeting.

9. **ADJOURNMENT**

The Traffic Commission adjourned at 8:07 PM.
To: Chair Patz and Members of the Traffic Commission
From: Vanessa Munoz, Traffic Engineer
Subject: Consideration of a Signal Modification at Los Alamitos Boulevard at Rossmoor Way and Bradbury Road

Summary: A request has been received by the Traffic Commission to look at changing the left-turn signal phases at Los Alamitos Boulevard at Rossmoor Way and Bradbury Road going into the Highlands Neighborhood.

Recommendation: Based on the findings of Staff's analysis, the installation of protected-permissive left-turn phasing is not recommended.

Background

Hartzog & Crabill, Inc. (HCI) has completed a Left-Turn Phasing Warrant Analysis for the subject intersections. The analysis was completed on November, 2012 in response to the City’s request to verify if protected-permissive left-turn phasing is warranted, and recommended based on meeting standard guidelines.

Recommendation

At the present time, the intersections are signalized with a 5-phase operation with protected left-turn phasing on Los Alamitos Boulevard. The California Manual of Uniform Traffic Control Devices (California MUTCD) was used for defining the requirements for left-turn phasing, as well as the Highway Capacity Manual (HCM) and Institute of Traffic Engineers (ITE) Traffic Engineering Handbook. Based on these guidelines, there are four conditions considered for left-turn phasing:

1) Accident History;
2) Delay;
3) Traffic Volumes; and
4) Miscellaneous (i.e., impaired sight distance, roadway curvature, etc.).
Based on the findings of the analysis, the installation of protected-permissive left-turn phasing is not recommended due to the following reasons:

**Los Alamitos Boulevard and Rossmoor Way**

There were sufficient traffic volumes that met all three reference guidelines for supporting the current installation of fully-protected left-turn phasing.

Sight distance is considered restrictive for the northbound left-turning driver, as the actual sight distance measured to the nearest oncoming lane of traffic is less than 400 feet when a vehicle was in the opposing left-turn lane.

There are three opposing lanes with a significant amount of oncoming traffic that left-turning drivers would need to account for under the ‘permissive’ portion.

Recognizing that this intersection already has fully-protected left-turn phasing on Los Alamitos Boulevard, and one left-turn collision still occurred within the last 10 years, it can be expected that an increase in left-turn type accidents will occur if modified to protected-permissive.

**Los Alamitos Boulevard and Bradbury Road**

There are sufficient traffic volumes that satisfy all three reference guidelines for supporting the current installation of fully-protected left-turn phasing.

There are three opposing lanes with a significant amount of oncoming traffic that left-turning drivers need to account for under the ‘permissive’ portion. The northbound approach (south leg of the intersection) has a posted speed limit of 45 MPH, which is considered ‘higher’ roadway speeds. Recognizing that this intersection already has fully-protected left-turn phasing on Los Alamitos Boulevard, it can be expected that left-turn type accidents may occur if modified to protected-permissive.

To comply with current CA MUTCD guidelines for traffic signal timing, a Citywide traffic signal timing analysis is being performed on all signalized intersections. Once completed, a more focus review of the left turn phasing operation for the subject intersections can be furthered analyzed to ensure the left turn phasing operation has been optimized.

**Fiscal impact**

None

**Attachments:**
1) Left Turn Phasing Analysis – Los Alamitos Boulevard Rossmoor Way
2) Left turn Phasing Analysis – Los Alamitos Boulevard Bradbury Road
3) Traffic Commission Staff Report - December 12, 2012
4) Meeting Minutes - December 12, 2012
November 7, 2012

Mr. Dave Hunt, P.E.
Director of Public Works/City Engineer
City of Los Alamitos
3191 Katella Avenue
Los Alamitos, CA 90720

Subject: Left-Turn Phasing Analysis at the Intersection of Los Alamitos Boulevard and Rossmoor Way

Dear Mr. Hunt:

Hartzog & Crabill, Inc. (HCI) has completed a Left-Turn Phasing Warrant Analysis for the subject intersection. As you will see in the attached report, the findings of this study show that the modification from protected to protected-permissive left-turn phasing on Los Alamitos Boulevard is not recommended for this intersection.

The analysis was completed in response to the City’s request to verify if protected-permissive left-turn phasing is warranted, and recommended based on meeting standard guidelines. At the present time, the intersection is signalized with a 5-phase operation with protected left-turn phasing on Los Alamitos Boulevard. The California Manual of Uniform Traffic Control Devices (California MUTCD) was used for defining the requirements for left-turn phasing, as well as the Highway Capacity Manual (HCM) and Institute of Traffic Engineers (ITE) Traffic Engineering Handbook. Based on these guidelines, there are four conditions considered for left-turn phasing: 1) Accident History; 2) Delay; 3) Traffic Volumes; and 4) Miscellaneous (i.e., impaired sight distance, roadway curvature, etc.).

Based on the findings of our analysis, the installation of protected-permissive left-turn phasing is not recommended due to the following reasons:

- There were sufficient traffic volumes that met all three reference guidelines for supporting the current installation of fully-protected left-turn phasing.
- Sight distance is considered restrictive for the northbound left-turning driver, as the actual sight distance measured to the nearest oncoming lane of traffic is less than 400 feet when a vehicle was in the opposing left-turn lane.
There are three opposing lanes with a significant amount of oncoming traffic that left-turning drivers would need to account for under the 'permissive' portion.

Recognizing that this intersection already has fully-protected left-turn phasing on Los Alamitos Boulevard, and one left-turn collision still occurred within the last 10 years, it can be expected that an increase in left-turn type accidents will occur if modified to protected-permissive.

It has been our pleasure to prepare this analysis for the City of Los Alamitos. If you have any questions or need more information please call (714) 731-9455.

Regards,
HARTZOG & CRABILL, INC.

Mark J. Esposito, PE, TE, PTOE
Project Manager

Attach: Left-Turn Phasing Analysis Report
LEFT-TURN PHASING ANALYSIS:

INTERSECTION OF
LOS ALAMITOS BOULEVARD AND ROSSMOOR WAY
IN THE CITY OF LOS ALAMITOS, CA

INTRODUCTION

The City of Los Alamitos requested Hartzog & Crabill, Inc. (HCI) to complete a Left-Turn Phasing Warrant Analysis at the intersection of Los Alamitos Boulevard and Rossmoor Way. This analysis was completed in order to verify if protected-permissive left-turn phasing is warranted for the left-turns on Los Alamitos Boulevard onto Rossmoor Way, and recommended based on meeting standard guidelines. The location is a residential intersection with Los Alamitos Boulevard running in the north-south directions and Rossmoor Way in the east-west directions. The intersection is located east of the I-605 Freeway, and south of Katella Avenue (see Location Map below). Presently, the intersection is signalized with a 5-phase operation, with protected left-turn phasing on the northbound and southbound approaches. This analysis will study if the protected left-turn phasing on Los Alamitos Boulevard may be modified to protected-permissive left-turn phasing.

[Location Map]
Left-Turn Phasing Analysis: Los Alamitos Boulevard at Rossmoor Way, in Los Alamitos, CA

BACKGROUND

Los Alamitos Boulevard is a north-south major arterial roadway. At the intersection with Rossmoor Way, the roadway has residential properties on both sides and a street width of approximately 90 feet. The painted striping provides for three through lanes of traffic with a dedicated left-turn lane for each direction. There is a raised landscaped median on both legs of Los Alamitos Boulevard, and curb, gutter, and sidewalk improvements along both sides of the roadway. Los Alamitos Boulevard has a posted speed limit of 40 MPH. On-street parking is restricted on both sides of the road with No Stopping Any Time signs. Currently, the traffic signal provides for protected left-turn phasing on Los Alamitos Boulevard when turning left onto Rossmoor Way.

See Exhibit 1 (next page) for photo images of Los Alamitos Boulevard.

Rossmoor Way is a residential roadway that varies in street width at its intersection with Los Alamitos Boulevard, with a 76-foot street width on the west leg and 60 feet on the east leg. The striping also varies at the intersection, with two through lanes of traffic in each direction on the west leg, and a single lane of traffic in each direction on the east leg. The directions on both legs are separated by raised landscaped medians. There are curb, gutter, and sidewalk improvements along both sides of Rossmoor Way, which has a posted speed limit of 25 MPH. On-street parking is allowed on both sides of the roadway, with exception to some red curb on the east leg near the intersection. Currently, the traffic signal provides for permissive phasing on Rossmoor Way when turning left onto Los Alamitos Boulevard.

See Exhibit 2 (following page) for photo images of Rossmoor Way.
Left-Turn Phasing Analysis: Los Alamitos Boulevard at Rossmoor Way, in Los Alamitos, CA

EXHIBIT 2

Rossmoor Way (Looking Eastbound) @ Los Alamitos Boulevard

Rossmoor Way (Looking Westbound) @ Los Alamitos Boulevard
LEFT-TURN PHASING ANALYSIS

The approach for this analysis follows typical left-turn phasing warrant studies (i.e., analysis of warrants for protected left-turn phasing when only permissive phasing exists). However, as the intersection already has protected left-turn phasing, particular guidelines will be focused on and under careful consideration to help determine if the possible modification to protected-permissive is recommended or not.

As is common practice with many municipal agencies, the City of Los Alamitos has an adopted practice for using State guidelines as reference standards in order to provide uniformity and consistency in terms of traffic control. Therefore, the following three prevailing sources that address this topic were considered: 1) State of California Manual of Uniform Traffic Control Devices (California MUTCD); 2) State of California Highway Capacity Manual (HCM); as well as 3) Institute of Traffic Engineers (ITE) Traffic Engineering Handbook. These sources were referenced because some diversity exists between them regarding left-turn phasing guidelines (see Appendix A for all three applicable guidelines).

Based on the comprehensive State guidelines found in the California MUTCD, which are most-typically referenced, there are four conditions that are considered for left-turn phasing: 1) Accident History; 2) Volume; 3) Delay; and 4) Miscellaneous. If any one of these conditions is met, then protected left-turn phasing should be considered.

Accident history, traffic volume data, and sight distance (visibility) are the conditions most often studied by HCI for this type of analysis, since they provide a good overall picture of the intersection characteristics. Consequently, the following analysis has focused on these three conditions to determine if protected-permissive left-turn phasing is warranted and recommended for the northbound and southbound approaches of Los Alamitos Boulevard.
Left-Turn Phasing Analysis: Los Alamitos Boulevard at Rossmoor Way, in Los Alamitos, CA

**Accident History**
The guidelines for left-turn phasing contained in the California MUTCD regarding accidents require a minimum of five (5) left-turn collisions for a particular left-turn movement during a recent 12-month period. The HCM does not include guidelines on collisions; however, the ITE guidelines do call for a minimum of (8) left-turn-related accidents occurring within the last three years at any one approach with permissive-only phasing.

In recognition that this intersection already has fully-protected left-turn phasing on Los Alamitos Boulevard, it can be expected that there may be no (or minimal) left-turn type accidents. Typically, left-turn type accidents are categorized as ‘Broadside’ or ‘Head-On’. If there are a considerable amount of these types of accidents still occurring, then the finding may not support modification to protected-permissive left-turn phasing.

The available accident history reported for the intersection was gathered from the California Highway Patrol Statewide Integrated Traffic Records System (SWITRS). More specifically, a comprehensive 10-year traffic collision history summary report was prepared and reviewed for any left-turn type collisions (*attached in Appendix B*).

As shown in the summary report, there were a total of (24) collisions reported at or near this intersection between years 2001 and 2011. Of these, only one was found involving north-south left-turning movements at the intersection (highlighted). Therefore, protected-permissive left-turn phasing may be further considered, if other factors such as ‘less than minimum’ traffic volumes and adequate sight distance support it as well.

**Traffic Volumes**
Again, recognizing that this intersection already has protected left-turn phasing on Los Alamitos Boulevard, it can be expected that minimum left-turn traffic volumes are met for this installation. If the minimum left-turn volume guidelines are not reached, the finding may further support modification to protected-permissive left-turn phasing.
As stated in the California MUTCD and noted below, protected left-turn phasing should be considered when the following left-turn traffic volume criteria are met:

For a pretimed signal or a background-cycle-controlled actuated signal, a left turn volume of more than two vehicles per approach per cycle for a peak hour; or for a traffic-actuated signal, 50 or more left turning vehicles per hour in one direction with the product of the turning and conflicting through traffic during the peak hour of 100,000 or more.

This particular intersection is a semi-actuated traffic signal since it has vehicle detection loops on each approach. Therefore, (50) or more left-turning vehicles per hour in one direction are required, along with the left/conflicting-through vehicle product of 100,000. The ITE guidelines similarly have minimum cross-products of 100,000 and 144,000 when opposed by 3 or 2 lanes, respectively.

It is noted, the conflicting-through, or opposing, traffic volumes used in this analysis do include the right-turning traffic. This is due to left-turning drivers on Los Alamitos Boulevard most likely yielding to right-turners as well as through-traffic since it may require merging/sharing the Rossmoor Way lane.

Intersection peak-hour turning movement counts were gathered at the intersection of Los Alamitos Boulevard and Rossmoor Way to determine the activity level during a typical mid-week time period. The traffic volumes were collected on Tuesday, September 18, 2012. The morning peak-hour was determined to start at 7:15 AM and the afternoon peak-hour at 4:45 PM.

Peak-hour traffic volume data is included in Appendix C.

Table 2 on the next page summarizes the weekday peak-hour traffic counts.
Left-Turn Phasing Analysis: Los Alamitos Boulevard at Rossmoor Way, in Los Alamitos, CA

Traffic Volumes (continued)

TABLE 2
INTERSECTION WEEKDAY
PEAK-HOUR VEHICLE TURNING MOVEMENT COUNTS

<table>
<thead>
<tr>
<th>Intersection</th>
<th>Peak Hour</th>
<th>Northbound</th>
<th>Southbound</th>
<th>Eastbound</th>
<th>Westbound</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L  T  R</td>
<td>L  T  R</td>
<td>L  T  R</td>
<td>L  T  R</td>
</tr>
<tr>
<td>Los Alamitos Boulevard and Rossmoor Way</td>
<td>AM</td>
<td>72 1476 7</td>
<td>33 1237 100</td>
<td>175 19 66</td>
<td>9 33 110</td>
</tr>
<tr>
<td></td>
<td>PM</td>
<td>30 1429 13</td>
<td>95 1698 59</td>
<td>54 8 36</td>
<td>8 5 59</td>
</tr>
</tbody>
</table>

L = Left-turning vehicles
T = Through vehicles
R = Right-turning vehicles

As highlighted in Table 2 above, the northbound and southbound left-turn movements meet the minimum (50) left-turning vehicles per hour in one direction that is needed to partially satisfy the California MUTCD Traffic Volume guideline described above.

The remaining portion of the guideline specifies that the product of the left-turning movement and the conflicting-through traffic during the peak-hour equal 100,000 or greater. As shown in Table 3 below, this portion of the guideline is satisfied for the southbound left-turn approach to the intersection, while the northbound approach is imminent (96%). The northbound approach can be considered satisfied as another day’s count may result in the difference of three more vehicles. Therefore, the volumes do meet the minimum product of 100,000 per CA MUTCD and ITE guidelines.

TABLE 3
LEFT-TURN PHASING CROSS-PRODUCT CHECK
LOS ALAMITOS BOULEVARD AT ROSSMOOR WAY

<table>
<thead>
<tr>
<th>Product of Left-Turns and Opposing Through Movements</th>
<th>Peak Hour</th>
<th>Northbound</th>
<th>Southbound</th>
<th>Eastbound</th>
<th>Westbound</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AM</td>
<td>72 1337 96,264</td>
<td>33 1483 48,939</td>
<td>175 143 25,025</td>
<td>9 85 765</td>
</tr>
<tr>
<td></td>
<td>PM</td>
<td>30 1757 52,710</td>
<td>95 1442 136,990</td>
<td>54 64 3,456</td>
<td>8 44 352</td>
</tr>
</tbody>
</table>

Hartzog & Crabill, Inc.
Traffic Volumes (continued)

In comparison to the California MUTCD, the guidelines given in the Highway Capacity Manual (HCM), 2010 edition, have minimum cross-products that are associated with the number of opposing through-lanes. The threshold set by the HCM establishes a minimum cross-product of 50,000 for left-turns opposed by one (1) through-lane, 90,000 when opposed by (2) lanes, and 110,000 with (3) opposing lanes. Similarly, it is shown from the table above that the southbound left-turn approach does meet the minimum product of 110,000 in the afternoon. It is common engineering practice to install left-turn phasing in both opposing directions, even if only one direction meets the guidelines, to provide consistency for drivers’ expectations. Consequently, the traffic volumes do support the existing installation of fully-protected left-turn phasing on Los Alamitos Boulevard.

Miscellaneous

Speeds

As mentioned, Los Alamitos Boulevard has a posted speed limit of 40 MPH and an 85th percentile (critical) speed of 42.6 MPH (see Appendix D). These speeds correspond with speeds that may be expected on an urbanized three-lane arterial roadway. Although posted 40 MPH, it is not uncommon to find drivers travelling approximately 5 MPH over the speed limit. Consequently, a 45 MPH speed was also considered in this analysis.

Sight Distance

The geometry of the intersection is relatively flat and does not have horizontal and vertical roadway curvature to account for. It was found that the geometry presents a roadway intersection that does not need special traffic signal head locations for impaired visibility or advanced signage for overall improved sight distance. As Los Alamitos Boulevard is a truck route, buses and trucks were observed on Los Alamitos Boulevard; however, none were observed making left-turns at this residential intersection.
Sight Distance  *(cont’d)*

Sight distance for the left-turning drivers was especially considered during our field-review of the surrounding urbanized residential environment. More specifically, a left-turning driver’s sight distance, or visibility, was measured from a typical stopped-vehicle location in the northbound and southbound left-turn lanes. The measured distances were applied to the Stopping Sight Distance as a Function of Speed Guidelines found in the California MUTCD *(see Appendix E)*. In these guidelines, roadway speeds of 40 and 45 MPH recommend a minimum Stopping Sight Distance of 305 and 360 feet, respectively. The HCM does not include guidelines on sight distance. The ITE guidelines state that restrictive sight distance is when there is less than 400 feet for roadway speeds of 40 MPH or more. As a result, 400 feet was used for sight distance.

The 400-foot stopping sight distance was field-measured from a typical ‘stopped’ left-turning vehicle location looking towards the nearest lane of on-coming traffic. An orange cone was set on the lane line at this distance. As shown in Exhibits 3 and 4 on the next pages, a photograph was then taken from a left-turning driver’s perspective in order to determine if a clear line of sight to the cone was met.

As can be seen, the field measurement for actual ‘clear’ sight distance for a southbound left-turning vehicle resulted in at least 400 feet. However, the field measurement for a northbound left-turning vehicle resulted in less than 400 feet due to a stopped left-turning vehicle in the opposing left-turn lane. Therefore, sight distance is considered restrictive for this particular left-turn movement as a driver cannot clearly see an oncoming vehicle in the nearest lane when a vehicle is in the opposing left-turn lane.
EXHIBIT 3

SB Los Alamitos Boulevard Looking at Oncoming NB Traffic

Aerial Image of SB Los Alamitos Boulevard Looking at Oncoming NB Traffic
Left-Turn Phasing Analysis: Los Alamitos Boulevard at Rossmoor Way, in Los Alamitos, CA

EXHIBIT 4

NB Los Alamitos Boulevard Looking at Oncoming SB Traffic

Aerial Image of NB Los Alamitos Boulevard Looking at Oncoming SB Traffic

Hartzog & Crabill, Inc.
**ANALYSIS SUMMARY**

Based on collisions reported for the intersection during the past 10 years, only one was found to involve north and south left-turning movements. Recognizing that this intersection already has fully-protected left-turn phasing on Los Alamitos Boulevard, it can be expected that an increase in left-turn accidents may occur with protected-permissive left-turn phasing.

Based on the minimum traffic volume guidelines set forth in three references, this analysis showed that existing traffic volumes at this intersection (amount of left-turns and opposing through-movements) did satisfy the minimum volume guidelines for supporting the existing installation of protected left-turn phasing.

Engineering judgment should always be included in any decision regarding traffic improvements; as a result, the geometry of the intersection was noted as not having any horizontal and vertical curvature to consider. Upon field verification, it was found that this geometry presents a roadway intersection that does not need special traffic signal head locations or advanced signage for impaired sight distance or improving overall visibility.

Moreover, a driver's visibility was also checked from a typical stopped left-turning vehicle location on both northbound and southbound approaches. A 400-foot stopping sight distance was field-measured from these locations looking towards the nearest lane of on-coming traffic, and an orange cone was set on the lane line. A photograph was then taken from a driver's perspective in order to determine if a clear line of sight to the cone was met. The actual sight distance for a southbound left-turning vehicle resulted in at least 400 feet; however, the field measurement for a northbound left-turning vehicle resulted in less than 400 feet due to blocking by a stopped left-turning vehicle in the opposing left-turn lane. Therefore, sight distance is considered restrictive for this particular left-turn movement.
RECOMMENDATION

Based on the findings of this analysis, the installation of protected-permissive left-turn phasing is not recommended for the intersection of Los Alamitos Boulevard and Rossmoor Way due to the following reasons:

- There are sufficient traffic volumes that satisfy all three reference guidelines for supporting the current installation of fully-protected left-turn phasing.
- Sight distance is considered restrictive for the northbound left-turning driver, as the actual sight distance measured to the nearest oncoming lane of traffic was less than 400 feet when a vehicle was in the opposing left-turn lane.
- There are three opposing lanes with a significant amount of oncoming traffic that left-turning drivers need to account for.
- Recognizing that this intersection already has fully-protected left-turn phasing on Los Alamitos Boulevard, and one left-turn collision still occurred within the last 10 years, it can be expected that an increase in left-turn type accidents will occur if modified to protected-permissive.
APPENDIX A

LEFT-TURN PHASING GUIDELINES:

CALIFORNIA MUTCD,
HIGHWAY CAPACITY MANUAL,
and
ITE TRAFFIC ENGINEERING HANDBOOK
CIRCULAR RED signal indications and the opposing left-turn signal faces display left-turn GREEN ARROW signal indications for a protected left-turn movement.

E. A supplementary sign shall not be required. If used, it shall be a LEFT TURN YIELD ON FLASHING RED ARROW AFTER STOP (R10-27) sign (see Figure 2B-27).

Option:

The requirements of Item A in Paragraph 5 may be met by a vertically-arranged signal face with a horizontal cluster of two left-turn RED ARROW signal indications, the left-most of which displays a steady indication and the right-most of which displays a flashing indication (see Figure 4D-8).

Section 4D.19 Signal Indications for Protected Only Mode Left-Turn Movements

Standard:

01 A shared signal face shall not be used for protected only mode left turns unless the CIRCULAR GREEN and left-turn GREEN ARROW signal indications always begin and terminate together. If a shared signal face is provided for a protected only mode left turn, it shall meet the following requirements (see Figure 4D-9):

A. It shall be capable of displaying the following signal indications: steady CIRCULAR RED, steady CIRCULAR YELLOW, CIRCULAR GREEN, and left-turn GREEN ARROW. Only one of the three colors shall be displayed at any given time.

B. During the protected left-turn movement, the shared signal face shall simultaneously display both a CIRCULAR GREEN signal indication and a left-turn GREEN ARROW signal indication.

C. The shared signal face shall always simultaneously display the same color of circular indication that the adjacent through signal face or faces display.

D. If the protected only mode is not the only left-turn mode used for the approach, the signal face shall be the same shared signal face that is used for the protected/permissive mode (see Section 4D.20).

Option:

02 A straight-through GREEN ARROW signal indication may be used instead of the CIRCULAR GREEN signal indication in Items A and B in Paragraph 1 on an approach where right turns are prohibited and a straight-through GREEN ARROW signal indication is also used instead of a CIRCULAR GREEN signal indication in the other signal face(s) for through traffic.

Standard:

03 If a separate left-turn signal face is provided for a protected only mode left turn, it shall meet the following requirements (see Figure 4D-10):

A. It shall be capable of displaying, the following signal indications: steady left-turn RED ARROW, steady left-turn YELLOW ARROW, and left-turn GREEN ARROW. Only one of the three indications shall be displayed at any given time. A signal instruction sign shall not be required with this set of signal indications. If used, it shall be a LEFT ON GREEN ARROW ONLY (R10-5) sign (see Figure 2B-27).

B. During the protected left-turn movement, a left-turn GREEN ARROW signal indication shall be displayed.

C. A steady left-turn YELLOW ARROW signal indication shall be displayed following the left-turn GREEN ARROW signal indication.

D. If the protected only mode is not the only left-turn mode used for the approach, the signal face shall be the same separate left-turn signal face that is used for the protected/permissive mode (see Section 4D.20 and Figures 4D-8 and 4D-12) except that the flashing left-turn YELLOW ARROW or flashing left-turn RED ARROW signal indication shall not be displayed when operating in the protected only mode.

Guidance:

Since separate signal phases for protected left turns will reduce the green time available for other phases, alternate means of handling left turn conflicts should be considered first.
Support:
1. Prohibition of left turns. This can be done only if there are convenient alternate means of making the movement. Typical alternate means are:
   a. A series of right and/or left turns around a block to permit getting to the desired destination; or
   b. Making the left turn at an adjacent unsignalized intersection during gaps in the opposing through traffic.
2. Geometric changes to eliminate the left turn. An effective change would be a complete separation or a complete or partial "clover leaf" at grade. Any of these, while eliminating left turns, requires additional cost and right of way.
3. Provide protected-permissive or permissive-protected left turn operation. The protected left turn interval may be prohibited during certain periods of the day to allow only permissive intervals for left turn movement in order to increase the green time available for other phases. Refer to Section 4D.20 for the requirements of protected-permissive or permissive-protected left turn operation.

Guidance:
1. Protected left turn phases should be considered where such alternatives couldn’t be utilized, and one or more of the following conditions exist:
   a. Collisions - Five or more left turn collisions for a particular left turn movement during a recent 12-month period.
   b. Delay - Left-turn delay of one or more vehicles, which were waiting at the beginning of the green interval and are still remaining in the left turn lane after at least 80% of the total number of cycles for one hour.
   c. Volume - At new intersections where only estimated volumes are available, the following criteria may be used. For pretimed signal or a background-cycle-controlled actuated signal, a left turn volume of more than two vehicles per approach per cycle for a peak hour, or for a traffic-actuated signal, 50 or more left turning vehicles per hour in one direction with the product of the turning and conflicting through traffic during the peak hour of 100,000 or more.
   d. Miscellaneous. Other factors that might be considered include but are not limited to: impaired sight distance due to horizontal or vertical curvature, or where there are a large percentage of buses and trucks.

Section 4D.20 Signal Indications for Protected/Permissive Mode Left-Turn Movements

Standard:
1. If a shared signal face is provided for a protected/permissive mode left turn, it shall meet the following requirements (see Figure 4D-11):
   a. It shall be capable of displaying the following signal indications: steady CIRCULAR RED, steady CIRCULAR YELLOW, CIRCULAR green, steady left-turn YELLOW ARROW, and left-turn GREEN ARROW. Only one of the three circular indications shall be displayed at any given time. Only one of the two arrow indications shall be displayed at any given time. If the left-turn GREEN ARROW signal indication and the CIRCULAR GREEN signal indication(s) for the adjacent through movement are always terminated together, the steady left-turn YELLOW ARROW signal indication shall not be required.
   b. During the protected left-turn movement, the shared signal face shall simultaneously display a left-turn GREEN ARROW signal indication and a circular signal indication that is the same color as the signal indication for the adjacent through lane on the same approach as the protected left turn.
   c. A steady left-turn YELLOW ARROW signal indication shall be displayed following the left-turn GREEN ARROW signal indication, unless the left-turn GREEN ARROW signal indication and the CIRCULAR green signal indication(s) for the adjacent through movement are being terminated together. When the left-turn GREEN ARROW and CIRCULAR green signal indications are being terminated together, the required display following the left-turn GREEN ARROW signal indication shall be either the display of a CIRCULAR YELLOW signal indication alone or the simultaneous display of the CIRCULAR YELLOW and left-turn YELLOW ARROW signal indications.
   d. During the permissive left-turn movement, the shared signal face shall display only a CIRCULAR GREEN signal indication.
   e. A protected/permissive shared signal face, regardless of where it is positioned and regardless of how many adjacent through signal faces are provided, shall always simultaneously display the same color of circular indication that the adjacent through signal face or faces display.
F. A supplementary sign shall not be required. If used, it shall be a LEFT TURN YIELD ON GREEN (symbolic circular green) (R10-12) sign (see Figure 2B-27).

o If a separate left-turn signal face is being operated in a protected/permisive left-turn mode, a CIRCULAR GREEN signal indication shall not be used in that face.

o If a separate left-turn signal face is being operated in a protected/permisive left-turn mode and a flashing left-turn yellow arrow signal indication is provided, it shall meet the following requirements (see Figure 4D-12):
   A. It shall be capable of displaying the following signal indications: steady left-turn RED ARROW, steady left-turn YELLOW ARROW, flashing left-turn YELLOW ARROW, and left-turn GREEN ARROW. Only one of the four indications shall be displayed at any given time.
   B. During the protected left-turn movement, a left-turn GREEN ARROW signal indication shall be displayed.
   C. A steady left-turn YELLOW ARROW signal indication shall be displayed following the left-turn GREEN ARROW signal indication.
   D. During the permisive left-turn movement, a flashing left-turn YELLOW ARROW signal indication shall be displayed.
   E. A steady left-turn YELLOW ARROW signal indication shall be displayed following the flashing left-turn YELLOW ARROW signal indication if the permisive left-turn movement is being terminated and the separate left-turn signal face will subsequently display a steady left-turn RED ARROW indication.
   F. It shall be permitted to display a flashing left-turn YELLOW ARROW signal indication for a permisive left-turn movement while the signal faces for the adjacent through movement display steady CIRCULAR RED signal indications and the opposing left-turn signal faces display left-turn GREEN ARROW signal indications for a protected left-turn movement.
   G. When a permisive left-turn movement is changing to a protected left-turn movement, a left-turn GREEN ARROW signal indication shall be displayed immediately upon the termination of the flashing left-turn YELLOW ARROW signal indication. A steady left-turn YELLOW ARROW signal indication shall not be displayed between the display of the flashing left-turn YELLOW ARROW signal indication and the display of the steady left-turn GREEN ARROW signal indication.
   H. The display shall be a four-section signal face except that a three-section signal face containing a dual-arrow signal section shall be permitted where signal head height limitations (or lateral positioning limitations for a horizontally-mounted signal face) will not permit the use of a four-section signal face. The dual-arrow signal section, where used, shall display a GREEN ARROW for the protected left-turn movement and a flashing YELLOW ARROW for the permisive left-turn movement.
   I. During steady mode (stop-and-go) operation, the signal section that displays the steady left-turn YELLOW ARROW signal indication during change intervals shall not be used to display the flashing left-turn YELLOW ARROW signal indication for permisive left turns.
   J. During flashing mode operation (see Section 4D.30), the display of a flashing left-turn YELLOW ARROW signal indication shall be only from the signal section that displays a steady left-turn YELLOW ARROW signal indication during steady mode (stop-and-go) operation.

Option:
   04 A separate left-turn signal face with a flashing left-turn RED ARROW signal indication during the permisive left-turn movement may be used for unusual geometric conditions, such as wide medians with offset left-turn lanes, but only when an engineering study determines that each and every vehicle must successively come to a full stop before making a permisive left turn.

Standard:
   05 If a separate left-turn signal face is being operated in a protected/permisive left-turn mode and a flashing left-turn RED arrow signal indication is provided, it shall meet the following requirements (see Figure 4D-8):
      A. It shall be capable of displaying the following signal indications: steady or flashing left-turn RED ARROW, steady left-turn YELLOW ARROW, and left-turn GREEN ARROW. Only one of the three indications shall be displayed at any given time.
B. During the protected left-turn movement, a left-turn GREEN ARROW signal indication shall be displayed.
C. A steady left-turn YELLOW ARROW signal indication shall be displayed following the left-turn GREEN ARROW signal indication.
D. During the permissive left-turn movement, a flashing left-turn RED ARROW signal indication shall be displayed.
E. A steady left-turn YELLOW ARROW signal indication shall be displayed following the flashing left-turn RED ARROW signal indication if the permissive left-turn movement is being terminated and the separate left-turn signal face will subsequently display a steady left-turn RED ARROW indication.
F. When a permissive left-turn movement is changing to a protected left-turn movement, a left-turn GREEN ARROW signal indication shall be displayed immediately upon the termination of the flashing left-turn RED ARROW signal indication. A steady left-turn YELLOW ARROW signal indication shall not be displayed between the display of the flashing left-turn RED ARROW signal indication and the display of the steady left-turn GREEN ARROW signal indication.
G. It shall be permitted to display a flashing left-turn RED ARROW signal indication for a permissive left-turn movement while the signal faces for the adjacent through movement display steady CIRCULAR RED signal indications and the opposing left-turn signal faces display left-turn GREEN ARROW signal indications for a protected left-turn movement.
H. A supplementary sign shall not be required. If used, it shall be a LEFT TURN YIELD ON FLASING RED ARROW AFTER STOP (R10-27) sign (see Figure 2B-27).

Option:

The requirements of Item A in Paragraph 5 may be met by a vertically-arranged signal face with a horizontal cluster of two left-turn RED ARROW signal indications, the left-most of which displays a steady indication and the right-most of which displays a flashing indication (see Figure 4D-8).

Standard:

Protected/permisive mode left-turn shall not be used for left turn movements that oppose phases that require preemption for rail traffic.

Section 4D.21 Signal Indications for Right-Turn Movements – General

Standard:

In Sections 4D.21 through 4D.24, provisions applicable to right-turn movements and right-turn lanes shall also apply to signal indications for U-turns to the right that are provided at locations where right turns are prohibited or not geometrically possible.

Support:

Right-turning traffic is controlled by one of four modes as follows:
A. Permissive Only Mode—turns made on a CIRCULAR GREEN signal indication, a flashing right-turn YELLOW ARROW signal indication, or a flashing right-turn RED ARROW signal indication after yielding to pedestrians, if any.
B. Protected Only Mode—turns made only when a right-turn GREEN ARROW signal indication is displayed.
C. Protected/Permissive Mode—both modes occur on an approach during the same cycle.
D. Variable Right-Turn Mode—the operating mode changes among the protected only mode and/or the protected/permisive mode and/or the permissive only mode during different periods of the day or as traffic conditions change.

Standard:

During a permissive right-turn movement, the signal faces, if any, that exclusively control U-turn traffic that conflicts with the permissive right-turn movement (see Item F.1 in Section 4D.05) shall simultaneously display steady U-turn RED ARROW signal indications. If pedestrians crossing the lane or lanes used by the permissive right-turn movement to depart the intersection are controlled by pedestrian signal heads, the signal indications displayed by those pedestrian signal heads shall not be limited to any particular display during the permissive right-turn movement.

During a protected right-turn movement, the signal faces for left-turn traffic, if any, on the opposing approach shall not simultaneously display a steady left-turn GREEN ARROW or steady left-turn...
### QUICK ESTIMATION LEFT-TURN TREATMENT WORKSHEET

**General Information**

**Description**

Intersection of Los Angeles Blvd. at Rosemead Way

**Check # 1. Left-Turn Lane Check**

<table>
<thead>
<tr>
<th>Approach</th>
<th>EB</th>
<th>WB</th>
<th>NB</th>
<th>SB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of left-turn lanes</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Protected left turn (Y or N)?</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

If the number of left-turn lanes on any approach exceeds 1, then it is recommended that the left turns on that approach be protected. Those approaches with protected left turns need not be evaluated in subsequent checks.

**Check # 2. Minimum Volume Check**

<table>
<thead>
<tr>
<th>Approach</th>
<th>EB</th>
<th>WB</th>
<th>NB</th>
<th>SB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left-turn volume</td>
<td>75</td>
<td>9</td>
<td>72</td>
<td>95</td>
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<tr>
<td>Opposing mainline volume</td>
<td>143</td>
<td>95</td>
<td>142</td>
<td>142</td>
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<tr>
<td>Opposing through lanes</td>
<td>25,025</td>
<td>765</td>
<td>26,304</td>
<td>26,390</td>
</tr>
<tr>
<td>Protected left turn (Y or N)?</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

If left-turn volume on any approach exceeds 240 veh/h, then it is recommended that the left turns on that approach be protected. Those approaches with protected left turns need not be evaluated in subsequent checks.

**Check # 3. Minimum Cross-Product Check**

<table>
<thead>
<tr>
<th>Approach</th>
<th>EB</th>
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<th>NB</th>
<th>SB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left-turn volume, ( V_t ) (veh/h)</td>
<td>75</td>
<td>9</td>
<td>72</td>
<td>95</td>
</tr>
<tr>
<td>Opposing mainline volume, ( V_m ) (veh/h)</td>
<td>143</td>
<td>95</td>
<td>142</td>
<td>142</td>
</tr>
<tr>
<td>Minimum Cross-Product Values for Recommending Left-Turn Protection</td>
<td>1</td>
<td>50,000</td>
<td>2</td>
<td>90,000</td>
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</tbody>
</table>

If the cross-product on any approach exceeds the above values, then it is recommended that the left turns on that approach be protected. Those approaches with protected left turns need not be evaluated in subsequent checks.

**Check # 4. Sneaker Check**

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<th>Approach</th>
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<th>SB</th>
</tr>
</thead>
<tbody>
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<td>Left-turn volume, ( V_t ) (veh/h)</td>
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<td>9</td>
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<td>95</td>
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<td>Sneaker capacity, ( c_s ) (veh/h)</td>
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<td>60</td>
<td>60</td>
<td>60</td>
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<td>Equivalence factor, ( E_t )</td>
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<td>1.4</td>
<td>7.9</td>
<td>3</td>
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<tr>
<td>Protected left turn (Y or N)?</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

If the equivalence factor is 3.5 or higher (computed in the Quick Estimation Lane Volume Worksheet) and the unadjusted left turn is greater than the sneaker capacity, then it is recommended that the left turns on that approach be protected.

**Notes**

1. If any approach is recommended for left-turn protection but the analyst evaluates it as having permitted operation, then this quick estimation method may give overly optimistic results. The analyst should instead use the methodology described in Chapter 18, Signalized Intersections.
2. All volumes used in this worksheet are unadjusted hourly volumes.

---

**Step 2: Determine Lane Volume**

The lane volume worksheet is shown in Exhibit 31-39. Its purpose is to establish the individual lane flow rate (in veh/h/ln) on each intersection approach. This information is then used in the control delay and level-of-service worksheet to synthesize the signal-timing plan. The directional designations (e.g., RT = right turn, LT = left turn) refer to the traffic movements as they approach the intersection.
The number of through lanes \( N_T \) includes any lane that serves through vehicles. Exclusive turn lanes should be excluded.

For an unopposed shared lane, the total approach volume \( V_{th} \) is the sum of the shared-lane right-turn volume, through volume, and left-turn volume.

### D. Compute Lane Volume for Through Movement with Exclusive Turn Lane

For approaches with an exclusive left-turn lane (or lanes), the through-lane volume \( V_{th} \) is computed by dividing total approach volume by the number of through lanes.

The critical lane volume \( V_{cl} \) is normally the same as the through-lane volume, unless the right turn has an exclusive lane or the left turn is not opposed and either of these movements is more critical than the through movement. If both conditions apply, the critical lane volume will be the largest of the left-lane volume, exclusive right-lane volume, and through-lane volume.

### E. Compute Lane Volume for Through Movement with Shared Lane

The computation of critical lane volume in the case of shared left-turn lanes is more complicated and requires a more detailed computational procedure. The equivalence factor \( E_{th} \) for a permitted left turn is obtained from Exhibit 31-40 or computed with Equation 31-152.

#### Exhibit 31-40

<table>
<thead>
<tr>
<th>Type of Left-Turn Lane</th>
<th>Through-Car Equivalent ( E_{th} ) as a Function of Opposing Flow Rate (veh/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Shared</td>
<td>1.4</td>
</tr>
<tr>
<td>Exclusive</td>
<td>1.3</td>
</tr>
</tbody>
</table>

*Note: Use Equation 31-152, with Equation 31-153, for opposing flow in excess of 1,200 veh/h; \( v_o \) must be \( \geq 0.1 \) veh/h.*

Equation 31-152

\[
E_{th} = \frac{s_o}{s_p} - I_{sh}
\]

with

\[
s_p = \frac{v_o e^{-v_o t_{pc}/3.600}}{1 - e^{-v_o t_{pc}/3.600}}
\]

where

- \( E_{th} \) = equivalent number of through cars for a permitted left-turning vehicle,
- \( s_o \) = base saturation flow rate (pc/h/ln),
- \( s_p \) = saturation flow rate of a permitted left-turn movement (veh/h/ln),
- \( I_{sh} \) = indicator variable for shared lane (= 1.0 if the subject left turn is served in a shared lane, 0 if the subject left turn is served in an exclusive lane),
- \( v_o \) = opposing demand flow rate (veh/h),
- \( t_{ch} \) = critical headway = 4.5 (s), and
Figure 13-7  Recommended Procedure for Determining Type of Left-Turn Phasing


The University of Texas at Arlington has developed guidelines for left-turn phasing based on research, actual field data, easy-to-use quantitative measures, and statistical analysis of most suitable left-turn options. The process favors the least restrictive option—permitted left-turn—unless traffic and geometrics warrant a more restrictive control. The decisions to be made are classified into three levels summarized as follows and shown in Figure 13–8.

Level 1: Permissive-Only Versus Some Protection

The permissive option should be used only if all of the following conditions exist:

Note: This procedure applies to locations with a separate left-turn lane.

---

APPENDIX B

INTERSECTION COLLISION HISTORY DATA
# CITY OF LOS ALAMITOS
## SWITRS COLLISION HISTORY 2001 TO 2011
### INTERSECTION OF LOS ALAMITOS BLVD AND ROSSMOOR WAY

<table>
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<th>CASE ID</th>
<th>COLLISION DATE</th>
<th>COLL. TIME</th>
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<th>SECONDARY ROAD</th>
<th>DISTANCE</th>
<th>DIRECTION</th>
<th>INTERSECTION</th>
<th>WEATHER</th>
<th>COLLISION SEVERITY</th>
<th>PRIMARY COLL. FACTOR</th>
<th>PCF</th>
<th>VIOL</th>
<th>HIT</th>
<th>ROLLOVER</th>
<th>VELOCITY</th>
<th>TYPE OF COLL.</th>
<th>VEHICLE INVOLVED</th>
<th>ROAD SURF.</th>
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<td>2056</td>
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## CITY OF LOS ALAMITOS
### SWITRS COLLISION HISTORY 2001 TO 2011
#### INTERSECTION OF LOS ALAMITOS BLVD AND ROSSMOOR WAY

**NOTES:**
- Weather
- Collision Severity
- Primary Collision Factor
- PCF Violation Category
- Hit and Run
- Type of Collision
- Motor Vehicle Involved With:
- Road Surface

<table>
<thead>
<tr>
<th>Weather 1</th>
<th>Collision Severity</th>
<th>Primary Collision Factor</th>
<th>PCF Violation Category</th>
<th>Hit and Run</th>
<th>Type of Collision</th>
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<tbody>
<tr>
<td>A - Clear</td>
<td>1 - Fatal</td>
<td>A - (Vehicle) Code Violation</td>
<td>01 - Driving or Bicycling Under Influence</td>
<td>F - Felony</td>
<td>A - Head-On</td>
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<td>B - Cloudy</td>
<td>2 - Injury (Severe)</td>
<td>B - Other Improper Driving</td>
<td>02 - Impeding Traffic</td>
<td>M - Misdemeanor</td>
<td>B - Sideswipe</td>
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<td>C - Raining</td>
<td>3 - Injury (Other Visible)</td>
<td>C - Other Than Driver</td>
<td>03 - Unsafe Speed</td>
<td>N - Not Hit &amp; Run</td>
<td>C - Rear-End</td>
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<td>D - Snowing</td>
<td>4 - Injury (Complaint of Pain)</td>
<td>D - Unknown</td>
<td>04 - Following Too Closely</td>
<td>D - Broadside</td>
<td>E - Hit Object</td>
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<td>E - Fog</td>
<td>0 - PDO (Property Damage Only)</td>
<td>E - Fell Asleep</td>
<td>05 - Wrong Side of Road</td>
<td>F - Overtaken</td>
<td>G - Vehicle/Pedestrian</td>
</tr>
<tr>
<td>F - Other</td>
<td>6 - Not Stated</td>
<td>F - Overturned</td>
<td>06 - Improper Pass</td>
<td>H - Other</td>
<td>- - Not Stated</td>
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<td>G - Wind</td>
<td>07 - Unsafe Lane Change</td>
<td>F - Overturned</td>
<td>08 - Improper Turning</td>
<td>10 - Pedestrian ROW</td>
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<td>- - Not Stated</td>
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<tr>
<th>Motor Vehicle Involved With:</th>
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<tbody>
<tr>
<td>A - Non-Collision</td>
<td>11 - Pedestrian Violation</td>
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<tr>
<td>B - Pedestrian</td>
<td>12 - Traffic Signals and Signs</td>
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<td>C - Other Motor Vehicle</td>
<td>13 - Hazardous Parking</td>
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<td>14 - Lights</td>
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<td>E - Parked Motor Vehicle</td>
<td>15 - Brake</td>
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<td>F - Train</td>
<td>16 - Other Equipment</td>
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<td>G - Bicycle</td>
<td>17 - Other Hazardous Violation</td>
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<td>H - Animal</td>
<td>18 - Other Than Driver (or Ped)</td>
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</tr>
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<td>I - Fixed Object</td>
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<tr>
<td>J - Other Object</td>
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<tr>
<td>- - Not Stated</td>
<td>21 - Unsafe Starting or Backing</td>
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<td></td>
<td>22 - Other Improper Driving</td>
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<td>23 - Pedestrian or &quot;Other&quot; Under the Influence</td>
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<td>24 - Fell Asleep</td>
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<tr>
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<td>25 -</td>
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</tr>
<tr>
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Page 2 of 2
APPENDIX C

PEAK-HOUR TURNING MOVEMENT

TRAFFIC VOLUME DATA
## Intersection Turning Movement

**Prepared by:**
National Data & Surveying Services

**Project ID:** CA12_1195_001

**Day:** TUESDAY

**City:** City of Los Alamitos

**Date:** 9/18/2012

**NS/EW Streets:**
- Los Alamitos Blvd
- Rossmoor Way

### AM

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<th>Lanes</th>
<th>NL</th>
<th>NT</th>
<th>NR</th>
<th>SL</th>
<th>ST</th>
<th>SR</th>
<th>EL</th>
<th>ET</th>
<th>ER</th>
<th>WL</th>
<th>WT</th>
<th>WR</th>
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<td>8</td>
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<td>11</td>
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<td>7</td>
<td>241</td>
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<td>313</td>
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<td>8</td>
<td>2</td>
<td>11</td>
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<td>59</td>
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<td>317</td>
<td>1</td>
<td>9</td>
<td>237</td>
<td>9</td>
<td>22</td>
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**TOTAL VOLUMES:**
- NL: 92
- NT: 2716
- NR: 15
- SL: 69
- ST: 2105
- SR: 137
- EL: 248
- ET: 20
- ER: 103
- WL: 14
- WT: 37
- WR: 194
- TOTAL: 5750

**APPROACH %'s:**
- NL: 3.26%
- NT: 96.21%
- NR: 0.53%
- SL: 2.99%
- ST: 91.09%
- SR: 5.93%
- EL: 66.85%
- ET: 5.39%
- ER: 27.76%
- WL: 5.71%
- WT: 15.10%
- WR: 79.18%

### PEAK HR START TIME: 7:15 AM

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**CONTROL:** Signalized
Intersection Turning Movement

Prepared by:
National Data & Surveying Services

Project ID: CA12_1195_001
Day: TUESDAY
City: City of Los Alamitos
Date: 9/18/2012

NS/EW Streets: Los Alamitos Blvd  Los Alamitos Blvd  Rossmoor Way  Rossmoor Way

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TOTAL VOLUMES:

| NL NT NR SL ST SR EL ET ER WL WT WR TOTAL |
| 69 2777 24 176 3089 120 100 27 77 16 12 124 6611 |

APPROACH %:

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PEAK HR START TIME: 4:45 PM

PEAK HR VOL:

| NL NT NR SL ST SR EL ET ER WL WT WR TOTAL |
| 30 1429 13 95 1698 59 54 8 36 8 5 59 3494 |

PEAK HR FACTOR:

| NL NT NR SL ST SR EL ET ER WL WT WR TOTAL |
| 0.971 0.975 0.845 0.750 0.997 |

CONTROL: Signalized
APPENDIX D

ENGINEERING AND TRAFFIC SURVEY

FOR

LOS ALAMITOS BOULEVARD
# CITY OF LOS ALAMITOS

## ENGINEERING AND TRAFFIC SURVEY

### FIELD REVIEW FORM

**LOS ALAMITOS BOULEVARD**

**FIELD REVIEW BY:** C. BUENDIA

**FARQUHAR AVENUE TO BRADBURY ROAD**

**CHECKED BY:** JERRY STOCK

**DATE:** 5/12/03

## FACTORS

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<td>66.9 %</td>
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| **B. ACCIDENT HISTORY** |                       |                       |
| NO. OF MONTHS COVERED | 36                     | 36                    |
| SPEED-RELATED ACCIDENTS | 1                    | 0                     |
| TOTAL ACCIDENTS       | 5                      | 0                     |
| ANNUAL ACCIDENT RATE  | 0.33 ACCIDENTS PER YEAR (SPEED ONLY) | 0.00 ACCIDENTS PER YEAR (SPEED ONLY) |
| ACCIDENTS/MILE, VEH. MILES | 0.05 ACCIDENTS PER MVM (SPEED ONLY) | 0.00 ACCIDENTS PER MVM (SPEED ONLY) |

| **C. TRAFFIC FACTORS** |                       |                       |
| AVERAGE DAILY TRAFFIC | 21,150                 | 21,150                |
| LANE CONFIGURATION    | 3 LANES               | 3 LANES              |
| TRAFFIC CONTROLS      | SIGNAL - FARQUHAR / ORANGEWOOD & > | SIGNAL - ROSSMOOR / BRADBURY |
| CROSSWALKS            | AT SIGNALS            | AT SIGNALS           |
| PEDESTRIAN/BICYCLES   | YES / YES             | YES / YES            |
| TRUCK TRAFFIC         | YES                   | YES                  |
| ON-STREET PARKING     | NO PARKING ANYTIME    | NO PARKING ANYTIME   |
| OTHER (SPECIFY)       |                       |                       |

| **D. ROADWAY FACTORS** |                       |                       |
| LENGTH OF SEGMENT (MILES) | 0.81                 | 0.81                  |
| VERTICAL CURVE         | NONE                  | NONE                  |
| HORIZONTAL CURVE       | NONE                  | NONE                  |
| LATERAL VISIBILITY     | GOOD                  | GOOD                  |
| SURFACE CONDITION      | GOOD                  | GOOD                  |
| SIDEWALKS/DRIVEWAYS   | YES / YES             | YES / NO              |
| STREET LIGHTING        | YES                   | YES                   |
| DRIVEWAY DENSITY       | LIGHT                 | NONE                  |
| OTHER (SPECIFY)        |                       |                       |

| **E. ADJACENT LAND USES** | COMMERCIAL / BUSINESS / RES / CHURCH | RESIDENTIAL |
| RECOMMENDED SPEED LIMIT | 40 MPH                     | 40 MPH       |
| SPEED LIMIT CHANGE?    | NO                         | NO           |
APPENDIX E

STOPPING SIGHT DISTANCE AS A FUNCTION OF SPEED

CALIFORNIA MUTCD
### Table 6C-1. Recommended Advance Warning Sign Minimum Spacing

<table>
<thead>
<tr>
<th>Road Type</th>
<th>Distance Between Signs*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Urban (low speed) - 25 mph or less</td>
<td>100 feet</td>
</tr>
<tr>
<td>Urban (high speed) - more than 25 mph to 40 mph</td>
<td>250 feet</td>
</tr>
<tr>
<td>Urban (high speed) - more than 40 mph</td>
<td>350 feet</td>
</tr>
<tr>
<td>Rural</td>
<td>500 feet</td>
</tr>
<tr>
<td>Expressway / Freeway</td>
<td>1,000 feet</td>
</tr>
</tbody>
</table>

* A speed category to be determined by the highway agency.
** The column headings A, B, and C are the dimensions shown in Figures 6H-1 through 6H-46. The A dimension is the distance from the transition or point of restriction to the first sign. The B dimension is the distance between the first and second signs. The C dimension is the distance between the second and third signs. (The "first sign" is the sign in a three-sign series that is closest to the TTC zone. The "third sign" is the sign that is furthest upstream from the TTC zone.)

### Table 6C-2. Stopping Sight Distance as a Function of Speed

<table>
<thead>
<tr>
<th>Speed*</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 mph</td>
<td>115 feet</td>
</tr>
<tr>
<td>25 mph</td>
<td>155 feet</td>
</tr>
<tr>
<td>30 mph</td>
<td>200 feet</td>
</tr>
<tr>
<td>35 mph</td>
<td>250 feet</td>
</tr>
<tr>
<td>40 mph</td>
<td>305 feet</td>
</tr>
<tr>
<td>45 mph</td>
<td>360 feet</td>
</tr>
<tr>
<td>50 mph</td>
<td>425 feet</td>
</tr>
<tr>
<td>55 mph</td>
<td>495 feet</td>
</tr>
<tr>
<td>60 mph</td>
<td>570 feet</td>
</tr>
<tr>
<td>65 mph</td>
<td>645 feet</td>
</tr>
<tr>
<td>70 mph</td>
<td>730 feet</td>
</tr>
<tr>
<td>75 mph</td>
<td>820 feet</td>
</tr>
</tbody>
</table>

*Posted speed, off-peak 85th-percentile speed prior to work starting, or the anticipated operating speed. Can also be used as Stopping Sight Distance as suggested buffer space length or location for flagger station.

### Table 6C-3. Taper Length Criteria for Temporary Traffic Control Zones

<table>
<thead>
<tr>
<th>Type of Taper</th>
<th>Taper Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merging Taper</td>
<td>at least L</td>
</tr>
<tr>
<td>Shifting Taper</td>
<td>at least 0.5 L</td>
</tr>
<tr>
<td>Shoulder Taper</td>
<td>at least 0.33 L</td>
</tr>
<tr>
<td>One-Lane, Two-Way Traffic Taper</td>
<td>50 feet minimum, 100 feet maximum</td>
</tr>
<tr>
<td>Downstream Taper</td>
<td>50 feet minimum, 100 feet maximum</td>
</tr>
</tbody>
</table>

Note: Use Table 6C-4 to calculate L
November 13, 2012

Mr. Dave Hunt, P.E.
Director of Public Works/City Engineer
City of Los Alamitos
3191 Katella Avenue
Los Alamitos, CA 90720

Subject: Left-Turn Phasing Analysis at the Intersection of Los Alamitos Boulevard and Bradbury Road

Dear Mr. Hunt:

Hartzog & Crabill, Inc. (HCl) has completed a Left-Turn Phasing Warrant Analysis for the subject intersection. As you will see in the attached report, the findings of this study show that the modification from protected to protected-permissive left-turn phasing on Los Alamitos Boulevard is not recommended for this intersection.

The analysis was completed in response to the City’s request to verify if protected-permissive left-turn phasing is warranted, and recommended based on meeting standard guidelines. At the present time, the intersection is signalized with a 5-phase operation with protected left-turn phasing on Los Alamitos Boulevard. The California Manual of Uniform Traffic Control Devices (California MUTCD) was used for defining the requirements for left-turn phasing, as well as the Highway Capacity Manual (HCM) and Institute of Traffic Engineers (ITE) Traffic Engineering Handbook. Based on these guidelines, there are four conditions considered for left-turn phasing: 1) Accident History; 2) Delay; 3) Traffic Volumes; and 4) Miscellaneous (i.e., impaired sight distance, roadway curvature, etc.).

Based on the findings of our analysis, the installation of protected-permissive left-turn phasing is not recommended due to the following reasons:

- There were sufficient traffic volumes that met all three reference guidelines for supporting the current installation of fully-protected left-turn phasing.
- There are three opposing lanes with a significant amount of oncoming traffic that left-turning drivers would need to account for under the ‘permissive’ portion.
- Recognizing that this intersection already has fully-protected left-turn phasing on Los Alamitos Boulevard, it can be expected left-turn type accidents may occur if modified to protected-permissive.

Consulting Traffic Engineers to Government Agencies
It has been our pleasure to prepare this analysis for the City of Los Alamitos. If you have any questions or need more information please call (714) 731-9455.

Regards,
HARTZOG & CRABILL, INC.

Mark J. Esposito, PE, TE, PTOE
Project Manager

Attach: Left-Turn Phasing Analysis Report
LEFT-TURN PHASING ANALYSIS:

INTERSECTION OF
LOS ALAMITOS BOULEVARD AND BRADBURY ROAD
IN THE CITY OF LOS ALAMITOS, CA

INTRODUCTION

The City of Los Alamitos requested Hartzog & Crabill, Inc. (HCI) to complete a Left-Turn Phasing Warrant Analysis at the intersection of Los Alamitos Boulevard and Bradbury Road. This analysis was completed in order to verify if protected-permissive left-turn phasing is warranted for the left-turns on Los Alamitos Boulevard onto Bradbury Road, and recommended based on meeting standard guidelines. The location is a residential/commercial intersection with Los Alamitos Boulevard running in the north-south directions and Bradbury Road in the east-west directions. The intersection is located east of the I-605 Freeway, and south of Katella Avenue (see Location Map below). Presently, the intersection is signalized with a 5-phase operation, with protected left-turn phasing on the northbound and southbound approaches. This analysis will study if the protected left-turn phasing on Los Alamitos Boulevard may be modified to protected-permissive left-turn phasing.
BACKGROUND

Los Alamitos Boulevard is a north-south major arterial roadway. At the intersection with Bradbury Road, the roadway has residential properties on both sides, commercial properties on the southwest corner, and a street width of approximately 90 feet. The painted striping provides for three through lanes of traffic with a dedicated left-turn lane for each direction. There is a raised landscaped median on the north leg of Los Alamitos Boulevard, and curb, gutter, and sidewalk improvements along both sides of the roadway. Los Alamitos Boulevard has a posted speed limit of 40 MPH on the north leg and 45 MPH on the south leg. The street name changes south of this intersection to Seal Beach Boulevard. On-street parking is restricted on both sides of the road with No Stopping Any Time signs. Currently, the traffic signal provides for protected left-turn phasing on Los Alamitos Boulevard when turning left onto Bradbury Road.

See Exhibit 1 (next page) for photo images of Los Alamitos Boulevard.

Bradbury Road is a residential roadway that has a street width of approximately 60 feet. The striping provides for a single lane of traffic in each direction. The directions on the east leg are separated by a raised landscaped median. There are curb, gutter, and sidewalk improvements along both sides of Bradbury Road, which has a posted speed limit of 25 MPH. On-street parking is allowed on both sides of the roadway, with exception to some red curb on the east leg near the intersection. Currently, the traffic signal provides for permissive phasing on Bradbury Road when turning left onto Los Alamitos Boulevard.

See Exhibit 2 (following page) for photo images of Bradbury Road.
Left-Turn Phasing Analysis: Los Alamitos Boulevard at Bradbury Road, in Los Alamitos, CA

EXHIBIT 1

Seal Beach Boulevard (Looking Northbound) @ Bradbury Road

Los Alamitos Boulevard (Looking Southbound) @ Bradbury Road
Left-Turn Phasing Analysis: Los Alamitos Boulevard at Bradbury Road, in Los Alamitos, CA

EXHIBIT 2

Bradbury Road (Looking Eastbound) @ Los Alamitos Boulevard

Bradbury Road (Looking Westbound) @ Los Alamitos Boulevard
LEFT-TURN PHASING ANALYSIS

The approach for this analysis follows typical left-turn phasing warrant studies (i.e., analysis of warrants for protected left-turn phasing when only permissive phasing exists). However, as the intersection already has protected left-turn phasing, particular guidelines will be focused on and under careful consideration to help determine if the possible modification to protected-permissive is recommended or not.

As is common practice with many municipal agencies, the City of Los Alamitos has an adopted practice for using State guidelines as reference standards in order to provide uniformity and consistency in terms of traffic control. Therefore, the following three prevailing sources that address this topic were considered: 1) State of California Manual of Uniform Traffic Control Devices (California MUTCD); 2) State of California Highway Capacity Manual (HCM); as well as 3) Institute of Traffic Engineers (ITE) Traffic Engineering Handbook. These sources were referenced because some diversity exists between them regarding left-turn phasing guidelines (see Appendix A for all three applicable guidelines).

Based on the comprehensive State guidelines found in the California MUTCD, which are most-typically referenced, there are four conditions that are considered for left-turn phasing: 1) Accident History; 2) Volume; 3) Delay; and 4) Miscellaneous. If any one of these conditions is met, then protected left-turn phasing should be considered.

Accident history, traffic volume data, and sight distance (visibility) are the conditions most often studied by HCI for this type of analysis, since they provide a good overall picture of the intersection characteristics. Consequently, the following analysis has focused on these three conditions to determine if protected-permissive left-turn phasing is warranted and recommended for the northbound and southbound approaches of Los Alamitos Boulevard.
**Accident History**

The guidelines for left-turn phasing contained in the California MUTCD regarding accidents require a minimum of five (5) left-turn collisions for a particular left-turn movement during a recent 12-month period. The HCM does not include guidelines on collisions; however, the ITE guidelines do call for a minimum of (8) left-turn-related accidents occurring within the last three years at any one approach with permissive-only phasing.

In recognition that this intersection already has fully-protected left-turn phasing on Los Alamitos Boulevard, it can be expected that there may be no (or minimal) left-turn type accidents. Typically, left-turn type accidents are categorized as ‘Broadside’ or ‘Head-On’. If there are a considerable amount of these types of accidents still occurring, then the finding may not support modification to protected-permissive left-turn phasing.

The available accident history reported for the intersection was gathered from the California Highway Patrol Statewide Integrated Traffic Records System (SWITRS). More specifically, a comprehensive 10-year traffic collision history summary report was prepared and reviewed for any left-turn type collisions (*attached in Appendix B*).

As shown in the summary report, there were a total of (9) collisions reported at or near this intersection between years 2001 and 2011. Of these, none were found involving north-south left-turning movements at the intersection. Therefore, protected-permissive left-turn phasing may be further considered, if other factors such as ‘less than minimum’ traffic volumes and adequate sight distance support it as well.

**Traffic Volumes**

Again, recognizing that this intersection already has protected left-turn phasing on Los Alamitos Boulevard, it can be expected that minimum left-turn traffic volumes are met for this installation. If the minimum left-turn volume guidelines are not reached, the finding may further support modification to protected-permissive left-turn phasing.
Traffic Volumes (continued)

As stated in the California MUTCD and noted below, protected left-turn phasing should be considered when the following left-turn traffic volume criteria are met:

For a pretimed signal or a background-cycle-controlled actuated signal, a left turn volume of more than two vehicles per approach per cycle for a peak hour; or for a traffic-actuated signal, 50 or more left turning vehicles per hour in one direction with the product of the turning and conflicting through traffic during the peak hour of 100,000 or more.

This particular intersection is a semi-actuated traffic signal since it has vehicle detection loops on each approach. Therefore, (50) or more left-turning vehicles per hour in one direction are required, along with the left/conflicting-through vehicle product of 100,000. The ITE guidelines similarly have minimum cross-products of 100,000 and 144,000 when opposed by 3 or 2 lanes, respectively.

It is noted, the conflicting-through, or opposing, traffic volumes used in this analysis do include the right-turning traffic. This is due to left-turning drivers on Los Alamitos Boulevard most likely yielding to right-turners as well as through-traffic since it will require merging/sharing the Bradbury Road lane.

Intersection peak-hour turning movement counts were gathered at the intersection of Los Alamitos Boulevard and Bradbury Road to determine the activity level during a typical mid-week time period. The traffic volumes were collected on Tuesday, September 18, 2012. The morning peak-hour was determined to start at 7:15 AM and the afternoon peak-hour at 4:45 PM.

Peak-hour traffic volume data is included in Appendix C.

Table 2 on the next page summarizes the weekday peak-hour traffic counts.
Traffic Volumes (continued)

TABLE 2
INTERSECTION WEEKDAY
PEAK-HOUR VEHICLE TURNING MOVEMENT COUNTS

<table>
<thead>
<tr>
<th>Intersection</th>
<th>Peak Hour</th>
<th>Northbound</th>
<th>Southbound</th>
<th>Eastbound</th>
<th>Westbound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Los Alamitos Boulevard</td>
<td>AM</td>
<td>L = 111 T = 1230 R = 15</td>
<td>L = 14 T = 1114 R = 176</td>
<td>L = 291 T = 17 R = 107</td>
<td>L = 63 T = 13 R = 32</td>
</tr>
<tr>
<td>and Bradbury Road</td>
<td>PM</td>
<td>L = 100 T = 1296 R = 48</td>
<td>L = 16 T = 1536 R = 195</td>
<td>L = 154 T = 9 R = 79</td>
<td>L = 47 T = 5 R = 15</td>
</tr>
</tbody>
</table>

L = Left-turning vehicles
T = Through vehicles
R = Right-turning vehicles

As highlighted in Table 2 above, the northbound left-turn movements meet the minimum (50) left-turning vehicles per hour in one direction that is needed to partially satisfy the California MUTCD Traffic Volume guideline described above.

The remaining portion of the guideline specifies that the product of the left-turning movement and the conflicting-through traffic during the peak-hour equal 100,000 or greater. As shown in Table 3 below, this portion of the guideline is satisfied for the northbound left-turn approach to the intersection during both peak periods. Therefore, the volumes do meet the minimum product of 100,000 per CA MUTCD and ITE guidelines.

TABLE 3
LEFT-TURN PHASING CROSS-PRODUCT CHECK
LOS ALAMITOS BOULEVARD AT BRADBURY ROAD

<table>
<thead>
<tr>
<th>Product of Left-Turns and Opposing Through Movements</th>
<th>Peak Hour</th>
<th>Northbound</th>
<th>Southbound</th>
<th>Eastbound</th>
<th>Westbound</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Left Opposing Thru</td>
<td>Product</td>
<td>Left Opposing Thru</td>
<td>Product</td>
</tr>
<tr>
<td>AM</td>
<td>111</td>
<td>1290</td>
<td><strong>143,190</strong></td>
<td>14</td>
<td>1248</td>
</tr>
<tr>
<td>PM</td>
<td>100</td>
<td>1731</td>
<td><strong>173,100</strong></td>
<td>16</td>
<td>1344</td>
</tr>
</tbody>
</table>
Traffic Volumes  (continued)

In comparison to the California MUTCD, the guidelines given in the Highway Capacity Manual (HCM), 2010 edition, have minimum cross-products that are associated with the number of opposing through-lanes. The threshold set by the HCM establishes a minimum cross-product of 50,000 for left-turns opposed by one (1) through-lane, 90,000 when opposed by (2) lanes, and 110,000 with (3) opposing lanes. Similarly, it is shown from the table above that the northbound left-turn approach does meet the minimum product of 110,000 in both peak periods. It is common engineering practice to install left-turn phasing in both opposing directions, even if only one direction meets the guidelines, to provide consistency for drivers' expectations. Consequently, the traffic volumes do support the existing installation of fully-protected left-turn phasing on Los Alamitos Boulevard.

Miscellaneous

Speeds
As mentioned, north of Bradbury Road, Los Alamitos Boulevard has a posted speed limit of 40 MPH and an 85th percentile (critical) speed of 42.6 MPH (see Appendix D). South of Bradbury Road, the posted speed limit is 45 MPH. These speeds correspond with speeds that may be expected on an urbanized three-lane arterial roadway. Although posted 40 MPH, it is not uncommon to find drivers travelling approximately 5 MPH over the speed limit. Consequently, 45 and 50 MPH speeds were also considered.

Sight Distance
The geometry of the intersection is relatively flat and does not have horizontal and vertical roadway curvature to account for. It was found that the geometry presents a roadway intersection that does not need special traffic signal head locations for impaired visibility or advanced signage for overall improved sight distance.
**Miscellaneous (continued)**

*Sight Distance (cont’d)*

As Los Alamitos Boulevard is a truck route, buses and trucks were observed on Los Alamitos Boulevard. Large trucks were observed making left-turns at this residential/commercial intersection, especially in regards to accessing the gas station at the southwest corner.

Sight distance for the left-turning drivers was especially considered during our field-review of the surrounding urbanized residential/commercial environment. More specifically, a left-turning driver’s sight distance, or visibility, was measured from a typical stopped-vehicle location in the northbound and southbound left-turn lanes. The measured distances were applied to the Stopping Sight Distance as a Function of Speed Guidelines found in the California MUTCD (*see Appendix E*). In these guidelines, roadway speeds of 40, 45, and 50 MPH recommend a minimum Stopping Sight Distance of 305, 360, and 425 feet, respectively. The HCM does not include guidelines on sight distance. The ITE guidelines state that restrictive sight distance is when there is less than 400 feet for roadway speeds of 40 MPH or more. As a result, 400 feet was used for sight distance when looking in the northbound direction, and 425 feet for southbound.

These stopping sight distances were field-measured from a typical ‘stopped’ left-turning vehicle location looking towards the nearest lane of on-coming traffic. An orange cone was set on the lane line at this distance. As shown in Exhibits 3 and 4 on the next pages, a photograph was then taken from a left-turning driver’s perspective in order to determine if a clear line of sight to the cone was met.

As can be seen, the field measurement for actual ‘clear’ sight distance for a northbound and southbound left-turning vehicle resulted in at least 400 and 425 feet, respectively. Therefore, sight distance is not considered restrictive; however, 45 and especially 50 MPH speeds are considered ‘higher’ roadway speeds.
Left-Turn Phasing Analysis: Los Alamitos Boulevard at Bradbury Road, in Los Alamitos, CA

EXHIBIT 3

NB Seal Beach Boulevard Looking at Oncoming SB Traffic

Aerial Image of NB Seal Beach Boulevard Looking at Oncoming SB Traffic
**EXHIBIT 4**

**SB Los Alamitos Boulevard Looking at Oncoming NB Traffic**

**Aerial Image of SB Los Alamitos Boulevard Looking at Oncoming NB Traffic**
ANALYSIS SUMMARY

Based on collisions reported for the intersection during the past 10 years, none were found to involve north and south left-turning movements. Recognizing that this intersection already has fully-protected left-turn phasing on Los Alamitos Boulevard, it can be expected that left-turn accidents may occur with protected-permissive left-turn phasing.

Based on the minimum traffic volume guidelines set forth in three references, this analysis showed that existing traffic volumes at this intersection (amount of left-turns and opposing through-movements) did satisfy the minimum volume guidelines for supporting the existing installation of protected left-turn phasing.

Engineering judgment should always be included in any decision regarding traffic improvements; as a result, the geometry of the intersection was noted as not having any horizontal and vertical curvature to consider. Upon field verification, it was found that this geometry presents a roadway intersection that does not need special traffic signal head locations or advanced signage for impaired sight distance or improving overall visibility.

Moreover, a driver's visibility was also checked from a typical stopped left-turning vehicle location on both northbound and southbound approaches. A 400-foot and 425-foot stopping sight distance was field-measured from these locations looking towards the nearest lane of on-coming traffic, and an orange cone was set on the lane line. A photograph was then taken from a driver's perspective in order to determine if a clear line of sight to the cone was met. The actual sight distance for a northbound and southbound left-turning vehicle resulted in at least 400 feet and 425 feet, respectively. Therefore, sight distance is not considered restrictive; however, it should be mentioned that 45 and 50 MPH speeds used in this analysis are considered 'higher' roadway speeds.
RECOMMENDATION

Based on the findings of this analysis, the installation of protected-permissive left-turn phasing is not recommended for the intersection of Los Alamitos Boulevard and Bradbury Road due to the following reasons:

- There are sufficient traffic volumes that satisfy all three reference guidelines for supporting the current installation of fully-protected left-turn phasing.
- There are three opposing lanes with a significant amount of oncoming traffic that left-turning drivers need to account for.
- The northbound approach (south leg of the intersection) has a posted speed limit of 45 MPH, which is considered ‘higher’ roadway speeds.
- Recognizing that this intersection already has fully-protected left-turn phasing on Los Alamitos Boulevard, it can be expected that left-turn type accidents may occur if modified to protected-permissive.
APPENDIX A

LEFT-TURN PHASING GUIDELINES:

CALIFORNIA MUTCD,
HIGHWAY CAPACITY MANUAL,
and
ITE TRAFFIC ENGINEERING HANDBOOK
CIRCULAR RED signal indications and the opposing left-turn signal faces display left-turn GREEN ARROW signal indications for a protected left-turn movement.

E. A supplementary sign shall not be required. If used, it shall be a LEFT TURN YIELD ON FLASHING RED ARROW AFTER STOP (R10-27) sign (see Figure 2B-27).

Option:
06 The requirements of Item A in Paragraph 5 may be met by a vertically-arranged signal face with a horizontal cluster of two left-turn RED ARROW signal indications, the left-most of which displays a steady indication and the right-most of which displays a flashing indication (see Figure 4D-8).

Section 4D.19 Signal Indications for Protected Only Mode Left-Turn Movements

Standard:
01 A shared signal face shall not be used for protected only mode left turns unless the CIRCULAR GREEN and left-turn GREEN ARROW signal indications always begin and terminate together. If a shared signal face is provided for a protected only mode left turn, it shall meet the following requirements (see Figure 4D-9):

A. It shall be capable of displaying the following signal indications: steady CIRCULAR RED, steady CIRCULAR YELLOW, CIRCULAR GREEN, and left-turn GREEN ARROW. Only one of the three colors shall be displayed at any given time.
B. During the protected left-turn movement, the shared signal face shall simultaneously display both a CIRCULAR GREEN signal indication and a left-turn GREEN ARROW signal indication.
C. The shared signal face shall always simultaneously display the same color of circular indication that the adjacent through signal face or faces display.
D. If the protected only mode is not the only left-turn mode used for the approach, the signal face shall be the same shared signal face that is used for the protected/permisive mode (see Section 4D.20).

Option:
02 A straight-through GREEN ARROW signal indication may be used instead of the CIRCULAR GREEN signal indication in Items A and B in Paragraph 1 on an approach where right turns are prohibited and a straight-through GREEN ARROW signal indication is also used instead of a CIRCULAR GREEN signal indication in the other signal face(s) for through traffic.

Standard:
03 If a separate left-turn signal face is provided for a protected only mode left turn, it shall meet the following requirements (see Figure 4D-10):

A. It shall be capable of displaying, the following signal indications: steady left-turn RED ARROW, steady left-turn YELLOW ARROW, and left-turn GREEN ARROW. Only one of the three indications shall be displayed at any given time. A signal instruction sign shall not be required with this set of signal indications. If used, it shall be a LEFT ON GREEN ARROW ONLY (R10-5) sign (see Figure 2B-27).
B. During the protected left-turn movement, a left-turn GREEN ARROW signal indication shall be displayed.
C. A steady left-turn YELLOW ARROW signal indication shall be displayed following the left-turn GREEN ARROW signal indication.
D. If the protected only mode is not the only left-turn mode used for the approach, the signal face shall be the same separate left-turn signal face that is used for the protected/permisive mode (see Section 4D.20 and Figures 4D-8 and 4D-12) except that the flashing left-turn YELLOW ARROW or flashing left-turn RED ARROW signal indication shall not be displayed when operating in the protected only mode.

Guidance:
04 Since separate signal phases for protected left turns will reduce the green time available for other phases, alternate means of handling left turn conflicts should be considered first.
Support:
5. The most likely possibilities are:
1. Prohibition of left turns. This can be done only if there are convenient alternate means of making the movement. Typical alternate means are:
   a. A series of right and/or left turns around a block to permit getting to the desired destination; or
   b. Making the left turn at an adjacent unsignalized intersection during gaps in the opposing through traffic.
2. Geometric changes to eliminate the left turn. An effective change would be a complete separation or a complete or partial "clover leaf" at grade. Any of these, while eliminating left turns, requires additional cost and right of way.
3. Provide protected-permissive or permissive-protected left turn operation. The protected left turn interval may be prohibited during certain periods of the day to allow only permissive intervals for left turn movement in order to increase the green time available for other phases. Refer to Section 4D.20 for the requirements of protected-permissive or permissive-protected left turn operation.

Guidance:
5. Protected left turn phases should be considered where such alternatives couldn't be utilized, and one or more of the following conditions exist:
1. Collisions - Five or more left turn collisions for a particular left turn movement during a recent 12-month period.
2. Delay - Left-turn delay of one or more vehicles, which were waiting at the beginning of the green interval and are still remaining in the left turn lane after at least 80% of the total number of cycles for one hour.
3. Volume - At new intersections where only estimated volumes are available, the following criteria may be used. For premitted signal or a background-cycle-controlled actuated signal, a left turn volume of more than two vehicles per approach per cycle for a peak hour, or for a traffic-actuated signal, 50 or more left turning vehicles per hour in one direction with the product of the turning and conflicting through traffic during the peak hour of 100,000 or more.
4. Miscellaneous. Other factors that might be considered include but are not limited to: impaired sight distance due to horizontal or vertical curvature, or where there are a large percentage of buses and trucks.

Section 4D.20 Signal Indications for Protected/Permissive Mode Left-Turn Movements

Standard:
01. If a shared signal face is provided for a protected/permissive mode left turn, it shall meet the following requirements (see Figure 4D-11):
A. It shall be capable of displaying the following signal indications: steady CIRCULAR RED, steady CIRCULAR YELLOW, CIRCULAR green, steady left-turn YELLOW ARROW, and left-turn GREEN ARROW. Only one of the three circular indications shall be displayed at any given time. Only one of the two arrow indications shall be displayed at any given time. If the left-turn GREEN ARROW signal indication and the CIRCULAR GREEN signal indication(s) for the adjacent through movement are always terminated together, the steady left-turn YELLOW ARROW signal indication shall not be required.
B. During the protected left-turn movement, the shared signal face shall simultaneously display a left-turn GREEN ARROW signal indication and a circular signal indication that is the same color as the signal indication for the adjacent through lane on the same approach as the protected left turn.
C. A steady left-turn YELLOW ARROW signal indication shall be displayed following the left-turn GREEN ARROW signal indication, unless the left-turn GREEN ARROW signal indication and the CIRCULAR GREEN signal indication(s) for the adjacent through movement are being terminated together. When the left-turn GREEN ARROW and CIRCULAR GREEN signal indications are being terminated together, the required display following the left-turn GREEN ARROW signal indication shall be either the display of a CIRCULAR YELLOW signal indication alone or the simultaneous display of the CIRCULAR YELLOW and left-turn YELLOW ARROW signal indications.
D. During the permissive left-turn movement, the shared signal face shall display only a CIRCULAR GREEN signal indication.
E. A protected/permissive shared signal face, regardless of where it is positioned and regardless of how many adjacent through signal faces are provided, shall always simultaneously display the same color of circular indication that the adjacent through signal face or faces display.
F. A supplementary sign shall not be required. If used, it shall be a LEFT TURN YIELD ON GREEN (symbolic circular green) (R10-12) sign (see Figure 2B-27).

0. If a separate left-turn signal face is being operated in a protected/permission left-turn mode, a CIRCULAR GREEN signal indication shall not be used in that face.

0. If a separate left-turn signal face is being operated in a protected/permission left-turn mode and a flashing left-turn yellow arrow signal indication is provided, it shall meet the following requirements (see Figure 4D-12):

A. It shall be capable of displaying the following signal indications: steady left-turn RED ARROW, steady left-turn YELLOW ARROW, flashing left-turn YELLOW ARROW, and left-turn GREEN ARROW. Only one of the four indications shall be displayed at any given time.

B. During the protected left-turn movement, a left-turn GREEN ARROW signal indication shall be displayed.

C. A steady left-turn YELLOW ARROW signal indication shall be displayed following the left-turn GREEN ARROW signal indication.

D. During the permission left-turn movement, a flashing left-turn YELLOW ARROW signal indication shall be displayed.

E. A steady left-turn YELLOW ARROW signal indication shall be displayed following the flashing left-turn YELLOW ARROW signal indication if the permission left-turn movement is being terminated and the separate left-turn signal face will subsequently display a steady left-turn RED ARROW indication.

F. It shall be permitted to display a flashing left-turn YELLOW ARROW signal indication for a permission left-turn movement while the signal faces for the adjacent through movement display steady CIRCULAR RED signal indications and the opposing left-turn signal faces display left-turn GREEN ARROW signal indications for a protected left-turn movement.

G. When a permission left-turn movement is changing to a protected left-turn movement, a left-turn GREEN ARROW signal indication shall be displayed immediately upon the termination of the flashing left-turn YELLOW ARROW signal indication. A steady left-turn YELLOW ARROW signal indication shall not be displayed between the display of the flashing left-turn YELLOW ARROW signal indication and the display of the steady left-turn GREEN ARROW signal indication.

H. The display shall be a four-section signal face except that a three-section signal face containing a dual-arrow signal section shall be permitted where signal head height limitations (or lateral positioning limitations for a horizontally-mounted signal face) will not permit the use of a four-section signal face. The dual-arrow signal section, where used, shall display a GREEN ARROW for the protected left-turn movement and a flashing YELLOW ARROW for the permission left-turn movement.

I. During steady mode (stop-and-go) operation, the signal section that displays the steady left-turn YELLOW ARROW signal indication during change intervals shall not be used to display the flashing left-turn YELLOW ARROW signal indication for permission left turns.

J. During flashing mode operation (see Section 4D.30), the display of a flashing left-turn YELLOW ARROW signal indication shall be only from the signal section that displays a steady left-turn YELLOW ARROW signal indication during steady mode (stop-and-go) operation.

Option:

0. A separate left-turn signal face with a flashing left-turn RED ARROW signal indication during the permission left-turn movement may be used for unusual geometric conditions, such as wide medians with offset left-turn lanes, but only when an engineering study determines that each and every vehicle must successively come to a full stop before making a permission left turn.

Standard:

0. If a separate left-turn signal face is being operated in a protected/permission left-turn mode and a flashing left-turn RED arrow signal indication is provided, it shall meet the following requirements (see Figure 4D-8):

A. It shall be capable of displaying the following signal indications: steady or flashing left-turn RED ARROW, steady left-turn YELLOW ARROW, and left-turn GREEN ARROW. Only one of the three indications shall be displayed at any given time.
B. During the protected left-turn movement, a left-turn GREEN ARROW signal indication shall be displayed.
C. A steady left-turn YELLOW ARROW signal indication shall be displayed following the left-turn GREEN ARROW signal indication.
D. During the permissive left-turn movement, a flashing left-turn RED ARROW signal indication shall be displayed.
E. A steady left-turn YELLOW ARROW signal indication shall be displayed following the flashing left-turn RED ARROW signal indication if the permissive left-turn movement is being terminated and the separate left-turn signal face will subsequently display a steady left-turn RED ARROW indication.
F. When a permissive left-turn movement is changing to a protected left-turn movement, a left-turn GREEN ARROW signal indication shall be displayed immediately upon the termination of the flashing left-turn RED ARROW signal indication. A steady left-turn YELLOW ARROW signal indication shall not be displayed between the display of the flashing left-turn RED ARROW signal indication and the display of the steady left-turn GREEN ARROW signal indication.
G. It shall be permitted to display a flashing left-turn RED ARROW signal indication for a permissive left-turn movement while the signal faces for the adjacent through movement display steady CIRCULAR RED signal indications and the opposing left-turn signal faces display left-turn GREEN ARROW signal indications for a protected left-turn movement.

H. A supplementary sign shall not be required. If used, it shall be a LEFT TURN YIELD ON FLASHING RED ARROW AFTER STOP (R10-27) sign (see Figure 2B-27),

Option:
0. The requirements of Item A in Paragraph 5 may be met by a vertically-arranged signal face with a horizontal cluster of two left-turn RED ARROW signal indications, the left-most of which displays a steady indication and the right-most of which displays a flashing indication (see Figure 4D-8).

Standard:
0. Protected/permissive mode left-turn shall not be used for left turn movements that oppose phases that require preemption for rail traffic.

Section 4D21 Signal Indications for Right-Turn Movements – General

Standard:
0. In Sections 4D21 through 4D24, provisions applicable to right-turn movements and right-turn lanes shall also apply to signal indications for U-turns to the right that are provided at locations where right turns are prohibited or not geometrically possible.

Support:
0. Right-turning traffic is controlled by one of four modes as follows:

A. Permissive Only Mode—turns made on a CIRCULAR GREEN signal indication, a flashing right-turn YELLOW ARROW signal indication, or a flashing right-turn RED ARROW signal indication after yielding to pedestrians, if any.
B. Protected Only Mode—turns made only when a right-turn GREEN ARROW signal indication is displayed.
C. Protected/Permissive Mode—both modes occur on an approach during the same cycle.
D. Variable Right-Turn Mode—the operating mode changes among the protected only mode and/or the protected/permissive mode and/or the permissive only mode during different periods of the day or as traffic conditions change.

Standard:
0. During a permissive right-turn movement, the signal faces, if any, that exclusively control U-turn traffic that conflicts with the permissive right-turn movement (see Item F.1 in Section 4D.05) shall simultaneously display steady U-turn RED ARROW signal indications. If pedestrians crossing the lane or lanes used by the permissive right-turn movement to depart the intersection are controlled by pedestrian signal heads, the signal indications displayed by those pedestrian signal heads shall not be limited to any particular display during the permissive right-turn movement.
0. During a protected right-turn movement, the signal faces for left-turn traffic, if any, on the opposing approach shall not simultaneously display a steady left-turn GREEN ARROW or steady left-turn...
### QUICK ESTIMATION LEFT-TURN TREATMENT WORKSHEET

#### General Information

**Description:** Intersection of Los Alamitos Blvd at Bradley Rd.

#### Check # 1. Left-Turn Lane Check

<table>
<thead>
<tr>
<th>Approach</th>
<th>EB</th>
<th>WB</th>
<th>NB</th>
<th>SB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of left-turn lanes</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Protect left turn (Y or N)?</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

If the number of left-turn lanes on any approach exceeds 1, then it is recommended that the left turns on that approach be protected. These approaches with protected left turns need not be evaluated in subsequent checks.

#### Check # 2. Minimum Volume Check

<table>
<thead>
<tr>
<th>Approach</th>
<th>EB</th>
<th>WB</th>
<th>NB</th>
<th>SB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left-turn volume</td>
<td>29</td>
<td>63</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>Protect left turn (Y or N)?</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

If left-turn volume on any approach exceeds 240 veh/h, then it is recommended that the left turns on that approach be protected. Those approaches with protected left turns need not be evaluated in subsequent checks.

#### Check # 3. Minimum Cross-Product Check

<table>
<thead>
<tr>
<th>Approach</th>
<th>EB</th>
<th>WB</th>
<th>NB</th>
<th>SB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left-turn volume, ( V_i ) (veh/h)</td>
<td>29</td>
<td>63</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>Opposing mainline volume, ( V_o ) (veh/h)</td>
<td>45</td>
<td>124</td>
<td>1240</td>
<td>45</td>
</tr>
<tr>
<td>Cross-product (( V_i \times V_o ))</td>
<td>1322</td>
<td>2712</td>
<td>10190</td>
<td>2160</td>
</tr>
<tr>
<td>Opposing through lanes</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Protect left turn (Y or N)?</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

Minimum Cross Product Values for Recommending Left-Turn Protection

<table>
<thead>
<tr>
<th>Number of Through Lanes</th>
<th>Minimum Cross-Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50,000</td>
</tr>
<tr>
<td>2</td>
<td>90,000</td>
</tr>
<tr>
<td>3</td>
<td>110,000</td>
</tr>
</tbody>
</table>

If the cross product on any approach exceeds the above values, then it is recommended that the left turns on that approach be protected. Those approaches with protected left turns need not be evaluated in subsequent checks.

#### Check # 4. Smaller Check

<table>
<thead>
<tr>
<th>Approach</th>
<th>EB</th>
<th>WB</th>
<th>NB</th>
<th>SB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left-turn volume, ( V_i ) (veh/h)</td>
<td>29</td>
<td>63</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>Smaller capacity, ( C_i ) (veh/h)</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Equivalence factor, ( E_i )</td>
<td>1.3</td>
<td>1.4</td>
<td>74.0</td>
<td>24.0</td>
</tr>
<tr>
<td>Protect left turn (Y or N)?</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

If the equivalence factor is 3.5 or higher (computed in the Quick Estimation Lane Volume Worksheet) and the unadjusted left turn is greater than the smaller capacity, then it is recommended that the left turns on that approach be protected.

### Notes

1. If any approach is recommended for left turn protection but the analyst evaluates it at having a permitted operation, then the quick estimation method may give overly optimistic results. The analyst should instead use the methodology described in Chapter 18, Signalized Intersections.
2. All volumes used in this worksheet are unadjusted hourly volumes.

### Step 2: Determine Lane Volume

The lane volume worksheet is shown in Exhibit 31-39. Its purpose is to establish the individual lane flow rate (in veh/h/ln) on each intersection approach. This information is then used in the control delay and level-of-service worksheet to synthesize the signal-timing plan. The directional designations (e.g., RT = right turn, LT = left turn) refer to the traffic movements as they approach the intersection.
The number of through lanes \( N_{TT} \) includes any lane that serves through vehicles. Exclusive turn lanes should be excluded.

For an unopposed shared lane, the total approach volume \( V_w \) is the sum of the shared-lane right-turn volume, through volume, and left-turn volume.

### D. Compute Lane Volume for Through Movement with Exclusive Turn Lane

For approaches with an exclusive left-turn lane (or lanes), the through-lane volume \( V_{TH} \) is computed by dividing total approach volume by the number of through lanes.

The critical lane volume \( V_{cl} \) is normally the same as the through-lane volume, unless the right turn has an exclusive lane or the left turn is not opposed and either of these movements is more critical than the through movement. If both conditions apply, the critical lane volume will be the largest of the left-lane volume, exclusive right-lane volume, and through-lane volume.

### E. Compute Lane Volume for Through Movement with Shared Lane

The computation of critical lane volume in the case of shared left-turn lanes is more complicated and requires a more detailed computational procedure. The equivalence factor \( E_{L1} \) for a permitted left turn is obtained from Exhibit 31-40 or computed with Equation 31-152.

#### Exhibit 31-40
Through-Car Equivalents for Permitted Left Turns

<table>
<thead>
<tr>
<th>Type of Left-Turn Lane</th>
<th>Through-Car Equivalent ( E_{L1} ) as a Function of Opposing Flow Rate (veh/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Shared</td>
<td>1.4</td>
</tr>
<tr>
<td>Exclusive</td>
<td>1.3</td>
</tr>
</tbody>
</table>

Note: 

\( \Delta \) Use Equation 31-152, with Equation 31-153, for opposing flow in excess of 1,200 veh/h; \( v_o \) must be \( \geq 0.1 \) veh/h.

#### Equation 31-152

\[
E_{L1} = \frac{s_o}{s_p} - I_{sh}
\]

with

\[
s_p = \frac{v_o e^{-v_o t_{ch}/3600}}{1 - e^{-v_o t_{ch}/3600}}
\]

where

\( E_{L1} \) = equivalent number of through cars for a permitted left-turning vehicle,

\( s_o \) = base saturation flow rate (pc/h/ln),

\( s_p \) = saturation flow rate of a permitted left-turn movement (veh/h/ln),

\( I_{sh} \) = indicator variable for shared lane (= 1.0 if the subject left turn is served in a shared lane, 0 if the subject left turn is served in an exclusive lane),

\( v_o \) = opposing demand flow rate (veh/h),

\( t_{ch} \) = critical headway = 4.5 (s), and
The University of Texas at Arlington has developed guidelines for left-turn phasing based on research, actual field data, easy-to-use quantitative measures, and statistical analysis of most suitable left-turn options. The process favors the least restrictive option—permitted left-turn—unless traffic and geometrics warrant a more restrictive control. The decisions to be made are classified into three levels summarized as follows and shown in Figure 13–8.

**Level 1: Permissive-Only Versus Some Protection**

The permissive option should be used only if all of the following conditions exist:

---

**Figure 13–7 Recommended Procedure for Determining Type of Left-Turn Phasing**


---

APPENDIX B

INTERSECTION COLLISION HISTORY DATA
### CITY OF LOS ALAMITOS

**SWITRS COLLISION HISTOR Y 2001 TO 2011**

**INTERSECTION OF LOS ALAMITOS BLVD AND BRADBURY RD**

<table>
<thead>
<tr>
<th>CASE ID</th>
<th>COLLISION ID</th>
<th>DATE</th>
<th>COLL. COLL.</th>
<th>PRIMARY ROAD</th>
<th>SECONDARY ROAD</th>
<th>DISTANCE</th>
<th>DIRECTION</th>
<th>INTERSECTION</th>
<th>WEATHER</th>
<th>COLL. SEVERITY</th>
<th>PRIMARY COLL. FACTOR</th>
<th>PCF</th>
<th>HIT AND RUN</th>
<th>TYPE OF COLL. INVOLVED WITH</th>
<th>ROAD SURF.</th>
</tr>
</thead>
<tbody>
<tr>
<td>003300203075009909</td>
<td>20010403</td>
<td>734</td>
<td>LOS ALAMITOS BLVD</td>
<td>BRADBURY</td>
<td>0</td>
<td>Y</td>
<td>B</td>
<td>1</td>
<td>1</td>
<td>A</td>
<td>8 N B C A</td>
<td>2006</td>
<td>D</td>
<td>Stellar</td>
<td>Slippery</td>
</tr>
<tr>
<td>003300203075009910</td>
<td>100901</td>
<td>0</td>
<td>LOS ALAMITOS BLVD</td>
<td>BRADBURY</td>
<td>0</td>
<td>N</td>
<td>A</td>
<td>4</td>
<td>A</td>
<td>21 N C C A</td>
<td>A</td>
<td>2006</td>
<td>D</td>
<td>Stellar</td>
<td>Slippery</td>
</tr>
<tr>
<td>003300203075009911</td>
<td>181267</td>
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<td>BRADBURY</td>
<td>66</td>
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<td>A</td>
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<td>A</td>
<td>3 N C C A</td>
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<td>2006</td>
<td>D</td>
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<td>Slippery</td>
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<tr>
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<td>811352</td>
<td>0</td>
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<td>BRADBURY</td>
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<td>N</td>
<td>A</td>
<td>0</td>
<td>A</td>
<td>3 N C C A</td>
<td>A</td>
<td>2006</td>
<td>D</td>
<td>Stellar</td>
<td>Slippery</td>
</tr>
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<td>BRADBURY</td>
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<td>A</td>
<td>0</td>
<td>A</td>
<td>9 N A C A</td>
<td>A</td>
<td>2006</td>
<td>D</td>
<td>Stellar</td>
<td>Slippery</td>
</tr>
<tr>
<td>003300203075009914</td>
<td>1977476</td>
<td>0</td>
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<td>BRADBURY</td>
<td>174</td>
<td>N</td>
<td>N</td>
<td>B</td>
<td>A</td>
<td>8 F C A</td>
<td>A</td>
<td>2006</td>
<td>D</td>
<td>Stellar</td>
<td>Slippery</td>
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<tr>
<td>003300203075009915</td>
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<td>BRADBURY</td>
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<td>N</td>
<td>N</td>
<td>A</td>
<td>A</td>
<td>1 N E I A</td>
<td>A</td>
<td>2006</td>
<td>D</td>
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<tr>
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<td>5051942</td>
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<td>BRADBURY</td>
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<td>A</td>
<td>0</td>
<td>A</td>
<td>8 N B I A</td>
<td>A</td>
<td>2006</td>
<td>D</td>
<td>Stellar</td>
<td>Slippery</td>
</tr>
</tbody>
</table>

### NOTES:

- **Weather 1:**
  - A - Clear
  - B - Cloudy
  - C - Raining
  - D - Snowing
  - E - Fog
  - F - Other
  - G - Wind
  - - Not Stated

- **Collision Severity:**
  - 1 - Fatal
  - 2 - Injury (Severe)
  - 3 - Injury (Other)
  - 4 - Injury (Unknown)
  - 5 - PDO
  - 6 - Other
  - - Not Stated

- **Primary Collision Factor:**
  - A - (Vehicle) Code Violation
  - B - Other Improper Driving
  - C - Other Than Driver
  - D - Unknown
  - E - PDO
  - F - Other
  - - Not Stated

- **PCF Violation Category:**
  - 01 - Driving or bicycling Under Influence
  - 02 - Impeding Traffic
  - 03 - Unsafe Speed
  - 04 - Following Too Closely
  - 05 - Wrong Side of Road
  - 06 - Improper Passing
  - 07 - Unlawful Lane Change
  - 08 - Improper Turning
  - 09 - Automobile ROW
  - 10 - Pedestrian ROW
  - 11 - Pedestrian Violation
  - 12 - Traffic Signals and Signs
  - 13 - Hazardous Parking
  - 14 - Lights
  - 15 - Brakes
  - 16 - Other Equipment
  - 17 - Other Hazardous Violation
  - 18 - Other Than Driver (or Ped)
  - 19 -
  - 20 -
  - 21 - Unsafe Starting or Backing
  - 22 - Other Improper Driving
  - 23 - Pedestrian or "Other" Under the Influence
  - 24 - Fall Asleep
  - 25 - Not Stated

- **Hit and Run:**
  - A - Head-On
  - B - Sideswipe
  - N - Not Hit & Run
  - C - Rear-End
  - D - Broadside
  - E - Hit Object
  - F - Overturned
  - G - Vehicle/Pedestrian
  - H - Other
  - - Not Stated

- **Type of Collision:**
  - A - Hit and Run
  - B - Sideswipe
  - C - Rear-End
  - D - Broadside
  - E - Hit Object
  - F - Overturned
  - G - Vehicle/Pedestrian
  - H - Other
  - - Not Stated

- **Road Surface:**
  - A - Dry
  - B - Wet
  - C - Snowy or Icy
  - D - Slippery
  - - Not Stated
APPENDIX C

PEAK-HOUR TURNING MOVEMENT

TRAFFIC VOLUME DATA
ITM Peak Hour Summary
Prepared by: NiDS National Data & Surveying Services

Los Alamitos Blvd and Bradbury Rd, City of Los Alamitos

Date: 9/18/2012
Day: Tuesday

Southbound Approach

<table>
<thead>
<tr>
<th>Lanes</th>
<th>AM</th>
<th>NOON</th>
<th>PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM</td>
<td>176</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>NOON</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>PM</td>
<td>195</td>
<td>1636</td>
<td>16</td>
</tr>
</tbody>
</table>

AM Peak Hour: 7:15 AM
NOON Peak Hour: 12:00 PM
PM Peak Hour: 4:45 PM

Northbound Approach

Total Ins & Outs

<table>
<thead>
<tr>
<th>Lanes</th>
<th>AM</th>
<th>NOON</th>
<th>PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM</td>
<td>1304</td>
<td>1556</td>
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<tr>
<td>NOON</td>
<td>0</td>
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<td>1747</td>
</tr>
<tr>
<td>PM</td>
<td>1747</td>
<td>1465</td>
<td>0</td>
</tr>
</tbody>
</table>

Total Volume Per Leg

<table>
<thead>
<tr>
<th>Lanes</th>
<th>AM</th>
<th>NOON</th>
<th>PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM</td>
<td>2860</td>
<td>0</td>
<td>3212</td>
</tr>
<tr>
<td>NOON</td>
<td>0</td>
<td>0</td>
<td>154</td>
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</tbody>
</table>
## Intersection Turning Movement

**Prepared by:**
National Data & Surveying Services

**Project ID:** CA12_1195_002

**Day:** TUESDAY

**Date:** 9/18/2012

**City:** City of Los Alamitos

### NS/EW Streets:

<table>
<thead>
<tr>
<th></th>
<th>NL</th>
<th>NT</th>
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<th>SL</th>
<th>ST</th>
<th>SR</th>
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<th>ET</th>
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<th>WL</th>
<th>WT</th>
<th>WR</th>
<th>TOTAL</th>
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### AM

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<th>SL</th>
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<th>ET</th>
<th>ER</th>
<th>WL</th>
<th>WT</th>
<th>WR</th>
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<td>175</td>
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<td>66</td>
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<td>28</td>
<td>10</td>
<td>1</td>
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<td>53</td>
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<td>809</td>
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<td>1</td>
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<td>745</td>
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</table>

### TOTAL VOLUMES:

<table>
<thead>
<tr>
<th></th>
<th>NL</th>
<th>NT</th>
<th>NR</th>
<th>SL</th>
<th>ST</th>
<th>SR</th>
<th>EL</th>
<th>ET</th>
<th>ER</th>
<th>WL</th>
<th>WT</th>
<th>WR</th>
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</tr>
</thead>
<tbody>
<tr>
<td>NORTHBOUND</td>
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<td>29</td>
<td>26</td>
<td>1923</td>
<td>271</td>
<td>505</td>
<td>22</td>
<td>184</td>
<td>106</td>
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<td>5966</td>
</tr>
<tr>
<td>SOUTHBOUND</td>
<td>160</td>
<td>2273</td>
<td>29</td>
<td>26</td>
<td>1923</td>
<td>271</td>
<td>505</td>
<td>22</td>
<td>184</td>
<td>106</td>
<td>14</td>
<td>53</td>
<td>5966</td>
</tr>
<tr>
<td>EASTBOUND</td>
<td>160</td>
<td>2273</td>
<td>29</td>
<td>26</td>
<td>1923</td>
<td>271</td>
<td>505</td>
<td>22</td>
<td>184</td>
<td>106</td>
<td>14</td>
<td>53</td>
<td>5966</td>
</tr>
<tr>
<td>WESTBOUND</td>
<td>160</td>
<td>2273</td>
<td>29</td>
<td>26</td>
<td>1923</td>
<td>271</td>
<td>505</td>
<td>22</td>
<td>184</td>
<td>106</td>
<td>14</td>
<td>53</td>
<td>5966</td>
</tr>
</tbody>
</table>

### APPROACH %:

- Total: 100%

- NL: 6.50%
- NT: 92.32%
- NR: 1.18%
- SL: 1.17%
- ST: 86.62%
- SR: 12.21%
- EL: 71.03%
- ET: 3.09%
- ER: 25.88%
- WL: 61.27%
- WT: 8.09%
- WR: 30.64%

### PEAK HR START TIME:

- 7:15 AM

### PEAK HR VOL:

|       | NL  | NT  | NR  | SL  | ST  | SR  | EL  | ET  | ER  | WL  | WT  | WR  |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| NORTHBOUND | 111 | 1233| 15  | 14  | 1114| 176 | 291 | 17  | 107 | 63  | 13  | 32  | 3186 |
| SOUTHBOUND| 111 | 1233| 15  | 14  | 1114| 176 | 291 | 17  | 107 | 63  | 13  | 32  | 3186 |
| EASTBOUND | 111 | 1233| 15  | 14  | 1114| 176 | 291 | 17  | 107 | 63  | 13  | 32  | 3186 |
| WESTBOUND| 111 | 1233| 15  | 14  | 1114| 176 | 291 | 17  | 107 | 63  | 13  | 32  | 3186 |

### PEAK HR FACTOR:

|       | NL  | NT  | NR  | SL  | ST  | SR  | EL  | ET  | ER  | WL  | WT  | WR  |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| NORTHBOUND | 0.896| 0.793| 0.850| 0.871| 0.897|      |      |      |      |      |      |      |      |
| SOUTHBOUND| 0.896| 0.793| 0.850| 0.871| 0.897|      |      |      |      |      |      |      |      |
| EASTBOUND | 0.896| 0.793| 0.850| 0.871| 0.897|      |      |      |      |      |      |      |      |
| WESTBOUND| 0.896| 0.793| 0.850| 0.871| 0.897|      |      |      |      |      |      |      |      |

**CONTROL:** Signalized
### Intersection Turning Movement

**Prepared by:**
National Data & Surveying Services

**Project ID:** CA12_1195_002

**Day:** TUESDAY

**City:** City of Los Alamitos

**Date:** 9/18/2012

**NS/EW Streets:**

<table>
<thead>
<tr>
<th>Time</th>
<th>NL</th>
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<th>NR</th>
<th>SL</th>
<th>ST</th>
<th>SR</th>
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<th>ET</th>
<th>ER</th>
<th>WL</th>
<th>WT</th>
<th>WR</th>
<th>TOTAL</th>
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<td>275</td>
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<td>322</td>
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<td>36</td>
<td>32</td>
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<td>12</td>
<td>5</td>
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<td>11</td>
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<td>1</td>
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<td>863</td>
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<tr>
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<td>12</td>
<td>4</td>
<td>332</td>
<td>40</td>
<td>41</td>
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<td>12</td>
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**TOTAL VOLUMES:**

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<th>ER</th>
<th>WL</th>
<th>WT</th>
<th>WR</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
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<td>99</td>
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<td>354</td>
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<td>135</td>
<td>94</td>
<td>11</td>
<td>28</td>
<td>6619</td>
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<td>SOUTHBOUND</td>
<td>6.84%</td>
<td>89.68%</td>
<td>3.47%</td>
<td>0.91%</td>
<td>88.02%</td>
<td>11.08%</td>
<td>65.76%</td>
<td>3.63%</td>
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<td>70.60%</td>
<td>8.27%</td>
<td>21.03%</td>
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**APPROACH %s:**

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<th>PEAK HR FACTOR</th>
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<td>0.963</td>
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<td>5:00 PM</td>
<td>1296</td>
<td>0.952</td>
</tr>
<tr>
<td>5:05 PM</td>
<td>1536</td>
<td>0.680</td>
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<tr>
<td>5:10 PM</td>
<td>195</td>
<td>0.728</td>
</tr>
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</table>

**CONTROL:** Signalized
APPENDIX D

ENGINEERING AND TRAFFIC SURVEY

FOR

LOS ALAMITOS BOULEVARD
# City of Los Alamitos
## Engineering and Traffic Survey Field Review Form

**Los Alamitos Boulevard**
**Field Review By:** C. Buendia

**Farquhar Avenue to Bradbury Road**
**Checked By:** Jerry Stock

**Date:** 5/12/03

### Factors

<table>
<thead>
<tr>
<th>A. Prevailing Speed Data</th>
<th>Direction: Northbound</th>
<th>Direction: Southbound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of Survey</td>
<td>05/12/03</td>
<td>05/12/03</td>
</tr>
<tr>
<td>Location of Survey</td>
<td>NORTH OF BRADBURY</td>
<td>NORTH OF BRADBURY</td>
</tr>
<tr>
<td>85th Percentile</td>
<td>42.6 MPH</td>
<td>42.6 MPH</td>
</tr>
<tr>
<td>10 MPH Pace</td>
<td>35 - 44 MPH</td>
<td>34 - 43 MPH</td>
</tr>
<tr>
<td>Percent in Pace</td>
<td>66.9%</td>
<td>71.8%</td>
</tr>
<tr>
<td>Posted Speed Limit</td>
<td>40 MPH / 25 MPH**</td>
<td>40 MPH / 25 MPH**</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B. Accident History</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Months Covered</td>
</tr>
<tr>
<td>Speed-Related Accidents</td>
</tr>
<tr>
<td>Total Accidents</td>
</tr>
<tr>
<td>Annual Accident Rate</td>
</tr>
<tr>
<td>Accidents/Mi. Veh. Miles</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>C. Traffic Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Daily Traffic</td>
</tr>
<tr>
<td>Lane Configuration</td>
</tr>
<tr>
<td>Traffic Controls</td>
</tr>
<tr>
<td>Crosswalks</td>
</tr>
<tr>
<td>Pedestrian/Bicycles</td>
</tr>
<tr>
<td>Truck Traffic</td>
</tr>
<tr>
<td>On-Street Parking</td>
</tr>
<tr>
<td>Other (Specify)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>D. Roadway Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of Segment (Miles)</td>
</tr>
<tr>
<td>Vertical Curve</td>
</tr>
<tr>
<td>Horizontal Curve</td>
</tr>
<tr>
<td>Lateral Visibility</td>
</tr>
<tr>
<td>Surface Condition</td>
</tr>
<tr>
<td>Sidewalks/Driveways</td>
</tr>
<tr>
<td>Street Lighting</td>
</tr>
<tr>
<td>Driveway Density</td>
</tr>
<tr>
<td>Other (Specify)</td>
</tr>
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<table>
<thead>
<tr>
<th>E. Adjacent Land Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial / Business / Res / Church</td>
</tr>
<tr>
<td>Recommended Speed Limit</td>
</tr>
<tr>
<td>Speed Limit Change?</td>
</tr>
</tbody>
</table>
APPENDIX E

STOPPING SIGHT DISTANCE AS A FUNCTION OF SPEED

CALIFORNIA MUTCD
Table 6C-1. Recommended Advance Warning Sign Minimum Spacing

<table>
<thead>
<tr>
<th>Road Type</th>
<th>Distance Between Signs*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Urban (low speed) - 25 mph or less</td>
<td>100 feet</td>
</tr>
<tr>
<td>Urban (high speed) - more than 25 mph to 40 mph</td>
<td>250 feet</td>
</tr>
<tr>
<td>Urban (high speed) - more than 40 mph</td>
<td>350 feet</td>
</tr>
<tr>
<td>Rural</td>
<td>500 feet</td>
</tr>
<tr>
<td>Expressway / Freeway</td>
<td>1,000 feet</td>
</tr>
</tbody>
</table>

* Speed category to be determined by the highway agency.  
** The column headings A, B, and C are the dimensions shown in Figures 6H-1 through 6H-46. The A dimension is the distance from the transition or point of restriction to the first sign. The B dimension is the distance between the first and second signs. The C dimension is the distance between the second and third signs. (The “first sign” is the sign in a three-sign series that is closest to the TTC zone. The “third sign” is the sign that is furthest upstream from the TTC zone.)

Table 6C-2. Stopping Sight Distance as a Function of Speed

<table>
<thead>
<tr>
<th>Speed*</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 mph</td>
<td>115 feet</td>
</tr>
<tr>
<td>25 mph</td>
<td>155 feet</td>
</tr>
<tr>
<td>30 mph</td>
<td>200 feet</td>
</tr>
<tr>
<td>35 mph</td>
<td>250 feet</td>
</tr>
<tr>
<td>40 mph</td>
<td>305 feet</td>
</tr>
<tr>
<td>45 mph</td>
<td>360 feet</td>
</tr>
<tr>
<td>50 mph</td>
<td>425 feet</td>
</tr>
<tr>
<td>55 mph</td>
<td>495 feet</td>
</tr>
<tr>
<td>60 mph</td>
<td>570 feet</td>
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<tr>
<td>65 mph</td>
<td>645 feet</td>
</tr>
<tr>
<td>70 mph</td>
<td>730 feet</td>
</tr>
<tr>
<td>75 mph</td>
<td>820 feet</td>
</tr>
</tbody>
</table>

* Posted speed, off-peak 85th-percentile speed prior to work starting, or the anticipated operating speed.  
Can also be used as Stopping Sight Distance as suggested buffer space length or location for flagger station.

Table 6C-3. Taper Length Criteria for Temporary Traffic Control Zones

<table>
<thead>
<tr>
<th>Type of Taper</th>
<th>Taper Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merging Taper</td>
<td>at least L</td>
</tr>
<tr>
<td>Shifting Taper</td>
<td>at least 0.5 L</td>
</tr>
<tr>
<td>Shoulder Taper</td>
<td>at least 0.33 L</td>
</tr>
<tr>
<td>One-Lane, Two-Way Traffic Taper</td>
<td>50 feet minimum, 100 feet maximum</td>
</tr>
<tr>
<td>Downstream Taper</td>
<td>50 feet minimum, 100 feet maximum</td>
</tr>
</tbody>
</table>

Note: Use Table 6C-4 to calculate L
City of Los Alamitos

Agenda Report
Discussion Item

December 12, 2012
Item No: 7C

To: Chairman and Members of the Traffic Commission

From: David Hunt, PE, City Engineer

Subject: Consideration of a Signal Modification at Los Alamitos Boulevard at Rossmoor Way and Bradbury Road

Summary: A request has been received to look at changing the left-turn signal phases at Los Alamitos Boulevard @ Rossmoor Way and Bradbury Road going into the Highlands Neighborhood.

Recommendation: Based on the findings of staff's analysis, the installation of protected-permissive left-turn phasing is not recommended.

Background

Hartzog & Crabill, Inc. (HCI) has completed a 'Left-Turn Phasing Warrant Analysis' for the subject intersections. The analysis was completed in response to the City's request to verify if protected-permissive left-turn phasing is warranted and recommended, based on meeting standard guidelines.

Discussion

At the present time, the intersection is signalized with a 5-phase operation with protected left-turn phasing on Los Alamitos Boulevard. The California Manual of Uniform Traffic Control Devices (California MUTCD) was used for defining the requirements for left-turn phasing, as well as the Highway Capacity Manual (HCM) and Institute of Traffic Engineers (ITE) Traffic Engineering Handbook. Based on these guidelines, there are four conditions considered for left-turn phasing:

1) Accident History;
2) Delay;
3) Traffic Volumes; and
4) Miscellaneous (i.e., impaired sight distance, roadway curvature, etc.).
Based on the findings of our analysis, the installation of protected-permissive left-turn phasing is not recommended due to the following reasons:

- There were sufficient traffic volumes that met all three reference guidelines for supporting the current installation of fully-protected left-turn phasing.

- Sight distance is considered restrictive for the northbound left-turning driver, as the actual sight distance measured to the nearest oncoming lane of traffic is less than 400 feet when a vehicle was in the opposing left-turn lane.

- There are three opposing lanes with a significant amount of oncoming traffic that left-turning drivers would need to account for under the 'permissive' portion.

- Recognizing that this intersection already has fully-protected left-turn phasing on Los Alamitos Boulevard, and one left-turn collision still occurred within the last 10 years, it can be expected that an increase in left-turn type accidents will occur if modified to protected-permissive.

Hartzog & Crabill, Inc. did some adjustments to both signals December 5, 2012, to improve the left-turn movement into the Highlands neighborhood. The midday coordination plan, which operated Monday - Friday between 1:00 pm and 3:35 pm, has been disabled. During this period, and all other non-coordinated times (7:00 pm to 7:00 am), these intersections will operate independently in "Free" mode. The free mode has also been modified to give preference to the vehicle(s) waiting in the southbound left-turn lanes. Due to the volumes on Los Alamitos Boulevard, the AM and PM coordination plans were not adjusted. These high traffic volume hours of operation are Monday - Friday, 7:00 to 9:00 am, and 3:35 to 7:00 pm.

Approved By:

[Signature]

David Hunt, PE
City Engineer

Attachments: 1. Left-turn Phasing Analysis at the Intersection of Los Alamitos Blvd. and Rossmoor Way
2. Left-turn Phasing Analysis at the Intersection of Los Alamitos Blvd. and Bradbury Rd.
November 7, 2012

Mr. Dave Hunt, P.E.
Director of Public Works/City Engineer
City of Los Alamitos
3191 Katella Avenue
Los Alamitos, CA 90720

Subject: Left-Turn Phasing Analysis at the Intersection of Los Alamitos Boulevard and Rossmoor Way

Dear Mr. Hunt:

Hartzog & Crabill, Inc. (HCI) has completed a Left-Turn Phasing Warrant Analysis for the subject intersection. As you will see in the attached report, the findings of this study show that the modification from protected to protected-permissive left-turn phasing on Los Alamitos Boulevard is not recommended for this intersection.

The analysis was completed in response to the City’s request to verify if protected-permissive left-turn phasing is warranted, and recommended based on meeting standard guidelines. At the present time, the intersection is signalized with a 5-phase operation with protected left-turn phasing on Los Alamitos Boulevard. The California Manual of Uniform Traffic Control Devices (California MUTCD) was used for defining the requirements for left-turn phasing, as well as the Highway Capacity Manual (HCM) and Institute of Traffic Engineers (ITE) Traffic Engineering Handbook. Based on these guidelines, there are four conditions considered for left-turn phasing: 1) Accident History; 2) Delay; 3) Traffic Volumes; and 4) Miscellaneous (i.e., impaired sight distance, roadway curvature, etc.).

Based on the findings of our analysis, the installation of protected-permissive left-turn phasing is not recommended due to the following reasons:

- There were sufficient traffic volumes that met all three reference guidelines for supporting the current installation of fully-protected left-turn phasing.
- Sight distance is considered restrictive for the northbound left-turning driver, as the actual sight distance measured to the nearest oncoming lane of traffic is less than 400 feet when a vehicle was in the opposing left-turn lane.
Mr. Dave Hunt, P.E.
November 7, 2012
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- There are three opposing lanes with a significant amount of oncoming traffic that left-turning drivers would need to account for under the 'permissive' portion.
- Recognizing that this intersection already has fully-protected left-turn phasing on Los Alamitos Boulevard, and one left-turn collision still occurred within the last 10 years, it can be expected that an increase in left-turn type accidents will occur if modified to protected-permissive.

It has been our pleasure to prepare this analysis for the City of Los Alamitos. If you have any questions or need more information please call (714) 731-9455.

Regards,
HARTZOG & CRABILL, INC.

Mark J. Esposito, PE, TE, PTOE
Project Manager

Attach: Left-Turn Phasing Analysis Report
CALL TO ORDER

A regular meeting of the Traffic Commission was called to order at 7:03 p.m. on December 12, 2012, in the Council Chambers, 3191 Katella Avenue, Los Alamitos, Chair Norman Wray presiding.

ROLL CALL

PRESENT: COMMISSIONERS Emerson, Murphy, Schleuter, Vardeman, Wilhelm, Wray

ABSENT: COMMISSIONER

PRESENT: STAFF Dave Hunt, City Engineer Bruce McAlpine, Police Captain Sharon Nowell, Department Secretary

1. CALL TO ORDER
Chair Wray called the meeting to order at 7:03 p.m.

2. ROLL CALL
No Commissioners absent.

3. PLEDGE OF ALLEGIANCE
The Pledge of Allegiance was led by Richard Murphy.

4. ORAL COMMUNICATIONS
None

5. ELECTION OF VICE CHAIR
Unanimously carried to appoint Johanna Schleuter as Vice Chair.

6. MINUTES
Motion made to approve the minutes of the November 14, 2012 Regular Traffic Commission Meeting:

Motion/Second: Murphy/Vardeman: Motion unanimously carried to approve the November 14, 2012 Traffic Commission meeting minutes. Chair Schleuter abstained due to her absence at that meeting.
7. **STAFF REPORTS**

C. **CONSIDERATION OF A SIGNAL MODIFICATION AT LOS ALAMITOS BOULEVARD AT ROSSMOOR WAY AND BRADBURY ROAD**

City Engineer, Dave Hunt, gave a summary of the staff report and the information contained therein. He stated that conditions do not support protected-permissive left-turns at the intersections under discussion. However, Hartzog & Crabill, our traffic engineers made adjustments during non-peak times that may make conditions better.

**PUBLIC COMMENTS:**

Chuck Sylvia, 5081 Kearsarge, New Dutch Haven

Mr. Sylvia stated that he attended previous meetings where the installation of protected-permissive signals was requested @ three intersections. He agreed with the decision at that time to deny the installation at Siboney Street because of visibility. Mr. Sylvia asked Mr. Hunt who made the request for the signal changes at the entrances to the Highlands. Mr. Hunt answered that Council members Kusumoto and Poe relayed those requests.

Mr. Sylvia has followed this item on behalf of members of the community who have supported him over the years. He is now in the position of telling them that the protected-permissive signals will not be going in.

He stated that he is confused because there are areas on Los Alamitos Boulevard where drivers have to make left-turns across three lanes of northbound traffic and merge into a southbound lane (Harrisburg, Von's Shopping Center, Howard, and Green). He does not see how making a left-turn into Rossmoor is more dangerous. Mr. Hunt explained the factors affecting sight distance.

**COMMISSIONER DISCUSSION:**

Commissioner Emerson stated that he is in support of the adjustments made to the Rossmoor Way and Bradbury Road signals, which allow them to operate on demand between the hours of 9 AM to 3:30 PM, and 7 PM to 7:00 AM. Suggested seeing how the Highlands residents feel about the new timing works out, and come back in 4 to 5 months.

Discussion of the following items followed:
• If the Commission overrides staff’s recommendation, does the City assume some liability?

Mr. Hunt answered that yes, the City will be exposed to some liability.

• Would it be possible to shorten the current cycle length from 100 seconds to 1 minute?

Mr. Cabey stated that the section of roadway from Farquhar Avenue to the 405 Freeway is synchronized with other signals and that adjustment would throw the signals out of synchronization with the rest of the system. Additionally, new requirements are coming up that will require an extension of the pedestrian signal @ Los Alamitos Blvd. & Katella Ave.

• Sitting and waiting at the light is frustrating. Shorten the wait time to make as many people happy as we can is a fair compromise.

Mr. Cabey stated that signal coordination is for peak volumes of traffic and left-turns can be favored during synchronization.

• Perception is that vehicles making a left-turn into the Highlands are the last to get the green. Opposing traffic seems to trigger the cycle, and southbound vehicles have to wait.

The adjustments made to the signal timing should remedy this during non-peak hours.

• Majority of complaints come from the wait for southbound left-turn. Would it be possible to let the southbound left-turn go before the northbound left turn, and explore the possibility of narrowing the peak hours?

Greg Cabey explained how the signals ‘lead and lag’ during synchronization, and the challenges or working within parameters presented by the synchronization of the signals from the 405 freeway to Farquhar Avenue.

MOTION: SCHLEUTER/MURPHY: Motion was made to observe changes made by the Traffic Engineer (signals operate on demand between the hours of 9 AM to 3:30 PM, and 7 PM to 7:00 AM); and bring back this issue in 2 months. Also, bring back traffic count data to justify peak time adjustments. Motion unanimously carried.
A. REQUEST TO INSTALL "KEEP CLEAR" STRIPING AT THE LOS ALAMITOS HIGH SCHOOL TEACHER PARKING ENTRANCE DRIVEWAY ON LOS ALAMITOS BOULEVARD, AND FARQUHAR AVENUE AND ROCHELLE STREET

City Engineer, Dave Hunt, gave summary of the staff report and the information contained therein.

COMMENTS FROM PUBLIC:

Art De Bolt – resident on Rochelle St. – has never seen intersection blocked. By law, don't intersections have to be kept clear? He is concerned about sign blight. Thinks solution is to have police give tickets to discourage vehicles blocking the intersection. Also suggested opening up Farquhar Avenue @ Los Alamitos Blvd. by making two left-lane turn lanes; and block off alley before Los Alamitos Blvd. Mr. De Bolt stated that he had been informed that the Traffic Commission had previously approved blocking off that alley.

Mr. Hunt stated that he received a resident complaint about the intersection. He also stated that improvements on Farquhar Ave. were approved as part of the Traffic Calming report done in 2005. It was designated as a Priority 3 project, and at this time there is no money available.

Although 'Keep Clear Zones' on the pavement are effective, restricting signage blight is also important. The pavement marking must be accompanied by signage. Moving traffic on Farquhar Ave. is the real issue. Need to address evaluating Farquhar Ave. as a whole.

Suggestion was made to defer painting both areas. Look at other solutions for traffic on Farquhar Ave. and work on a comprehensive solution on Los Alamitos Blvd. with the school.

Mr. De Bolt recalled that ten years ago the Base was restricted from using Farquhar Ave. as a transit point. City staff might need to re-visit that issue.

MOTION: MURPHY/SCHLEUTER: A motion was made to deny the recommendation to install "KEEP CLEAR" striping at the Los Alamitos High School teacher parking entrance driveway on Los Alamitos Boulevard, and Farquhar Avenue and Rochelle Street. Motion was unanimously carried.

The Commission would like to have staff coordinate a meeting with the School District to discuss a comprehensive approach for traffic issues around the High School.
B. APARTMENT ROW RED CURB PAINTING PRIORITY 1 PROJECTS – Continued

City Engineer, Dave Hunt gave summary of the agenda report and information contained therein. Staff is recommending removing the red curb at two locations on Farquhar Avenue and having the Traffic Engineer conduct a warrant study for five (5) intersections in Apartment Row to investigate whether or not a 4-way stop is justified. The intersections to be included are: Howard and Reagan, Bloomfield and Green, Bloomfield and Howard, Noel and Green and Noel and Howard. Mr. Hunt explained that the cost to do warrant studies for five (5) intersections needing 4-way stops is $10,000.

PUBLIC COMMENT:

Mr. De Bolt stated that he is in agreement with the City Engineer. In the Apartment Row area, he feels stop signs are needed at every intersection, and if there is a parking problem there, the City has exacerbated it with red curbs. Red curbs can be eliminated by putting in stop signs. He has not ever had anyone who lives in Apartment Row complain about not being able to find a place to park. He thinks it is a good move to get rid of red curbs and get 4-way stops. Suggests garage door openers be required on any new construction to encourage parking in garages.

COMMISSIONERS’ COMMENTS:

- Red curbs can be eliminated if stop signs are put in.
- Concerned with cost of warrant studies for stop signs.
- Stop signs will improve safety for vehicles exiting alleys without impacting parking by putting in more red curbs.
- Possible to do one warrant study that could apply to all the intersections?
- Get Council Member Mejia on board with 4-way stops. See if Council and Commission will override warrant studies.
- Need City Attorney's advice on necessity of warrants.

Dave Hunt stated that he feels the money for the warrant studies is well spent. The studies are part of the process and steps that need to be taken before the stop signs are put in.

Commissioner Murphy presented a challenge to Commission to look at the whole area, making it more resident-friendly, and less pass-through friendly. Increase safety with a series of small solutions; moving forward with a comprehensive plan.
MOTION: SCHLEUTER/MURPHY: Request City Engineer to conduct warrant studies for five (5) intersections (Howard and Reagan, Bloomfield and Green, Bloomfield and Howard, Noel and Green, and Noel and Howard) in Apartment Row for 4-way stops. Allow him to follow whatever procedures necessary to remove red curbs at 3691 and 4125 Farquhar Avenue. Motion passed with 5 ayes; 1 opposed (Emerson).

Commissioner Murphy expressed his pleasure at having worked with the Traffic Commission.

8. ITEMS FROM THE PUBLIC WORKS DEPARTMENT
None

9. TRAFFIC COMMISSION INITIATED BUSINESS

- Commissioner Emerson requested that discussion of reducing traffic on Farquhar Avenue traffic issues be agendized, specifically:
  - Options for the intersection of Lexington Drive and Farquhar Avenue
  - No left-turn for traffic exiting the Base
  - Issues relating to the intersection of Farquhar Avenue and Los Alamitos Boulevard with option to make 2 left-turn lanes on Farquhar Ave.
  - Addressing the alley that dead ends on Farquhar
  - Use of Orangewood as exit only for the Base during peak periods

- Commissioner Emerson would like to address minimizing impact to traffic of the construction planned for the Medical Center.

10. ADJOURNMENT

Motion/Second: SCHLEUTER/MURPHY
There being no further business the meeting was adjourned in memory of Traffic Commissioner, Pauline Bloom, at 10:10 p.m., to the next regularly scheduled meeting of January 9, 2013, at 7:00 p.m.

Dave Hunt, City Engineer
<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>DATE INITIATED</th>
<th>REQUESTED BY</th>
<th>COUNCIL OR STAFF</th>
<th>TAKEN TO</th>
<th>RECOMMENDED APPROVED/COMPLETED</th>
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<tbody>
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<td>A</td>
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<tr>
<td>A. 1</td>
<td>Install 4-way stop signs at 4-way stop intersections.</td>
<td>Jul-15</td>
<td>J. Wilhelm</td>
<td></td>
<td></td>
<td>Completed</td>
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<tr>
<td>A. 2</td>
<td>Farquhar/Los Alamitos Alley Study</td>
<td></td>
<td>Emerson/Mejia</td>
<td></td>
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<tr>
<td>A. 3</td>
<td>No Left Turn sign by the Post Office on Reagan St</td>
<td>Jun-15</td>
<td>D. Patz</td>
<td></td>
<td></td>
<td>Completed</td>
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<tr>
<td>A. 4</td>
<td>Katella/Cherry crosswalk on East side of Katella move to west side.</td>
<td>Jun-15</td>
<td>J. Mejia</td>
<td></td>
<td></td>
<td>Completed - Put on 7-yr CIP</td>
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<tr>
<td>A. 5</td>
<td>High School Traffic Study</td>
<td></td>
<td>D. Hunt</td>
<td></td>
<td>Apr-15</td>
<td>Completed - Needs Los Al Unified approval</td>
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<tr>
<td>A. 6</td>
<td>Extend signal time for cars crossing Katella @ Walnut/Wallingford</td>
<td>Apr-June-15</td>
<td>Lindsey</td>
<td></td>
<td></td>
<td>Completed</td>
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<tr>
<td>A. 7</td>
<td>Repaint arrows at bus pad on Katella @ Walnut</td>
<td>Apr-15</td>
<td>J. Mejia</td>
<td></td>
<td></td>
<td>Completed</td>
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<tr>
<td>A. 8</td>
<td>3-Way Stop Sign @ Cherry St &amp; Catalina St</td>
<td>Jan-13</td>
<td>J. Wilhelm</td>
<td>May-15</td>
<td>Jun-15</td>
<td>Completed</td>
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<tr>
<td>A. 9</td>
<td>Consider options for widening Civic Center Dr</td>
<td>Jan-14</td>
<td>J. Mejia</td>
<td></td>
<td></td>
<td>Included in development</td>
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<tr>
<td>A. 10</td>
<td>Upgrade fork-lift crossing on Catalina</td>
<td>Jan-16</td>
<td>J. Mejia</td>
<td></td>
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<td>Completed</td>
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<td>B. 1</td>
<td>Modifications to Katella/Wallingsford-Walnut for school ped safety</td>
<td>Jul-15</td>
<td>Rossmoor HOA</td>
<td>Possibly Council</td>
<td>Nov-15</td>
<td>Conducting follow-up</td>
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<td>E. 1</td>
<td>Piggy-back on Seal Beach Bl signal synch OCTA program for Los Alamitos Bl</td>
<td>Jan-16</td>
<td>D. Emerson</td>
<td>Council</td>
<td>Mar-16</td>
<td>On proposed 7-yr CIP (unfunded)</td>
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<td>F. 1</td>
<td>Modify pedestrian signal/sign for NB right turns - East leg Bloomfield &amp; Katella</td>
<td>Jan-14</td>
<td>J. Wilhelm</td>
<td>Staff</td>
<td></td>
<td>Reviewing</td>
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<tr>
<td>F. 2</td>
<td>Address sight distance for driveways on S/S Katella - Reagan to Cherry</td>
<td>Mar-16</td>
<td>J. Wilhelm</td>
<td>Possibly Council</td>
<td></td>
<td>Reviewing (will return to Comm.)</td>
</tr>
<tr>
<td>F. 3</td>
<td>Replace/repaint Xwalks &amp; stop signs-no reflectivity at night on Farquhar from Noel to Los Alamitos Bl</td>
<td>Apr-16</td>
<td>J. Mejia</td>
<td>Staff</td>
<td></td>
<td>Stop sign replaced bid out to repaint Farquad</td>
</tr>
<tr>
<td>F. 4</td>
<td>Remove parking spaces on S/S Catalina opposite Trend docks</td>
<td>Mar-16</td>
<td>J. Mejia</td>
<td>Possibly Council</td>
<td></td>
<td>Reviewing</td>
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<td>ITEM</td>
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<td>F - 6</td>
<td>Move or upgrade mid-block crosswalk on Cherry s/o Florista</td>
<td>Mar-16</td>
<td>J. Mejia &amp; D. Patz</td>
<td>Possibly Council</td>
<td>T.C.</td>
<td>Reviewing</td>
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<tr>
<td>F - 7</td>
<td>Bring the traffic study for Shea Properties Arrowhead to Commission</td>
<td>Mar-16</td>
<td>J. Mejia</td>
<td>Staff</td>
<td>C.C.</td>
<td>Waiting for study to be submitted</td>
</tr>
<tr>
<td>F - 8</td>
<td>Remove school signs for Laurel HS, which is closed</td>
<td>Nov-15</td>
<td>D. Patz</td>
<td>Staff</td>
<td>T.C.</td>
<td>Confirmed - Staff will remove</td>
</tr>
<tr>
<td>F - 9</td>
<td>Remove &quot;left over&quot; limit line at Farquhar/Pine (from Keep Clear)</td>
<td>Jun-16</td>
<td>D. Emerson</td>
<td>Staff</td>
<td>C.C.</td>
<td>Limit lines and Pavement Marking to remain per TC meeting 6/9/16. No Action needed</td>
</tr>
<tr>
<td>F - 10</td>
<td>Remove &quot;Keep Clear&quot; on Farquhar at Cherry</td>
<td>Mar-16</td>
<td>D. Emerson</td>
<td>Staff</td>
<td>T.C.</td>
<td>Reviewing it. TC want them removed per 6/9/16</td>
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<tr>
<td>F - 11</td>
<td>Street name signs at Los Alamitos Bl/Florista-paint/vinyl pealing off</td>
<td>Jan-16</td>
<td>J. Seaman</td>
<td>Staff</td>
<td>C.C.</td>
<td>Part of Citywide replacement</td>
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<tr>
<td>F - 12</td>
<td>Replace speed bumps in alley - poor condition</td>
<td>Jan-16</td>
<td>J. Mejia</td>
<td>Staff</td>
<td>T.C.</td>
<td>Ordering new ones</td>
</tr>
<tr>
<td>F - 13</td>
<td>Vehicles in N/bound left turn lanes on Los Alamitos at Katella back up into thru lane</td>
<td>Jan-16</td>
<td>D. Emerson</td>
<td>Council</td>
<td>T.C.</td>
<td>Reviewing - Would likely require capital improvements</td>
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<tr>
<td>F - 14</td>
<td>Add red curb for sight distance on Katella for n/bound Bloomfield</td>
<td>Mar-16</td>
<td>D. Emerson</td>
<td>Possibly Council</td>
<td>T.C.</td>
<td>Reviewing - Clarification needed from Commissioner</td>
</tr>
<tr>
<td>F - 15</td>
<td>PT/P Study to downgrade fully protected operation for Rosmoor Way/Los Alamitos TS and Bradbury/Los Alamitos TS S/B and N/B directions</td>
<td>Jun-16</td>
<td>D. Emerson</td>
<td>Staff</td>
<td>C.C.</td>
<td>Reviewing - Found Traffic Reports by HC on this item</td>
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Updated 7/7/2016