Report for:

Analysis of High Collision Locations in San Leandro

Prepared for:
City of San Leandro
Under
Traffic Engineering Technical Assistance Program (TETAP)

Submitted by:

Dowling Associates, Inc.
Transportation Engineering • Planning • Research • Education

180 Grand Avenue, Suite 250
Oakland, CA 94612
Phone: (510) 839-1742; Fax: (510) 839-0871
www.dowlinginc.com
Contact: Mark Bowman

February 3, 2005

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City of San Leandro
Engineering & Transportation Department
835 E. 14th Street
San Leandro, CA 94577
Attn: Mr. Reh-Lin Chen, Senior Transportation Engineer
Ms. Anna Vickroy, Traffic Operations Engineer

Subject: Draft Report for Analysis of High Collision Locations [P04047.1]

Dear Reh-Lin and Anna:

Dowling Associates is pleased to submit the report for the Analysis of High Collision Locations in San Leandro. Please contact me if you have questions or comments.

Sincerely,

Dowling Associates, Inc.

[Sent Via Email]

Mark Bowman
Principal

cc. Ms. Christine Atienza, MTC

180 Grand Avenue, Suite 250 Oakland, CA 94612 Phone: (510)839-1742 Fax: (510)839-0871

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Introduction

This report was prepared under the Transportation Engineering Technical Assistant Program (TETAP) for the City of San Leandro. The objective of the project was to evaluate traffic safety at locations with high collision rates and to recommend short- and long- term improvements at these locations.

The report described the data collection process and the information collected. It discusses the existing conditions at twelve highest collision locations in San Leandro and summarizes our findings regarding engineering deficiencies of eight selected analysis locations. It then presents conceptual recommendations for improvements. The analysis intersections were selected in cooperation with City staff. The goal of the recommendations is to improve safety for all travel modes; hence the needs of pedestrians and alternative modes were carefully considered where problems exist.

The recommendations are based on field observations as well as available collision and traffic volume data and other information received from the City. Because the analysis is limited by available data, this report recommends further studies at some locations before the most appropriate improvement measures may be selected and, at one location, may be developed. Additional discussions may be found in the relevant sections.

Where appropriate, several alternative measures were considered at each location. It should be noted that a comprehensive study of the traffic volumes was not conducted nor was the implications of the recommendations fully considered and tested. The evaluation and recommendations were based on generally accepted engineering principles and the expertise of the analysts.

The recommended improvement measures were prioritized based on pre-determined criteria set forth in the San Leandro High Collision Detailed Workscope, Schedule and Budget memorandum and are presented at the final section of the report.

Project Data

Dowling and City staff met on October 27 to discuss the highest collision locations and to survey seven intersections. Attendees at the meeting included Dowling Associates staff, City Transportation and Engineering staff and the City's Traffic Sergeant – Tom Overton. City Transportation and Engineering staff and Dowling staff visited the intersections to identify conditions that might potentially contribute to high collision rates. Dowling staff also conducted subsequent site visits to observe traffic flow and photograph the intersections.

The City provided Dowling with the following documents:

- High Incidence Intersection Report – Collision Rates for the top 50 locations
- High Incidence Midblock Report – Collision Rates for the top 50 locations
- Collision Report Summary – Pedestrian-related
- Collision Report Summary – Bicycle-related
- Traffic Collision History Reports – top 12 intersections
- Collision Diagrams – top 12 intersections
- Traffic Collision History Reports and Collisions Diagrams for Bancroft Avenue between:
  - 136th Avenue and Blossom Way
  - 136th Avenue and 137th Avenue
- Daily traffic count information for:
  - San Leandro Boulevard at Broadmoor Street
  - Park Street at San Leandro Boulevard
  - Broadmoor Street at San Leandro Boulevard
  - San Leandro Boulevard at 105th Avenue
  - Bancroft Avenue at 136th Avenue
  - Washington Avenue between W. Juana Avenue and San Leandro Boulevard
  - Washington Avenue at Williams Street
  - Williams Street at Washington Avenue
  - Castro Street at Washington Avenue
  - Estabrook Street between E. 14th Street and Washington Avenue
  - Doolittle Drive between Marina Boulevard and Fairway Drive
  - Doolittle Drive between Williams Street and Davis Street

- Williams Street between Doolittle Drive and Timothy Drive
- Williams Street between Neptune Drive
- San Leandro Boulevard at Castro Street
- Castro Street at San Leandro Boulevard
- W. Juana Avenue between E. 14th Street and San Leandro Boulevard

- Case listing reports for the intersections of:
  - Washington Avenue at Estabrook Street
  - Juana Avenue at 14th Street Hwy 185
  - Washington Avenue at Castro Street
  - Washington Avenue at Williams Street

Copies of the document may be found in the appendices. In addition to the documents, Dowling also received GIS shapefiles and aerial photographs of the city in digital format.

Table 1: Collisions in Police Database but not in Engineering Database

Date	Time	Dist	Dir.	Type of Collision	Motor Veh Involved with	Dir. Of Travel 1	Move-ment 1	Dir. Of Travel 2	Move-ment 2	Primary Collison Factor	Injury	Killed
Washington Avenue at Estabrook Street												
3/1/02	20:50	0	In Int.	Broadside	Other Vehicle	South	Left Turn	North	Straight	ROW Auto	2	0
2/13/03	8:20	0	In Int.	Head-On	Other Vehicle	North	Straight	West	Straight	Traffic Sign/Signal	0	0
Washington Avenue at Castro Street												
8/3/00	14:48	0	In Int.	Broadside	Other Vehicle	South	Straight	East	Straight	Traffic Sign/Signal	1	1
3/6/02	19:30	0	In Int.	Broadside	Other Vehicle	North	Straight	East	Straight	Traffic Sign/Signal	0	0
9/9/02	17:50	0	In Int.	Broadside	Other Vehicle	South	Left Turn	North	Straight	Improper Turning	1	0
Juana Avenue at 14th Street Highway 185												
7/4/02	13:50	0	In Int.	Broadside	Other Vehicle	East	Straight	South	Straight	Traffic Sign/Signal	0	0
7/26/02	10:10	0	In Int.	Broadside	Other Vehicle	South	Straight	West	Straight	Unknown	0	0
12/26/02	17:20	0	In Int.	Broadside	Other Vehicle	South	Straight	West	Left Turn	Unsafe Speed	0	0
Williams Street at Washington Avenue												
12/17/02	17:25	0	In Int.	Broadside	Other Vehicle	East	Straight	North	Straight	Unknown	0	0

In reviewing the data collected from the Engineering and Transportation Department and the Police Department, inconsistencies were identified. Several collisions were identified on the Police Department listing that was not identified in the Engineering listing. The City is aware of the need to upgrade the collision data transfer process and this issue is addresses as part of the new Police Department database project. As a result, the collision rates at the analyzed intersections may be affected and these collisions were not included in the evaluation of the locations. Table 1 details the collisions that were shown on Police Department listing but not the Engineering list.

High Collision Locations

Collision rates presented in this report were supplied by the City and were derived from the collisions that took place during a three-year period between June 1, 2001 and May 31, 2004. The intersections with the highest collision rates are shown in Table 2.

Table 2: Intersections with High Collision Rates
Collision Rates for the Top 12 Locations[1] – June 1, 2001 to May 31, 2004

Rank	Intersection	Collision Rate	Total Collisions	Entering ADT Volume
1	Williams Street at Hayes Street	1.10	6	5,000
2*	**San Leandro Boulevard at Castro Street**	**0.81**	**19**	**21,484**
3*	**Washington Avenue at Estabrook Street**	**0.80**	**9**	**10,234**
4*	**Washington Avenue at Castro Street**	**0.75**	**10**	**12,234**
5*	**San Leandro Boulevard at Park/Broadmoor/Apricot**	**0.74**	**18**	**16,326**
6	MacArthur Boulevard at Dutton Avenue	0.71	16	20,500
7*	**Juana Avenue at 14th Street Highway 185**	**0.63**	**16**	**23,200**
8*	**Bancroft Avenue at 136th Avenue**	**0.61**	**8**	**12,000**
9*	**Williams Street at Doolittle Drive**	**0.55**	**12**	**19,900**
10*	**Williams Street at Washington Avenue**	**0.53**	**6**	**10,336**
11	MacArthur Boulevard at Lewis Avenue	0.48	6	11,500
12	Davis Street at Alvarado Street	0.45	18	36,300

[1] Source: High Incidence Intersection Report, the City of San Leandro

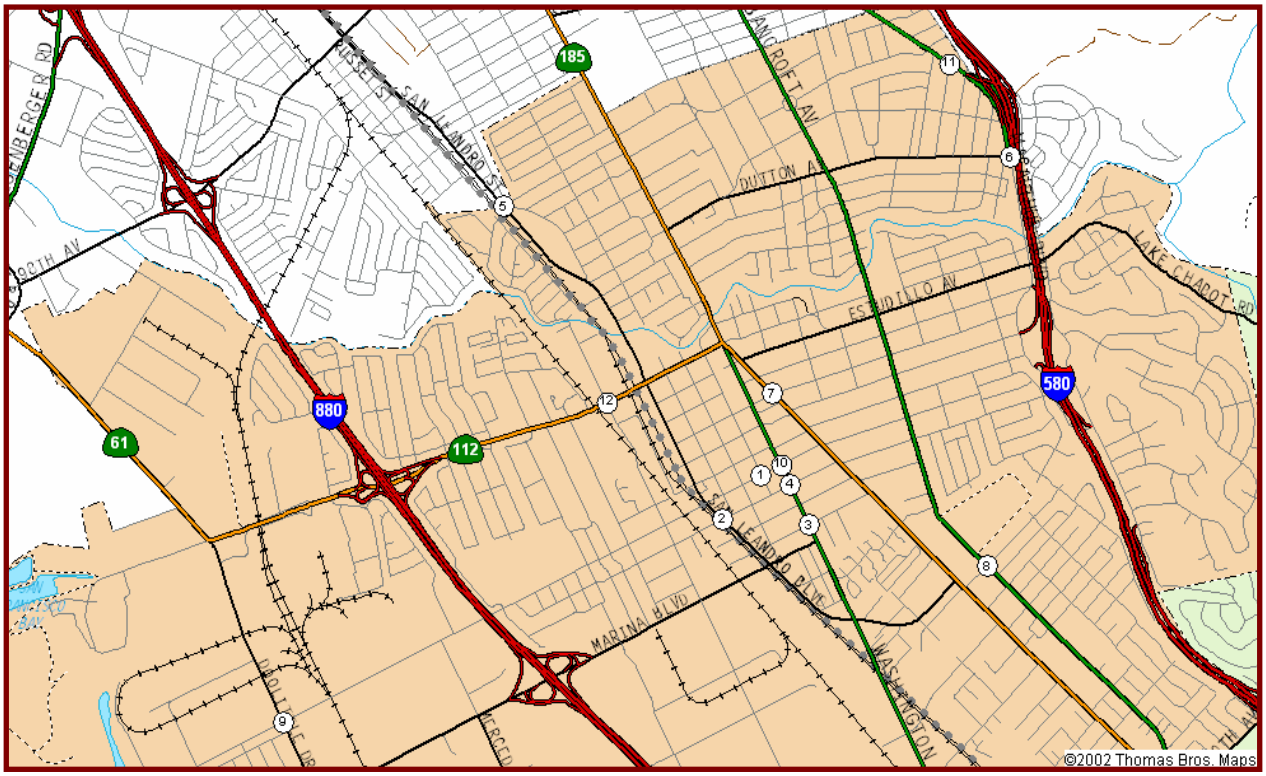
*** Intersections recommended for further analysis**

The calculation of collision rates took into account the number of collisions in the intersection as well as the average daily traffic (ADT)

volume for the intersections shown in the collision reports. Collisions involving bicycle-vehicle were not included in the calculation; while those involving pedestrian-vehicle were.

The twelve locations with the highest collision rates concentrated in the north central region of the city as shown in Figure 1. The numbers on the map correspond to the ranking shown in Table 2. The intersections recommended for further analysis shown in bold lettering in the table.

Figure 1: High Collision Intersections



Intersection Evaluation

This section describes the existing conditions at each of the high collision intersections. For the selected intersections, a discussion of the deficiencies is followed by improvement measures recommended to resolve the deficiencies.

Rank #1: Williams Street at Hayes Street

The intersection of Williams at Hayes has a collision rate of 1.10 making it the intersection with the highest collision rate in San Leandro between the three-year period of June 2001 and May 2004. There were a total of six collisions including one that involved a pedestrian and three that resulted in injuries. Of the causes that are known, right-of-way violation was cited as the cause of all the incidents. Right-of-way violations resulted in five broadside vehicle-to-vehicle collisions, four of which involved vehicles traveling westbound on Williams Street and southbound on Hayes.

All-way stop controls were installed in this intersection in December 2003. As there was no reported collision since, the City considers the problem resolved and requires no further improvement measure at this intersection. For this reason, this intersection was not selected for further analysis.

Rank #2: San Leandro Boulevard at Castro Street

The San Leandro Boulevard / Castro Street intersection is unsignalized with stop sign controls on Castro Street. The six travel lanes (plus two bike lanes) on San Leandro are divided by a median. Many cars use Castro Street as an alternative to Williams Street causing traffic to backup especially during peak hours. The collision rate was 0.81 for the three-year period, with a total of 19 collisions, including one pedestrian-related incident and resulting in six injuries. All but four of the collisions took place during day light hours. Over three-quarters of the vehicle-to-vehicle incidents were right-angle collisions.

Figure 2: San Leandro Boulevard Looking South Across Castro Street

Deficiencies

A possible cause of the collisions may be poor judgment of the crossing distance by drivers on Castro Street. This theory is supported by the fact that over half of the right-angle collisions occurred at the far side of the intersection. The remaining collisions mostly involved eastbound Castro Street traffic and northbound San Leandro Boulevard traffic, with poor sight distance considered a possible cause. High speeds on Castro Street and violation of stop controls may also contribute to the high collision rate. It was observed that some vehicles did not abide by the stop sign if there were traffic gaps on San Leandro Boulevard wide enough for more than one vehicle to cross.

Evaluation

Consideration for improvement at this intersection was focused on minimizing conflicts between vehicles on San Leandro Boulevard and Castro Street. The City has expressed reluctance to signalize the intersection (Figure 3) because it is located only a short block south of the already signalized San Leandro Boulevard / Williams Street intersection. Therefore, signalization was not considered as an alternative to improve the collision rate at this intersection.

All-way stop control was also found to be inappropriate. The daily traffic volume on east-west bound Castro Street is about one-sixth of that of north-south bound San Leandro Boulevard (3,125 and 18,981, respectively[1]). The *Manual on Uniform Traffic Control Devices* (MUTCD) published by the U.S. Department of Transportation Federal Highway Administration generally recommends that the traffic volume on the intersecting roads should be approximately equal. (See later section for more information on multi-way stop control.)

One way to minimize conflicts is by prohibiting through and left-turn movements on Castro Street. Several methods to achieve this objective were considered. A short term solution may entail posting of "Right Turn Only" sign on both legs of Castro Street. Since motorists are used to crossing San Leandro Boulevard at Castro Street, they may ignore the new signs and continue their habitual behaviors. To increase the effectiveness of this measure, it is recommended that the new restriction be diligently enforced by officers after the signs are first posted.

Complete closure of the existing median is another method to restrict traffic on Castro Street. This can be accomplished by connecting the two existing north and south medians with two sets of double solid

[1] Daily Traffic Count, the City of San Leandro

stripe markings on the pavement or extending the two medians to form one solid divide. The disadvantage of complete median closure is that it also restricts left-turn movements from San Leandro Boulevard, which were not found to be highly involved in collisions.

One way to overcome the limitation of complete median closure and still achieve the desired result would be to construct fully channelized left turn pockets (an S-Shaped median) at the intersection. This type of median would allow left-turn movements from San Leandro Boulevard but cut off through and left-turn movements from Castro Street. Currently the southbound through lanes on San Leandro Boulevard measure a total of 28 feet wide (Figure 3). This area would provide enough room to construct a four-foot median and two twelve-foot lanes, as shown in Figure 4. The northbound lanes may be left untouched.

Figure 3: Existing San Leandro Boulevard / Castro Street Intersection

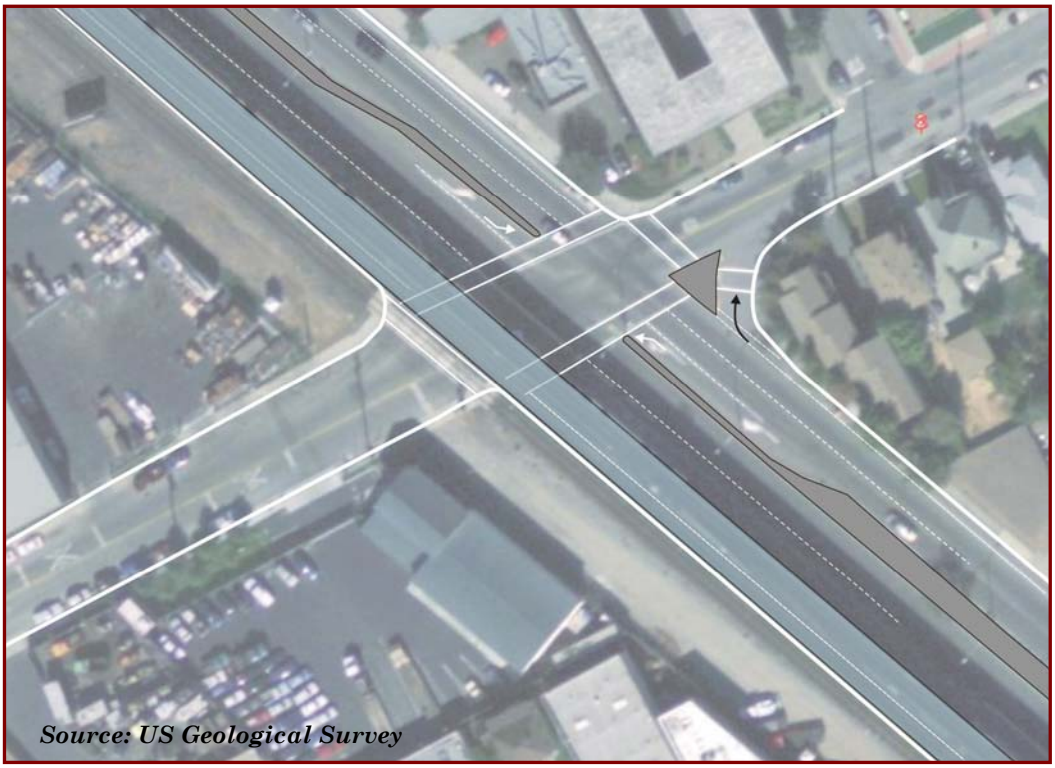
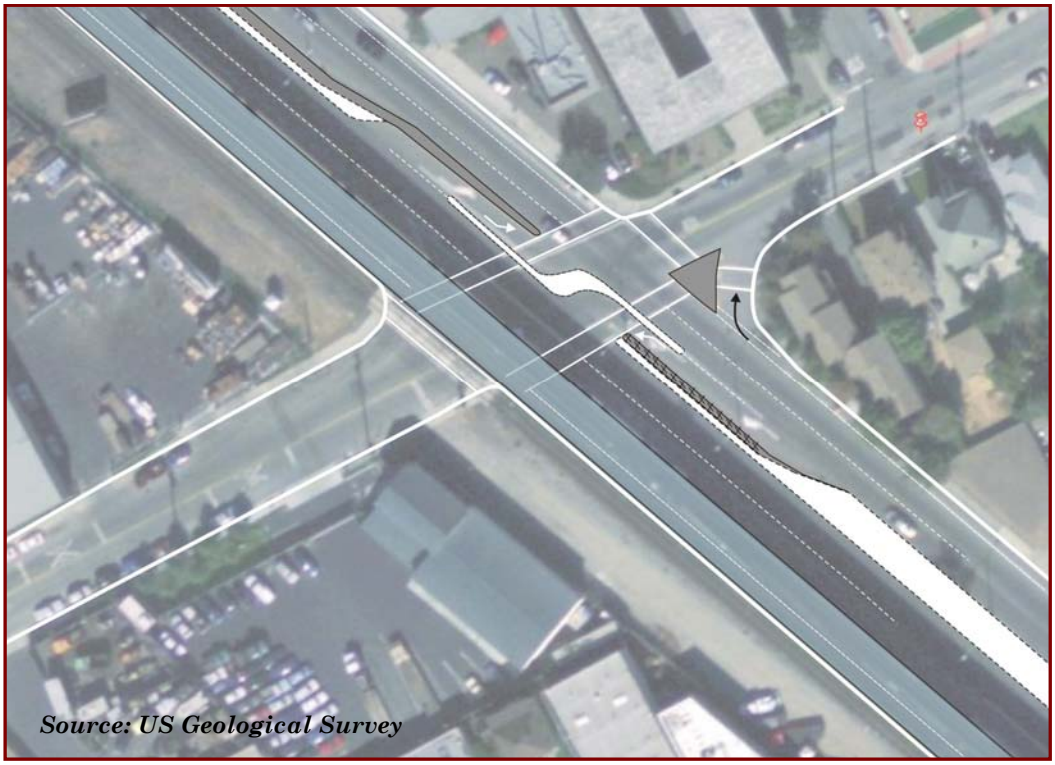


Figure 4: Possible Configuration at San Leandro Boulevard / Castro Street



The ramifications of disallowing through and left-turn movements on Castro Street would likely cause a diversion of traffic onto Williams Street in both directions. Marina Boulevard to the south may also carry more traffic but would not likely be affected to the same degree as Williams Street. Therefore, before any changes are made, it is recommended that the City examine the current traffic volumes and carrying capacity on Williams Street.

Recommendations

It is recommended that the City prohibit through and left-turn traffic on Castro Street. In the short term, the City may put up Right-Turn-Only signs on Castro Street and provide law enforcement to reinforce the new restrictions. For the long term, the City may construct fully channelized left-turn pockets at the intersection if subsequent studies establish that Williams Street could carrier the traffic that is likely to be diverted.

Rank #3: Washington Avenue at Estabrook Street

Three consecutive signalized intersections at the high collision locations list lie along Washington Avenue. These intersections are at Estabrook Street, Castro Street, and Williams Street. The deficiencies at the three intersections are similar and are addressed as a group. The evaluation and recommendations for all three intersections are presented below after the intersections are described.

Washington Avenue is classified as a collector roadway in the City's General Plan. The two-lane roadway is generally considered as a part of downtown; hence, it is intended to facilitate vehicular traffic while providing a comfortable environment for pedestrians and alternative modes. A mix of residential and commercial uses can be seen along Washington Avenue, while land uses on the three minor streets are primarily residential.

Figure 5: Estabrook Street Looking West Across Washington Avenue

The most distinctive feature of the Estabrook Street intersection is the presence of a small right-turn island at the southeast corner that houses an electrical pole as well as a pole where a set of traffic signals is mounted (Figure 5). This island is also used as a pedestrian refuge.

On both Washington Avenue and Estabrook Street, there are two travel lanes with parking on both sides of the street. The entering average daily traffic volume (ADT) of this intersection is 10,234[2]. The collision rate is 0.80 and the collisions totaled nine in the three-year period. The collisions included one pedestrian-related injury incident that occurred in the evening and two vehicle-to-vehicle incidents that also resulted in injuries. Of the nine collisions, just under one-half (4 incidents) were caused by signal violation and the causes of another one-third (3 incidents) are not known. At least five of the collisions involved northbound traffic.

[2] Ebid.

Rank #4: Washington Avenue at Castro Street

The middle of the three high-collision intersections on Washington Avenue, the intersection at Castro Street has a wide right-turn pocket on the eastbound approach. It has a collision rate of 0.75 and ten collisions between June 2001 and May 2004. Of the ten collisions, three were injury accidents; five involved the southbound through movement, of which four were rear-ended collisions. In addition, there was one bicycle-related collision. Two additional years of data (June 1999 to May 2001) were collected for analysis. It is interesting to note that, of the seven collisions that occurred during that period, there was not any rear-ended incident. However, five of them involved eastbound traffic. Most of the collisions over the five-year period were results of unsafe driving speed, violation of traffic signals, and improper maneuvers.

Figure 6: Castro Street Looking East Across Washington Avenue

At a recent site visit during non-peak hour, it was observed that some vehicles followed closely when traveling on Washington Avenue, showing signs of impatience behind slower moving vehicles on the two-lane street.

Rank #10: Washington Avenue at Williams Street

The northernmost of the three Washington Avenue intersections, the east-leg of the Williams Street intersection is an eastbound one-way street. Williams Street at Washington Avenue ranked tenth with a collision rate of 0.53 and had a total of six collisions during the three-year period. One of the collisions resulted in injury. Unlike other intersections, a distinct pattern to or cause of the collisions could not be surmised. Additional data from the preceding two years are also inconclusive.

Figure 7: Washington Avenue Looking North Across Williams Street

Deficiencies in the Washington Avenue Intersections

The Castro Street and Williams Street intersections with Washington Avenue have undergone several traffic control changes in recent years. In March 2002, the intersections were converted from signal control to all-way stop control. In March 2003, they were reverted to signal

control as the result of a signal warrant analysis. At Castro Street, a collision occurred three days after the reversion and may possibly be attributed to the change. No collisions occurred at either intersection during the one-year period when the intersections were controlled by all-way stop signs.

While Dowling staff did not have possession of the City's signal warrant study, the three intersections were analyzed based on Caltrans' signal warrant criteria for urban area using both peak hour traffic volume and four hour traffic volume. Based on volume data from December 2002 through September 2004 and assuming similar volumes along Washington Avenue at all three intersections, the peak hour signal warrant was not met at any of the three intersections.

One or more of the collisions may possibly be attributed to the visibility of the traffic signals. The signals are relatively small and difficult to see especially when traveling behind big vehicles. At Williams Street, there is only one overhang signal for southbound traffic; while the others are placed to the sides of the roads. At Castro Street, the east and west legs of Castro Street are somewhat offset and the signal control at the southeast corner is tucked back and placed at an angle that makes it difficult for eastbound traffic to see.

Evaluation

Review of the available data of these intersections revealed that the frequency of collisions is correlated with the type of traffic control on Washington Avenue. During the one-year period when the Castro Street and Williams Street intersections were controlled by all-way stop signs, there were no reported collisions at the two intersections. In contrast, between two and six collisions were reported during the one-year period before and after the conversion to all-way stop control at each intersection (i.e. while signal controlled).

Section 2B.07 of the third edition of the MUTCD provides criteria for installation of multi-way stop control. It suggests that the minimum volume "entering the intersection from the major street approaches average at least 300 vehicles per hour for any 8 hours of an average day and the combined vehicular, pedestrian, and bicycle volume from the minor street approaches average at least 200 units per hour for the same 8 hours, with an average delay to minor street vehicular traffic of at least 30 seconds per vehicle during the highest hour."

Non-vehicular volumes and average delay information are not available to determine if the MUTCD criteria are met at the three Washington Avenue intersections. However, Table 3, which shows the traffic volumes during the peak travel hours along Washington

Avenue, indicates that the major street approaches met the volume requirement and the minor street approaches met the requirement at Castro Street and Estabrook Street. Because Williams Street turns into a one-way street east of Washington Avenue, only the eastbound approach is applicable.

Table 3: Washington Avenue Intersection Approach Volumes

Hour	Washington Avenue (NB & SB)	Williams Street (EB only)	Castro Street (EB & WB)	Estabrook Street (EB & WB)
Data Collection Date	29 Sep 04	06 Jan 03	16 Dec 02	20 Sep 04
11am	551	113	186	216
Noon	680	128	210	212
1pm	701	114	233	238
2pm	717	136	214	264
3pm	716	170	327	412
4pm	702	176	334	331
5pm	760	202	325	348
6pm	684	102	367	282
7pm	497	76	237	190
Daily Total	9234	1752	3893	3742

Source: City of San Leandro Daily Traffic Counts Information

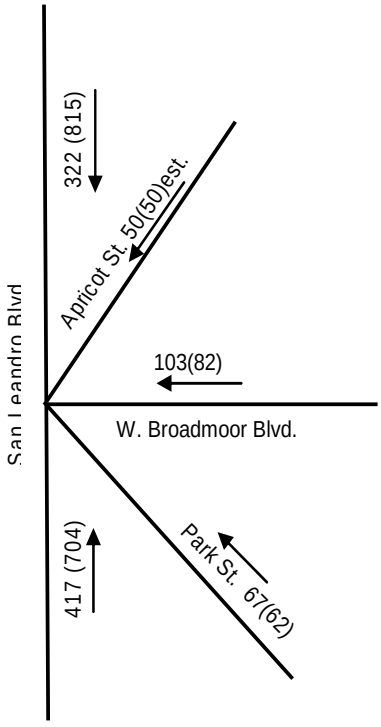
The MUTCD also states that the traffic volume on the intersecting roads should be approximately equal. The volume is approximately a two-to-one split between Washington Avenue and all three minor streets. The ratio is considered to be acceptable for multi-way stop installation.

Recommendations

It is recommended that the existing traffic signals at the three intersections be put on blinking red flashes to indicate stop control for a period of three months as an interim measure. After the test period, City staff should review the collision data during the trial period and determine if permanent stop signs should be installed. If so, the traffic control at the three intersections should be changed to all-way stop signs.

Rank #5: San Leandro Boulevard, West Broadmoor Boulevard, Park Street and Apricot Street

Figure 8: AM (PM) Peak Hour Traffic Volumes



Three minor streets converge at San Leandro Boulevard to form this intersection. One of the minor streets, Apricot Street, is located in the City of Oakland. Peak hour approach traffic counts conducting in June 2002 for the intersection is presented in Figure 8. Because approach counts and collision data for Apricot Street are not available, the presented estimates are based on adjacent street counts and observations.

The three minor streets are controlled by stop signs, while San Leandro Boulevard is uncontrolled. Vehicles on San Leandro Boulevard travel at high speed and may potentially be unaware of the intersection, which is set back slightly to the east.

Between June 2001 and May 2004, a total of 18 collisions were reported at the intersection of San Leandro Boulevard at West Broadmoor/Park, resulting in five injuries. The collision rate is 0.74 placing it fifth among the high collision intersections. Thirteen of the collisions occurred at Park Street, of which eight were broadside collisions between through vehicles on San Leandro Boulevard and left-turning vehicles on Park. One similar collision occurred at West Broadmoor. Right-of-way violation was the likely cause of these collisions.

Deficiencies

Figure 9: San Leandro Boulevard/W. Broadmoor/Park/Apricot

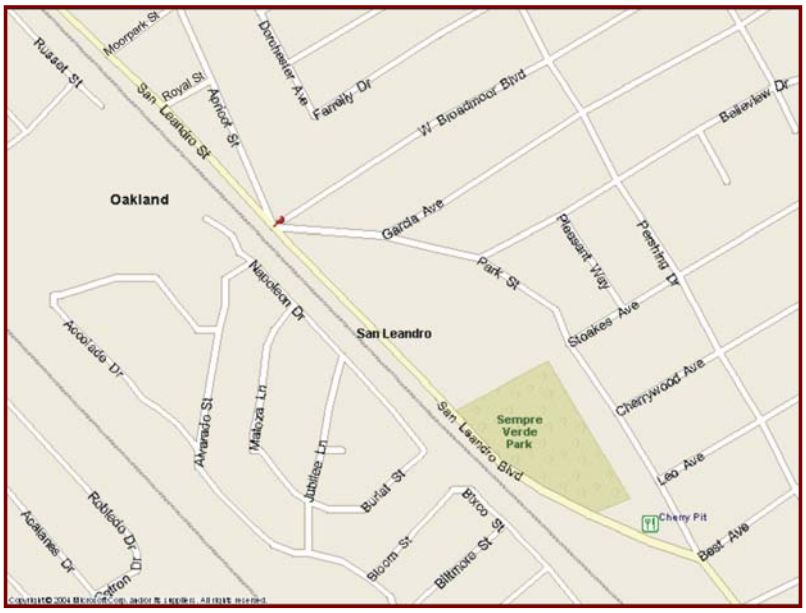
Sight distance has been identified as a problem at this intersection. The intersection setback requires minor street vehicles to move into the intersection to obtain better sight distance of vehicles traveling on San Leandro Boulevard. It is difficult for left-turning vehicles on Apricot Street to see vehicles traveling southbound on San Leandro Boulevard without moving well into the intersection and into the line of northbound traffic. The same is true for traffic on Park

Street. Sight distance is obstructed by the building at the corner of San Leandro Boulevard and Park Street. The openness of the intersection creates uncertainty for motorists at the intersection because of the limited sight distance.

Evaluation

The evaluation of the intersection is divided into two parts: Apricot Street and Park Street and West Broadmoor Boulevard. The objective is to simplify the intersection; thus reducing conflicts and potential collisions. Several alternative measures were considered for each part of the intersection. All the measures involve redesigning the intersection to eliminate the setback space and extend West Broadmoor Boulevard or Park Street out to meet San Leandro Boulevard.

Figure 10: Circulation Map



Two alternative measures were considered for Apricot Street. Closing the street at San Leandro Boulevard by creating a cul-de-sac would eliminate one source of conflict at the intersection. However, the relatively narrow Apricot Street dictates that a cul-de-sac could not be created without taking of adjacent properties. The small estimated volumes at this intersection make implementation of this option undesirable.

Another alternative would be to make Apricot Street into a one-way northbound street for one street block to Royal Street (Figure 10). It would remove the most hazardous movement at the intersection and, in essence, create a new intersection separate from West Broadmoor and Park Street. Traffic circulation would be altered but not significantly. Royal Street would be used by exiting traffic to San Leandro Boulevard. Those that would previously enter the 11000 block of Apricot Street through Royal Street or Moorpark Street may instead enter through the analysis intersection.

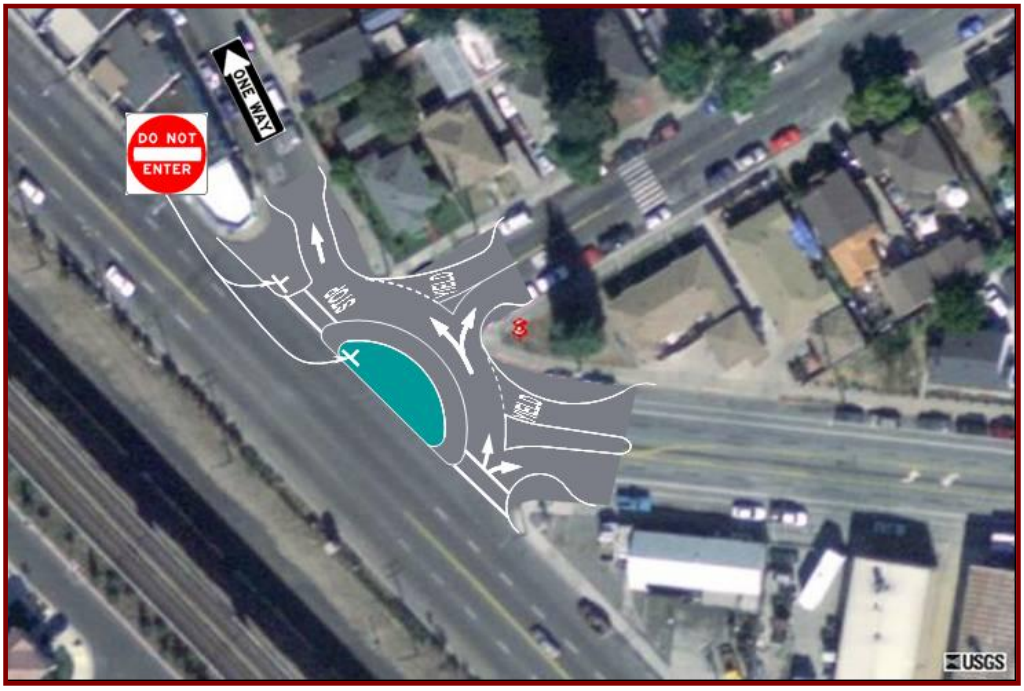
Park Street and West Broadmoor Boulevard are evaluated as a whole. The goal is to better delineate right-of-way and to provide better visibility for motorists. This may be handled in four different ways as illustrated in Figure 11, Figure 12, Figure 13, and Figure 14.

Figure 11: Alternative #1 – Cul-de-Sac

Figure 12: Alternative #2 Park Street Channeling

Figure 13: Alternative #3 – West Broadmoor Channeling

Figure 14: Alternative #4 – Semi-Roundabout



Alternative #1 and #2 allow West Broadmoor to be extended to intersect with San Leandro Boulevard. Alternative #3 channels West Broadmoor to Park Street and extends Park to intersect with San Leandro Boulevard. The last option creates a semi-roundable at the intersection.

Figure 15: Example of a Cul-de-Sac with Bike Access

Source: www.trans.ci.portland.or.us

The first treatment involves closing of Park Street by forming a cul-de-sac at the intersection (Figure 11). Bike lanes on Park and bike access to San Leandro Boulevard will be retained. Figure 15 shows an example of a cul-de-sac with bike access. The minimum suggested diameter of 60 feet for a cul-de-sac appears to be available at the location. The closure would create a more residential feel on Park Street and would make it safer for residents, pedestrians and users of the Sempre Verde Park. The City may also take advantage of the separation space for landscaping and public art.

Traffic circulation would be altered by this configuration. Traffic to and from the south may use Park Street's southern intersection with San Leandro Boulevard. Most other traffic would likely be diverted onto Garcia Avenue and travel back up West Broadmoor to San Leandro Boulevard. Consequently, traffic on Garcia Avenue, Pershing Drive, and West Broadmoor Boulevard would be likely to increase. In view of the morning and afternoon westbound peak hour traffic of 67 and 62, respectively, on Park Street, this diversion would not likely overburden the roadways or create unacceptable nuisance to the residents.

Alternative #2 would create a separation from San Leandro Boulevard by channeling Park Street to the right and intersecting West Broadmoor at a T-junction (Figure 12). This configuration would require a partial taking of the side yard of a residential property located at the corner of West Broadmoor and Park. If the entire property were acquired, a larger, more desirable separation could be created. Park Street would be a one-lane road in each direction and would be controlled by a stop sign. West Broadmoor would be uncontrolled at the intersection with Park Street. The bike lanes on Park Street would be retained. This alternative is not likely to divert traffic significantly.

The design of Alternative #3 is similar to Alternative #2 in many ways. A separation from San Leandro Boulevard would be created by channeling West Broadmoor Boulevard to the left and intersecting Park Street at a T-junction (Figure 13). Both Park Street and West Broadmoor would be one-lane roads in each direction and would be controlled by stop signs. Some of the drawbacks of this alternative are potential conflicts between eastbound vehicles on Park and vehicles entering West Broadmoor, short queuing distance on Park Street for both left-turning vehicles onto West Broadmoor and onto San Leandro, and the necessity to acquire right-of-way of the property at the corner of West Broadmoor and Park.

The last alternative, which involves the creation of a semi-roundabout, is illustrated in Figure 14. Vehicles intending to enter Park, West Broadrmoor or Apricot from San Leandro Boulevard may only approach through the southern end of the semi-roundabout. Eastbound vehicles approaching the semi-roundabout from both Park and West Broadmoor would yield to vehicles already on the semi-roundabout, which always have the right-of-way. Note that as in the other alternatives, Apricot is a one-way northbound street. A combination left- and right-turn lane are provided on the northern end of the semi-roundabout at San Leandro Boulevard is are stop-controlled.

This design does not require taking of any property and still has enough room for emergency vehicles and trucks to maneuver around. Traffic is also not expected to be diverted, hence would not impact adjacent neighborhood and roadways.

Concerns with the semi-roundabout alternative relate primarily to queuing and blocking as well as sight distance issues. Additional study is recommended to determine the feasibility of this alternative based on turning traffic volumes, which were not available for this study. The focus of the additional study should be on the potential for the concept to function without excessive queues at the westbound approach to San Leandro Boulevard. If the alternative is implemented, care should be taken so that landscaping or other amenities on the semi-roundabout would not obstruct visions of motorists in left-turning vehicles.

In evaluating the treatment of the analysis intersection, a true roundabout has been determined to be inappropriate for several reasons. First, the travel speed on San Leandro Boulevard is likely to be too high. Second, as a general rule, it is often recommended that the traffic volumes on all approaches to the roundabout should be relatively even. In this case, the volumes on San Leandro Boulevard are dramatically higher than those of the minor streets.

Recommendations

It is recommended that turning movement counts be conducted and additional study be conducted for San Leandro Boulevard, Park Street, West Broadmoor Boulevard, and Apricot Street. If the additional study indicates that the semi-roundabout (Alternative 4) is recommended, surface mounted curb, temporary barriers, pavement markings and signing may be installed to test the alternative. If the test proves to be successful, a permanent semi-roundabout may be installed. If the additional study or the test operation of the semi-roundabout is not successful, one of the other alternatives may be considered.

Rank #6: MacArthur Boulevard at Dutton Avenue

MacArthur Boulevard at Dutton Avenue is a signalized intersection where left-turns are unprotected on all approaches. The collision rate is 0.71 for the three-year period. The midblock collision rate between Dutton Avenue and MacArthur Boulevard Transition Road on MacArthur Boulevard is ranked 14 for the same period. There have been 16 collisions including one pedestrian-related and eight that resulted in injuries. Right-of-way violation was the stated cause of six collisions, while the causes of seven others were not known.

The City's traffic sergeant noted that vehicles came off the I-580 freeway at high speed. He also stated that northbound left-turn violation is prevalent. This is supported by available data. Over 80 percent of the collisions involved southbound vehicles coming off the freeway of which about 50 percent were collisions with northbound left-turning and 15 percent with westbound left-turning vehicles.

A traffic control improvement to add protected left-turn phasing on the northbound and southbound approaches is planned as part of the MacArthur Boulevard Streetscape Project. The collision rate is expected to improve as a result of the improvement; hence, the intersection was considered low priority for the current high collision locations study and was not included for further analysis.

Rank #7: Juana Avenue at 14th Street (Hwy 185)

The Juana Avenue/14th Street intersection is located in downtown San Leandro and experiences typical downtown traffic patterns where vehicular peak traffic hours are not clearly delineated. Pedestrian traffic is relatively heavy during business hours. It is signalized with two-phase control. E. 14th Street has four travel lanes and parking is allowed along the west side of the street. It is also a designated state highway; hence any changes must be approved by Caltrans. Juana

Avenue is a two-lane street, where metered parking may be found on both sides. Neither street has turn pockets.

This busy intersection has an entering ADT volume of 23,200 and a collision rate of 0.63 for the three-year period. The midblock collision rates on 14th Street to the north and south of Juana are ranked 21 and 17, respectively.

Figure 16: Juana Avenue at E. 14th Street

Source: US Geological Survey

In addition to a bicycle-related injury collision, there were 16 collisions including four that involved pedestrians. Two of the pedestrian-related collisions were caused by violations by the pedestrians and three resulted in injuries. There were three other injury collisions. One-quarter of the collisions occurred during afternoon peak traffic period of 4 pm to 6 pm and none in the morning peak period of 7 am to 9 am. The majority of the collisions were spread relatively evenly between 11 am to 8 pm.

Figure 17: E. 14th Street Looking North Across Juana Avenue

With the exception of one of the pedestrian-related incidents and two westbound vehicles colliding with southbound traffic, all the remaining collisions only involved vehicles originated from 14th Street that were either proceeding straight through the intersection (4 rear-ended collisions) or performing left-turn maneuvers (6 collisions).

Deficiencies

The Juana at E. 14th intersection experienced the highest number of pedestrian-vehicle collisions during the studied period among the analysis intersections. Pedestrian safety is clearly a concern that should be addressed. The lack of left-turning pockets and protected phasing may also cause right-of-way confusion among motorists at this busy intersection and may have contributed to the collisions that involved left-turning movements.

Evaluation

Improvement measures are necessary at the Juana and E. 14th intersection to facilitate safer crossing for pedestrians as well as better defined right-of-way for motorists. Two types of measures were considered that entailed pedestrian signal phasing and left turn lanes.

The first potential pedestrian signal phasing measure is to implement leading pedestrian intervals on both Juana and E. 14th Street. By retiming the signal splits to allow pedestrians a few second head start into the intersections before the signals turn green for vehicles, this measure would help better establish pedestrian right-of-way in the intersection, enhance visibility of the pedestrians to left-turning traffic, hence improve pedestrian safety.

An alternative to leading pedestrian intervals is an exclusive pedestrian signal phase, known as a pedestrian scramble or "barn dance". During this phase, all vehicular traffic is stopped and pedestrians are allowed to cross the intersection in all directions at the same time. This measure would reduce vehicle-pedestrian turning conflict and shorten pedestrian crossing distance, making the intersection more pedestrian-friendly. However, this measure has several drawbacks. The signal cycle is lengthened because of the additional phase. Some pedestrians may illegally cross the intersection that is parallel to moving traffic during non-scramble phase; thus compromising the safety of themselves and others. Visually impaired persons may have difficulty recognizing the onset of the walk interval without the sound of vehicular flow. Furthermore, information is not available to substantiate the amount of pedestrian utilization of the intersection. For these reasons, the leading pedestrian intervals option is more preferable at this location.

A leading pedestrian intervals measure may be implemented alone or in combination with one of the following left turn lanes alternatives. Both alternatives necessitate the creation of left-turn lanes on E. 14th with protected left-turn phasing, which would eliminate uncertainties with turning movements, thereby reducing turning conflict with pedestrians and rear-ended collisions.

- The first alternative would retain the current four travel lanes and create the necessary left-turn lane width by removing the parking lane on the west side of the street. Vehicular and pedestrian traffic flow would not likely be impeded by this design. However, the removal of parking spaces might not be acceptable to nearby retail merchants. A parking study to determine the impact of such a measure to downtown businesses may be necessary.

- The second alternative would involve reducing the four travel lanes on E. 14th to two. Under this alternative, it would be possible to not only retain the west side parking lane but also allow parking on the east side of the street; while creating left-turn lanes on E. 14th. This alternative would affect traffic flow in the downtown area and require further study to determine the potential congestion impact to E. 14th and adjacent streets. Additional study may also help identify the optimal extent of the two-lane configuration. One possible option is to extend the two-lane section north to Chumalia Street, where an existing two-lane roadway begins, and south to San Leandro Boulevard, where "downtown" seems to terminate.

Recommendations

Because retiming signal splits are the least costly to implement and may help reduce collision rate, it is recommended that the City apply leading pedestrian intervals at the Juana at E. 14th intersection as a first step measure to improve safety for pedestrians and motorists.

If this measure alone proves to be insufficient, the City may elect to create a left-turn lane on E. 14th Street by removing the parking lane on the west side of the street. However, the City may first work closely with downtown merchants and conduct a parking study to understand the supply and demand of parking in the downtown area and to identify alternative parking spaces as replacement if necessary.

Rank #8: Bancroft Avenue at 136th Avenue

Figure 18: Bancroft Avenue Looking North Across 136th Avenue

Bancroft Avenue and 136th Avenue are both two lane roadways controlled by all-way stops at their intersection. The intersection is near a major point of access to San Leandro High School. Therefore, foot traffic is particularly heavy immediately before and after school. At the same time, vehicular traffic is also heavy between 2:00 pm to 2:45 pm on Wednesdays and between 3:00 pm to 3:45 pm the rest of the weekdays due to after school pickup. It is common that traffic backs-up on both approaches on Bancroft and on the eastbound approach on 136th during this time as cars yield for pedestrians. The intersection meets traffic signal warrant for pedestrians.

The collision rate at the intersection is 0.61 with a total of eight collisions. Of the collisions, five were rear-ended collisions including three that occurred between 3:00 pm and 3:30 pm.

A new retail center is being built at the southwest quadrant of the intersection amidst primarily residential uses. It is expected that both the pedestrian and vehicle traffic levels will increase once the center opens.

Deficiencies

Although no pedestrians were directly involved with the collisions, a majority of the collisions may possibly be attributed to pedestrian traffic and unsafe driving speed according to the City of San Leandro's traffic sergeant and collision data. Improvement measures at this location may involve traffic warning and traffic calming techniques.

Evaluation

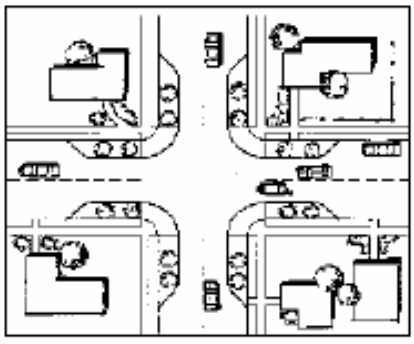
In evaluating and selecting potential traffic calming measures for the Bancroft at 136th intersection, adjacent land uses, desired neighborhood feel, and daily traffic volumes were taken into consideration. A two-step approach may be appropriate for the analysis intersection: advance warning and traffic calming.

Figure 19 Advance Warning Sign

As an initial measure, advance warning devices may be installed ahead of the intersection to alert motorists of the approaching control. Such devices include advance traffic control signs: "Stop Ahead" and "Be Prepared To Stop". Examples of the signs are shown in Figure 19. The signs may be supplemented by pavement marking of similar message. Another possible warning device is the flashing beacon. Section 4K.03 of the MUTCD suggested that warning beacon is appropriate to supplement warning signs and to emphasize regulatory signs.

If advance warning devices prove to be insufficient to reduce the collision rate at the intersection, traffic calming measures may be implemented. Two traffic calming techniques were considered for the study: bulb-outs and raised table.

Figure 20: Bulb-Outs

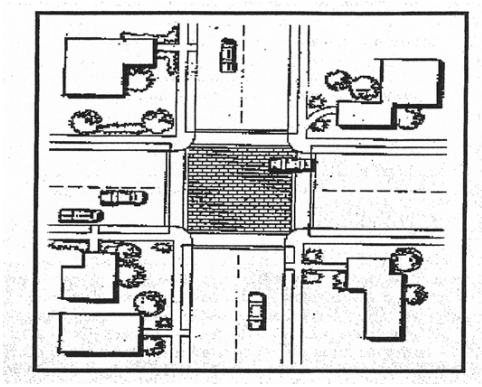


Source: Neighborhood Traffic Calming Program Handbook, City of San Leandro

Installing bulb-outs at all four corners of the intersection may improve safety for pedestrians by reducing crossing distance and making them more visible to motorists. The reduced curb radii would slow turning traffic and the

narrower feel of the intersection may also slow the speed of through vehicles. An example of an intersection with bulb-outs is shown in Figure 20.

Figure 21: Raised Table



Source: Neighborhood Traffic Calming Program Handbook, City of San Leandro

An alternative traffic calming device to bulb-outs is raised table, also known as raised intersection. Raised table has several advantages. It would reduce through movement speeds at the intersection as well as midblock speed. It would create a more pedestrian-friendly intersection and would signal land use transition from commercial uses to residential and school zones. It also would provide opportunity to improve aesthetic appeal and helps make the neighborhood commercial center a focal point of the area. Warning signs should be posted to alert motorists of the raised table prior to entering the intersection so that they can adjust their speed accordingly.

A major drawback of the raised table is that, even though the device would not impede access, it would slow emergency vehicles to approximately 15 miles per hour[3]. Such delay may not be acceptable to the City. An example of raised table is shown in Figure 21.

Recommendations

It is recommended that incremental measures be implemented to improve collision rate at the intersection. The following devices may be installed in the following order:

1. Advance traffic control signs
2. Advance traffic control pavement markings
3. Warning beacons
4. Bulb-outs
5. Raised table

[3] Institute of Transportation Engineers. "Traffic Calming for Communities." http://www.ite.org/traffic/raised.htm.

Rank #9: Williams Street at Doolittle Drive

Williams Street at Doolittle is a two-phased signalized intersection located in a light industrial area. Anecdotal evidence suggests that a high number of truck traffic traverses the area but exact volumes are not available. Doolittle is a major north-south arterial that runs parallel to I-880, serving the Oakland International Airport to the north. It is a four-lane roadway with left-turn pockets and bike lanes. Williams Street is a two-lane minor street with the west leg widened in 2003 to accommodate bike lanes.

Traffic distributes relatively evenly on both north- and south- bound approaches through the intersection. In contrast, volume is much heavier on the east leg of Williams Street with much of the traffic either turning into or coming from Doolittle Drive. The entering ADT volume is 19,900.

Figure 22: Williams Street Looking South Across Doolittle Drive

Deficiencies

A total of twelve collisions were reported during the three-year period. Four of the collisions involved southbound left-turning movements and two westbound left turning movements. There were three right angle collisions and three rear-ended collisions. Available data are not sufficient to pinpoint engineering deficiencies at this intersection though the lack of protected left-turn phasing might be a contributing factor to the high collision rate.

Evaluation

Protected left-turn signal phases may address some of the collision problems at this intersection. However, further study is necessary to justify this recommendation.

The California Supplement of the MUTCD 2003 suggested that protected left-turn phases should be considered for areas where there are a large percentage of trucks. Protected left-turn phases may also be applicable where "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" and where "a left-turn volume of more than two

vehicles per approach per cycle for a peak hour" for pre-timed signal or a back-ground-cycle-controlled actuated signal.[4]

Recommendations

It is recommended that further studies be conducted on truck traffic volume, delay, and turning movement volume in order to determine the applicability and potential effectiveness of implementing protected left-turn phases at the intersection of Williams Street and Doolittle Drive. Such studies would also provide additional information for further improvement measures development.

Rank #11: MacArthur Boulevard at Lewis Avenue

Lewis Avenue is a minor residential street; while MacArthur Boulevard is a major intercity arterial. The intersection is located in an area where "side show" activities take place at night; though only one of the total six reported collisions occurred after 8 pm. The collision rate is 0.48. The midblock collision rate between Lewis Avenue and Mitchell Avenue on MacArthur Boulevard is ranked 13.

The intersection is on the City's signal prioritization list. Further, the area is also covered under the MacArthur Boulevard Streetscape Project that will include improvements such as bulb-outs and parking. It is expected that such planned improvements will help to reduce collision rate in the intersection; thus further analysis was not conducted.

Rank #12: Davis Street at Alvarado Street

Davis Street has four travel lanes and Alvarado Street has two travel lanes. At this intersection, both roads have left-turn pockets; and right-turn pockets are also provided on Alvarado Street.

Although the number of collisions at the intersection of Davis at Alvarado is relatively high, at a total of 18, the collision rate is 0.45 ranking it #12 on the high collision rate list. The collisions included one pedestrian-related and four that occurred in the early evening hours. Over 61 percent (11 collisions) of the collisions are caused by rear-ended vehicles. All but one of the rear-ended collisions involved traffic on Davis Street. This intersection was not selected for further analysis.

[4] MUTCD 2003 California Supplement, May 20, 2004. p4D-2.

Conclusions

The report evaluated selected high collisions locations in the City of San Leandro and proposed conceptual countermeasures to address some of the engineering deficiencies at these intersections. Some of the recommendations may provide more immediate rectification of the high collision rates; while others require addition studies on surrounding traffic patterns before the determinations on implementation can be made. The application of the recommendations will likely help reduce collision rates and improve safety for pedestrians, motorists and users of alternative modes.