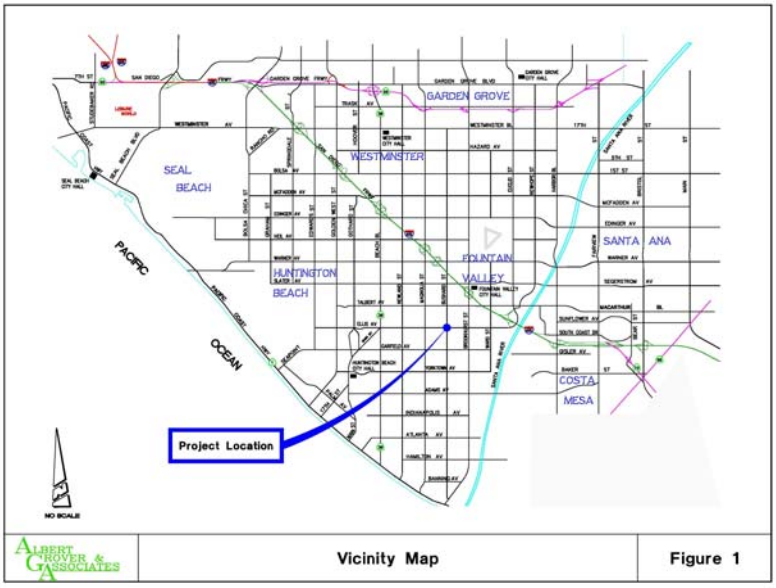
Measures to Mitigate Impacts Associated with Temporary Closure of a Major Intersection in Orange County

Chalap K. Sadam, P.E., Greg Wong, P.E., and Wolfgang Scherr

Introduction

The Orange County Sanitation District is proposing to close the intersection of Ellis Avenue and Bushard Street, in the City of Fountain Valley, for approximately seven to nine months beginning in May 2006, due to construction activities related to the "Bushard Trunk Sewer Rehabilitation Project I-2-4A". A vicinity map identifying the project location and nearby arterial highways is provided in Figure 1.

Albert Grover & Associates, a municipal and traffic engineering services consulting company, based in Fullerton, California, was retained by the Sanitation District to conduct a traffic impact assessment study to evaluate potential impacts of the temporary intersection closure and to develop methods to ameliorate these impacts.



Analysis Methodology

Using various transportation models, a sensitivity analysis was conducted to identify locations that could potentially have temporary peak hour traffic volume changes. Based on this analysis, a total of 40 signalized intersections were identified as study intersections for detailed capacity and Level of Service (LOS) analyses. Traffic signals on all major arterials in the study area are currently coordinated and operate using a 120 second system cycle length. Capacity and LOS analyses were conducted for the following scenarios for the AM, midday and PM peak hours:

- Existing Traffic Conditions – Year 2006 (i.e., just prior to when the closure is scheduled to occur)
- Detoured Traffic Conditions – Year 2006 with Ellis Avenue/Bushard Street Intersection Closed
    - With Existing Lane Geometrics and Signal Timings
    - With Signal Timing Modifications

Chalap K. Sadam, P.E. – Vice President, Albert Grover & Associates, Fullerton, California
Greg Wong, P.E. – Transportation Engineer, Albert Grover & Associates, Fullerton, California
Wolfgang Scherr, Principal, PTV America Inc., Wilmington, Delaware

Using existing traffic volumes as a basis and origin-destination and trip table information from the Orange County Transportation Analysis Model provided by the Orange County Transportation Authority for both "existing" as well as "with project" conditions (i.e., with the Ellis Avenue/Bushard Street intersection closed), transportation modeling was used to estimate potential detoured traffic volumes expected to occur with the project for each of the analysis peak periods.

The capacity and level of service analyses were completed for all study intersections for "With Project Conditions" and also with specific measures identified to reduce temporary intersection impacts.

The main input data for level of service analyses include:

- Peak Hour Turning Movement Counts
- Signal Phasing Sequence
- Saturation Flow Rates and Number of Lanes
- Minimum Split Times for Pedestrians
- Actual Coordination Timing Splits

The following measures of effectiveness were used to compare "existing" intersection operations to intersection operations "with project" conditions:

- Overall intersection LOS per the 2000 Highway Capacity Manual (HCM)
- Overall intersection volume-to-capacity (V/C) ratios
- Average intersection delays
- Queuing, delays per approach, and V/C ratios for each movement

Existing Roadway System and Traffic Volumes

The project study area included a grid of regionally significant arterials that provide primary and secondary access to area residents and businesses. Many of the major roadways have four to six lanes with the exception of Beach Boulevard, which is an eight-lane facility north of Ellis Avenue and a six-lane facility south of Ellis Avenue.

Two roadways that will be temporarily impacted by the proposed project are Ellis Avenue and Bushard Street. The following is a brief description of these two facilities.

> **Ellis Avenue** is a four-lane facility with a posted speed limit of 45 mph in the project vicinity. Ellis Avenue is signalized at all major cross streets and carries approximately 23,000 vehicles daily in the project vicinity. Additionally, Ellis Avenue daily traffic volumes increase to over 31,000 vehicles in the vicinity of I-405 southbound ramps, within two miles of the intersection closure.

Bushard Street is a four-lane facility with a posted speed limit of 45 mph in the project vicinity. Bushard Street is signalized at all major cross streets and carries approximately 16,000 vehicles daily in the project vicinity.

To adequately evaluate any traffic impacts associated with the project, all analyses were conducted using peak hour traffic volume measurements.

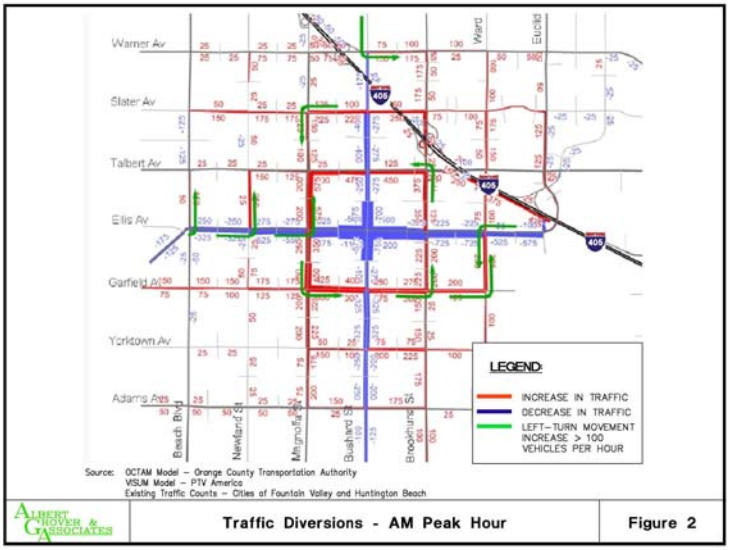
Traffic Re-Distribution/Assignment

Transportation modeling was used to estimate potential traffic detours expected to occur with the project for each of the analysis peak periods. As the surrounding network already operated at relatively congested conditions, the nature of diversion was expected to be too complex to predict with engineering judgment alone. Therefore, a traffic assignment model was used to estimate the expected traffic detours. The assignment model was refined and used for all three analysis peak periods.

VISUM, a transportation modeling software by PTV America, was used for traffic distribution. VISUM is a comprehensive, flexible software system for transportation planning, travel demand modeling and network data management. VISUM provides a variety of assignment procedures and four-stage modeling components which include trip-end based as well as activity based approaches. The VISUM software was chosen as the model platform because of its import/export interface with Synchro software, which allowed the model to be built quickly. Also, VISUM provides state-of-the-art methods for equilibrium assignment and matrix calibration and the results can be easily transferred to VISSIM software for micro-simulation.

The first step in building the traffic assignment method was to import network topology, intersection geometry, signal timing and traffic count data from Synchro software. This raw import model was enriched with the following network objects and attributes:

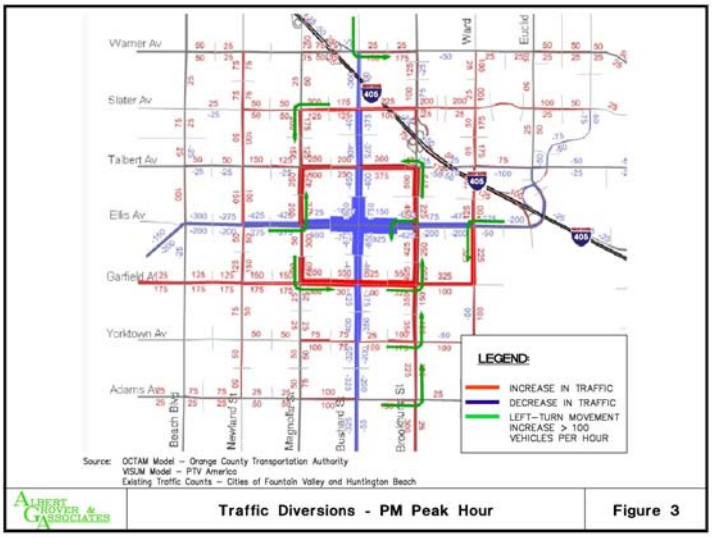
- street capacities
- turn capacities
- traffic analysis zones and zone connectors.



One important assumption in the transportation model, developed specifically for this project, is that the area motorists will be aware of the proposed closure, via information signs, flyers, detour signs etc. such that drivers can take alternate routes to avoid congested areas. The detour volumes developed in the model represent a rather stable equilibrium – traffic volumes that are expected to occur after the

initial week to ten days of traffic disturbance period in the immediate aftermath of intersection closure during which drivers learn to use alternate routes. Typically, in construction areas, traffic volumes decrease as motorists avoid new temporary congestion areas and use alternate routes or even avoid non-critical trips during the peak hours. The transportation models for this project used a worst-case scenario approach and no such trip-reductions were used in the analyses.

Separate VISUM models were developed for each of the peak periods. Arterial facility type as well as available mid-block lanes, signalized locations, left-turn and right-turn capacities, current traffic volumes, etc., were all included in the model. As identified in Figures 2 and 3, traffic is expected to re-route to various parallel roadways. Traffic volume changes vary from an increase in a particular turning movement due to detours to decreases in other turning movements.



Capacity and Level of Service Analysis

With the proposed closure of the Ellis Avenue/Bushard Street intersection and the expected detour to alternate routes, there will be an increase of specific turning movements at several nearby intersections. All study intersections with volume-to-capacity (V/C) ratios of at least 0.80 were identified, and those that showed an increase in V/C ratios or those that experienced deterioration in level of service with detour traffic were further evaluated. In addition to two intersections that were already operating at Level of Service (LOS) F during the peak hours with existing traffic, three additional intersections were expected to operate at LOS F with project traffic conditions.

To better evaluate impacts to turning movements at the study intersections, any individual movement with a minimum V/C ratio of 0.80 or greater and which experienced a downgrade in delay LOS from D or better to E or F, or any individual movement that experienced a significant increase in V/C ratio, was identified for each of the peak periods. While the overall intersection LOS at many of the intersections could be D or better, certain individual movements could see a drop in LOS from D to F, E to F, etc., due to the temporary increase in traffic on those particular movements. This movement specific evaluation was conducted for all non-oversaturated intersections, and signal timing improvements were identified for the impacted intersections.

Preliminary analysis results are as follow:

1. ***Increase in overall volume-to-capacity ratios for intersections:*** A comparison of intersection overall volume-to-capacity (V/C) ratios for existing traffic conditions versus

project traffic conditions, and including only those intersections with V/C of a minimum of 0.80, revealed that up to 12 intersections would experience an increase in V/C ratios.

2. ***Individual movements at each study intersection with level of service downgrade:*** Individual movements at several study intersections are expected to degrade, including 14 intersections in the AM peak hour, 10 intersections in the midday peak hour, and 14 intersections in the PM peak hour.

Evaluation Criteria for Mitigation Measures

To reduce traffic impacts associated with the proposed closure of the Ellis/Bushard intersection, various measures were considered. These include development of a traffic management plan in the form of improved signal timing; the development and implementation of detour (signing) plans; and the development of a list of feasible physical improvements, either in the form of roadway re-striping or traffic signal modifications such as conversion to protected/permissive left-turn phasing, right-turn overlap phasing, etc. Mitigation measures were developed at intersections where detour traffic due to the proposed project is expected to result in temporary increases in traffic volumes.

Mitigation measures in the form of traffic signal timing improvements were developed for various intersections that met the following guidelines for any of the AM, midday or PM peak hour traffic conditions:

1. If the project traffic resulted in a degradation of intersection level of service from D or better to E or F, or

2. If there was an increase in overall intersection volume-to-capacity ratio (V/C) for intersections with a minimum V/C of 0.80, or

3. If there is deterioration in delay level of service for certain individual movements that have a minimum V/C ratio of 0.80 or if any individual movement experiences a significant increase in V/C ratio.

Based on the above-defined guidelines, signal timing improvements, where feasible, were provided for 12 intersections for the AM peak hour, 7 intersections for the midday peak hour and 12 intersections for the PM peak hour. The signal timing improvements were recommended for intersections that will not be over-saturated during any of the analyzed peak periods. Additionally, since traffic volumes were expected to decrease at certain intersections due to project detours, signal timing re-allocations were developed for two such intersections for each of the AM, midday and PM peak hours. Traffic signal timing modifications ranged from an increase in phase split times for left-turn movements to increases for certain through phases. No adjustments were recommended for those locations that could be adversely impacted with any changes to signal timing.

While many of the project traffic related impacts can be reduced with improved traffic signal timing, there still remained certain intersections that would continue to temporarily operate at a failing LOS. Intersections that remain temporarily failing or individual movements at certain intersections that could not be improved without adversely impacting other movements were also identified. Project detoured traffic was expected to result in longer delays at these unmitigated locations.

Since, in typical construction areas, traffic volumes may decrease as motorists avoid new temporary congestion areas and use alternate routes or even avoid non-critical trips during peak hours, the actual congestion severity was expected to be less than the predicted "worst case" analysis results presented herein.

Proposed Mitigations

Mitigation measures, in the form of traffic signal phasing modifications or lane re-striping, were identified to improve levels of service for intersections that become over-saturated due to project traffic. Specific mitigations include the following:

- Proposed mitigation for two impacted intersections (Brookhurst/Slater and Brookhurst/Talbert) was the use of right-turn overlap phasing for a potential slight reduction in delays for the eastbound right-turn movements.

- Proposed mitigation for another intersection (Talbert/Magnolia) required the removal of a raised median and re-striping of the westbound approach to achieve an additional westbound left-turn lane. This was achieved via the use of 10-foot lanes within the existing curb-to-curb street width. Additionally, this intersection required modification of the traffic signal to provide northbound right-turn overlap phasing.

- Another major intersection (Adams/Brookhurst) is presently over-saturated during the PM peak hour and continues to operate at LOS F with the inclusion of detour traffic. Since there were no signal phasing modifications or intersection lane geometric re-striping improvements that could be implemented at this intersection, the following measures were proposed at near-by locations which were already operating at or near capacity during the peak hours. Implementation of the following measures will provide area motorists the benefits of improved traffic operations at other non-significantly impacted intersections within the study area:

    - Protected/Permissive Left-turn Phasing at Slater Avenue/Newland Street
    - Dual southbound left-turn lanes at Adams Avenue/Magnolia Street

- Optimized signal coordination timings were recommended to be implemented at all impacted intersections prior to the closure of the Ellis-Bushard intersection. Additionally, traffic engineers should be assigned to implement the new coordination signal timing plans and observe/monitor traffic conditions in the field and make required signal timing adjustments, both in the immediate

aftermath of intersection closure and throughout the construction period, in order to minimize delays to area motorists.

Localized Traffic Operational Concerns

Two specific areas that were addressed included the use of information signs to provide details about the proposed intersection closure, and measures to minimize neighborhood traffic intrusions into local streets in the area.

a) Information Signage for Traffic Detours

The use of information signs relating to the proposed closure of the Ellis Avenue/Bushard Street intersection will be beneficial to the area motorists. While Changeable Message Signs and other traffic detours signs will be installed as part of construction efforts to help direct the traffic, the use of stationary information signs will be essential so that motorists can decide on alternate routes prior to reaching the impacted area, thus minimizing additional delays.

It was also recommended that the Sanitation District send flyers to area residents and businesses informing them of the proposed intersection closure.

b) Potential Neighborhood Traffic Intrusions

The closure of the Ellis Avenue/Bushard Street intersection could potentially result in non-local traffic attempting to utilize local neighborhood streets as through/by-pass routes. Since many of the local streets directly access either Ellis Avenue or Bushard Street, there is a potential for neighborhood traffic intrusions to occur as motorists try to by-pass the closed intersection and not necessarily use alternate major roadways. To help minimize such occurrences, use of signs that display “Local Traffic Only” or similar wording was suggested. Use of barricades to discourage thru traffic; traffic diverters in the form of K-rail with appropriate signage; partial to complete closure of some of the local streets etc., was also suggested. The local agency may also consider using other neighborhood traffic calming measures. Before any local streets are closed, town hall meetings should be conducted to obtain input from area residents and businesses, as well as input from City fire services and paramedics.

Summary, Findings and Conclusions

The results and conclusions of the traffic analysis conducted for the proposed closure of the Ellis Avenue/Bushard Street intersection in the City of Fountain Valley include the following:

1. With the proposed temporary closure of Ellis Avenue/Bushard Street intersection, traffic was expected to detour to the surrounding street network. To reduce impacts associated with the proposed closure, a traffic management plan in the form of improved signal timing, project construction detour plans, information signing, any minor improvements either in the form of roadway re-striping or traffic signal modifications etc., were all considered.

2. Under detoured traffic conditions, traffic signal timing improvements were recommended for 12 intersections in the AM peak hour, 7 intersections for the midday peak hour and 12 intersections for the PM peak hour, to help mitigate traffic impacts associated with the project. Additionally, since traffic volumes were expected to decrease at certain intersections due to project detours, signal timing re-allocations were developed for two intersections each for the AM, midday and PM peak hours.

3. With proposed mitigations, such as the use of right-turn overlap signal phasing, protected/permissive left-turn phasing, and dual protected left-turn lanes, the impacted intersections were expected to operate at acceptable levels of service. Additionally, since there were no traffic signal modifications or intersection lane geometric re-striping improvements that can be implemented at a major intersection (Adams Avenue/Brookhurst Street) for improving traffic operations, enhancements were identified at near-by locations. Implementation of the proposed signal modifications (mainly, conversion to protected/permissive left-turn phasing operation) will provide area motorists the benefits of improved traffic operations at non-impacted intersections within the study area.

4. All capacity and level of service analyses were conducted assuming a worst case scenario for traffic detours. Reduction in background traffic demand, typical in construction areas with congested conditions, was not assumed in the analysis, but most likely will lessen the traffic impacts.

5. With the proposed project, traffic is expected to re-route to various parallel roadways. The resulting traffic volume changes were expected to increase delays and queuing at nearby major intersections. With modifications to signal timing at various area intersections, the level of impact from the proposed construction can be ameliorated or significantly reduced.

6. The use of information signs and detour signs relating to the proposed closure of the intersection of Ellis Avenue/Bushard Street should be provided before and during the construction to inform area motorists and encourage use of alternate routes. Flyers should also be sent to area residents and businesses informing them of the proposed intersection closure.

7. To minimize the potential of external traffic using neighborhood streets as by-pass routes in the immediate vicinity of project area, traffic calming measures should be undertaken.

8. The signal coordination timings developed and provided as mitigations in this report should be implemented at all impacted intersections prior to the closure of the Ellis-Bushard intersection. Additionally, traffic engineers should be assigned to implement new coordinated signal timing plans and observe/monitor traffic conditions in the field and make required signal timing adjustments, both in the immediate aftermath of intersection closure and throughout the construction period, so as to minimize delays to area motorists.

9. While field observations of traffic conditions would be required for all impacted intersections during the Ellis/Bushard intersection closure, for those non-oversaturated intersections that did

not receive any signal timing changes, field adjustments could be made based on prevailing traffic conditions. Additionally, during the traffic signal monitoring phase (with Ellis-Bushard intersection closed), additional minor improvements such as the installation of protected/permissive left-turn phasing, right-turn overlap phasing etc., may also be required to improve traffic operations within the project study area.

10. After the construction is completed, coordination signal timings will need to revert back to normal traffic conditions. However, because the Ellis-Bushard intersection will have been closed to traffic for approximately seven to nine months, traffic and travel patterns may have changed, requiring additional changes to the normal signal coordination plans currently in use. Those additional changes will need to be made before the revised signal coordination plans are implemented.

Acknowledgements

The authors would like to thank the staff of Albert Grover & Associates and PTV America for their support, Orange County Transportation Authority for transportation modeling support, Orange County Sanitation District and the Cities of Fountain Valley and Huntington Beach for the opportunity to assist them in evaluating and identifying the required improvements to ameliorate impacts due to the temporary closure of Ellis/Bushard intersection in Fountain Valley.

References

1. Final Report, "Traffic Impact Analysis for the Proposed Temporary Closure of the Ellis Avenue/Bushard Street Intersection in the City of Fountain Valley", February 2006, prepared for Orange County Sanitation District by Albert Grover & Associates, Fullerton, California.

2. Traffic Signal Systems Information and Traffic Count Data, Cities of Fountain Valley and Huntington Beach, California.

3. Highway Capacity Manual (HCM), Transportation Research Board, 2000.

4. Orange County Transportation Analysis Model, Orange County Transportation Authority, Orange, California, 2006.

5. VISUM Transportation Modeling Software, PTV America, Inc., Wilmington, Delaware.

6. Synchro Software, Trafficware, Albany, California.

7. Webster Software - WEbster Based Signal Timing Evaluation Routine for Capacity and Level and Service Analysis using HCM 2000 Control Delay, Albert Grover & Associates, Fullerton, California.