BROCKTON AVENUE RESTRIPING PROJECT

TRAFFIC IMPACT STUDY
SIX MONTH POST-PROJECT ANALYSIS

PREPARED BY CITY OF RIVERSIDE PUBLIC WORKS – TRAFFIC ENGINEERING DIVISION

April 24, 2015

Table of Contents

Project Description 2
Brockton Avenue Striping Configurations 5
Brockton Avenue 5
Riverside Community Hospital Expansion Project 6
Accident Reduction 7
Level of Service (LOS) Standard 9
Project Impact Analysis Approach 11
Study Intersections and Segments 12
Analysis Software 12
Analysis Process 12
Signalized Intersections 12
'Before and After' Conditions: 2014 Without Restriping Project and 2015 With Restriping Project 13
Parallel Route Analysis 16
Summary 18

Project Description

At the request of City Council, the Public Works Traffic Division prepared this supplementary study to evaluate the 6 month impact of the Brockton Avenue Restriping Project. This study serves as an addendum to the initial Brockton Avenue Restriping Project Traffic Impact Analysis. This study evaluates the operational, circulation and queuing impacts of restriping a 2.45 mile segment of Brockton Avenue, from Mission Inn Avenue to Central Avenue, from a 4-lane to a 3-lane configuration that includes a two-way left-turn lane and Class II bike lanes, see Figure 1. Approximately 2 miles of the project (Mission Inn Avenue to Jurupa Avenue) was completed in October 2014. The remaining segment of the project (Jurupa Avenue to Central Avenue) was completed in January 2015. Vehicle turning movement counts were taken prior to the project during January of 2014, and then during March of 2015 following project completion.

The Public Works Department was pleased to observe that bicycle traffic had doubled and pedestrian volumes had tripled during the study period at the study intersection of Brockton Avenue and Bandini Avenue. The new Class II Bike lanes and sidewalk improvements provide continuous, comfortable, improved connectivity, and safer paths that have promoted increased biking and walking in the area.

The 85% speeds, roadway capacity, LOS at signalized intersections, and vehicular volumes on Brockton Avenue have remained relatively unchanged. In addition, preliminary findings indicate that accidents have decreased by 30%. Increased use of Brockton Avenue by motorists suggest they find comfort and acceptable operations thus discouraging them from utilizing adjacent parallel streets and diverging to reach their destination. Public Works will continue to monitor Brockton Avenue to make signal timing changes and/or striping improvements to ensure Brockton Avenue continues to serve all road users.

The Brockton Avenue Restriping Project is one of several major projects in this area of the City. The State Route 91 HOV Widening project, Streeter Grade Separation, and Riverside Grade Separation are active projects that have closed streets, detoured traffic, and have impacted the circulation element.

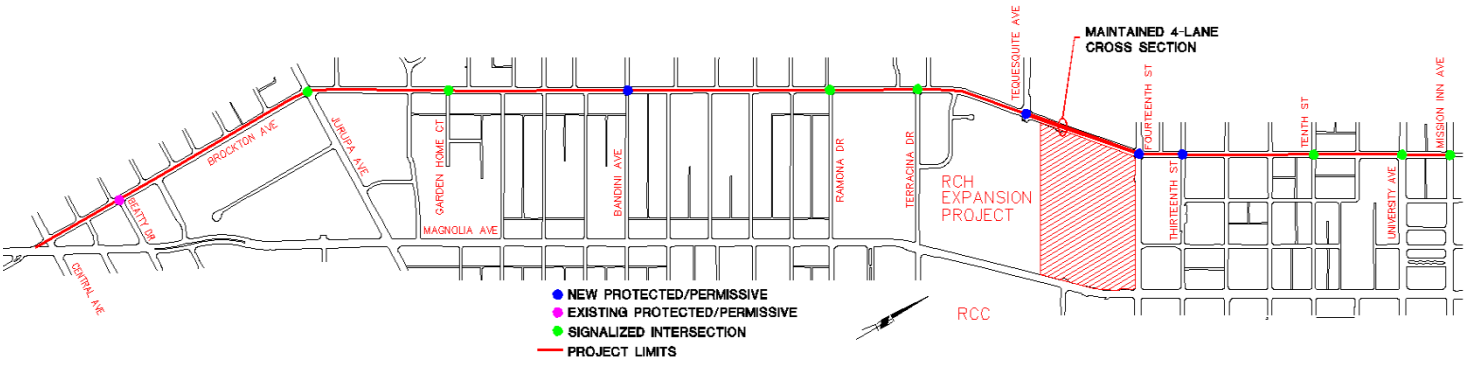

Figure 1 – Vicinity Map (Project as Completed)

This study further examines the impacts after 6 months of reducing Brockton Avenue from a 4-lane cross section to a 3-lane cross section:

- Impacts Summary –
    - Accidents have decreased by 30% following the project.
    - Average Daily Traffic (ADT) on Brockton Ave increased by 2%
    - Traffic volumes on Brockton Ave and adjacent side and parallel streets on average have increased. The increase in traffic on the parallel routes is not due to traffic diverting from Brockton Ave as Brockton Ave too has increased volumes. Instead, large projects such as the 91 HOV/Widening, Streeter Ave Grade Separation, and Riverside Ave Grade Separation Projects have closed roads and detoured motorists causing increased traffic to local roads.
    - Delays at Brockton Ave intersections increased by an average of 4.6 seconds in the AM, and 2.4 seconds in the PM.
    - Average estimated queues per lane increased by 0.7 vehicles (15-ft) during the AM, and by 1.0 vehicle (22-ft) in the PM peak hours. Motorists typically clear the respective intersections within one traffic signal cycle.
    - Increased sight distance from side streets.
    - Reduced number of conflict points at intersections from 8 to 4.
    - Two-way left-turn lane provides refuge for turning vehicles
    - Class II bicycle lanes and 2-ft buffers installed per Bicycle Master Plan Addendum
- Maintains Roadway Capacity and Speeds-
    - Brockton Avenue has maintained acceptable capacity ratios following the reduction to a three-lane section, despite increasing Average Daily Traffic volumes along the majority of Brockton Avenue
    - The four-lane section was maintained adjacent to Riverside Community Hospital to facilitate Hospital access and growth.
    - Speeds along Brockton Avenue have remained similar to those observed prior to project implementation. The 85th% speed dropped only by 3 mph from 41 mph to 38 mph.
    - Levels of Service have remained acceptable during peak hours of traffic.
    - Project limits were extended to Central Ave. The original striping reconfiguration terminated at Beatty Avenue but at the request of residents and local businesses the project limits were extended to Central Ave and a second southbound thru lane was added between Sunnyside Dr and Central Ave to reduce the queue.
- Maintains Vehicle Parking
    - The shared 11-ft buffered bicycle/parking lane allows motorists to park along Brockton Avenue and provide adequate width for cyclists.
    - The 11-ft bike/parking lane allows RTA buses to serve patrons without blocking travel lanes
    - The 11-ft bike/parking lane allows motorists to encroach into the street and increase their sight distance to facilitate maneuvers onto Brockton Avenue

Key aspects of the completed project include:

- Synchronization of traffic signals to maintain vehicle flow.

- Installed left-turn protected/permissive improvements at four of the signalized intersections as shown on Figure 1.
- Installed right-turn overlaps at locations with dedicated right-turn lanes to reduce delay.
- Repaired pavement within the project limits, including slurry seal application.
- Installed sidewalk improvements on segments missing sidewalk

Below are aerial and cross section views of the previous four-lane and existing three-lane configurations:

Figure 2 – 'Before' Previous 4-Lane Brockton Avenue Configuration

Figure 3 – 'After' Implemented 3-Lane Brockton Ave Configuration

Figure 4 – Brockton Ave 3-Lane Illustrated Aerial View (Shown As-Built)

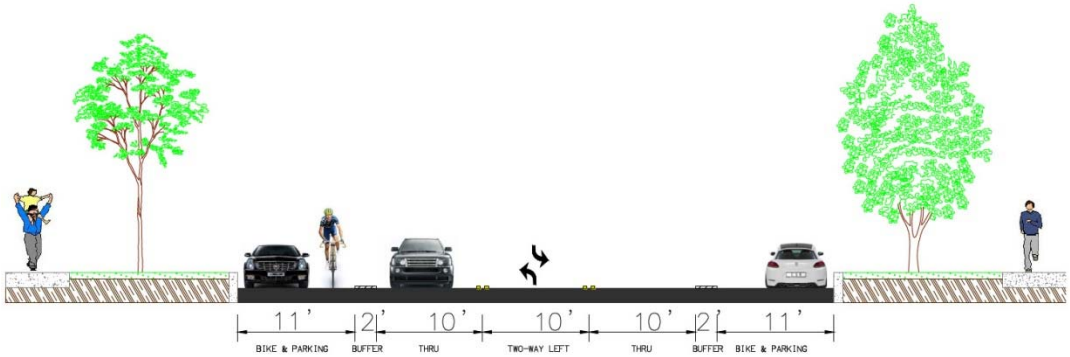

Figure 5 – Brockton Ave 3-Lane Typical Cross Section

Brockton Avenue Striping Configurations

Brockton Avenue

Brockton Avenue is a north-south undivided street that runs between Indiana Avenue and Park View Terrace. Brockton Avenue is configured as follows:

- 4-lane roadway with a two-way left-turn lane between Indiana Avenue and Arlington Avenue.
- 3-lane roadway between Arlington Avenue and Nelson Street
- 2-lane roadway between Nelson Street and Magnolia Avenue
- (**Segment Modified by Project)** 3-lane roadway with a two-way left-turn lane between Central Avenue and Sunnyside Drive. (previously 4-lane with two-way left-turn)
- 4-lane roadway with a two-way left-turn lane between Sunnyside Drive and Beatty Drive.
- (**Segment Modified by Project)** 2-lane roadway with a two-way left-turn lane between Beatty Drive and Tequesquite Avenue. (previously 4-lane roadway)
- 4-lane roadway between Tequesquite Avenue and Fourteenth Street
- (**Segment Modified by Project)** 2-lane roadway with a two-way left-turn lane between Fourteenth Street and Mission Inn Avenue (previously 4 lane roadway)
- 2-lane roadway between Mission Inn Avenue and Park View Terrace

Per the City's 2025 General Plan, Brockton Avenue is classified as a two-lane collector road north of Mission Inn Avenue with a posted speed limit of 25 mph. South of Mission Inn Avenue, it is classified as a four-lane arterial with a posted speed limit of 35 mph, except the segment between Dewey Avenue and Arlington Avenue where the speed limit is 30 mph.

Riverside Community Hospital Expansion Project

The Riverside Community Hospital (RCH) is implementing a new Specific Plan for its 22.5 acre campus located between Brockton Ave, Tequesquite Ave, Magnolia Ave, and 14th Street (see hatched area in Figure 1). Phase I includes a new replacement medical office building and a new parking garage. In addition, Phase I would ultimately increase the hospital's bed capacity from 373 beds to 562 beds. Phase II includes demolition, relocation, and new construction of several hospital facilities over the next 30 years, ultimately increasing the hospital capacity to no more than 600 beds. The internal reorganization of the RCH campus, particularly the relocation of the parking garage, will impact traffic patterns on Brockton Ave.

Phase I was initially anticipated to be completed during 2014. As of the writing of this report, Phase I of the RCH expansion project has not been fully completed, although the new parking structure and medical office building have been partially occupied. Because Phase I was partially occupied at the time 2015 Peak Hour Counts were taken, this report does not analyze the roadway network with and without RCH Phase I scenarios of the initial report.

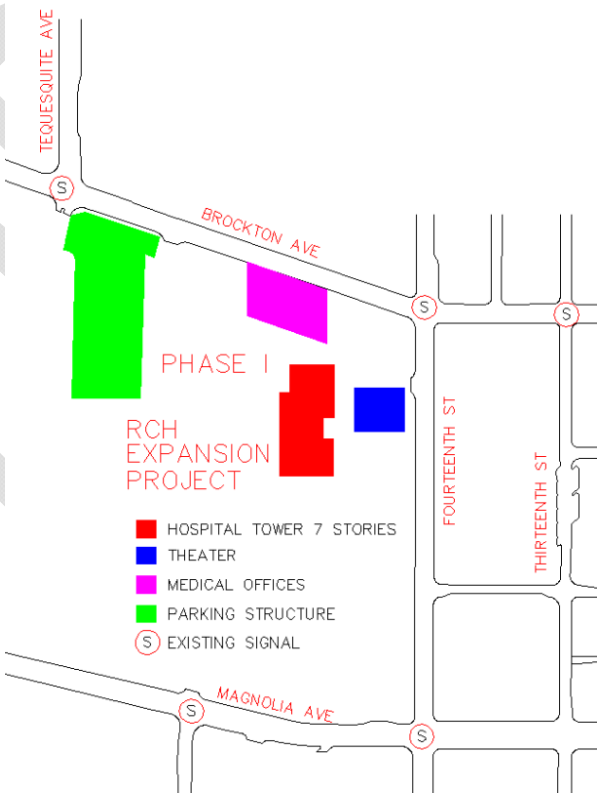

Figure 6 – Phase I of RCH Expansion Project (Partially Occupied)

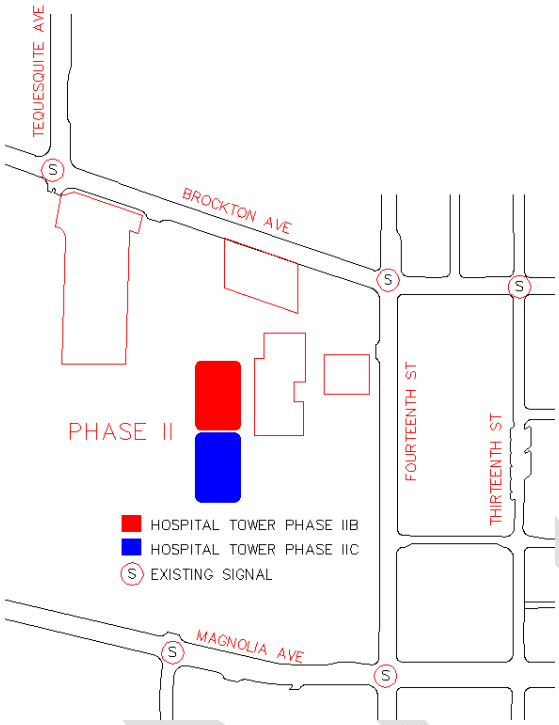

Figure 7 – Phase II of RCH Expansion Project

Accident Reduction

The initial Traffic Impact Analysis evaluated accidents over a ten year period prior to project construction. A review of accident data estimated that changes made by the project could result in a 37% reduction in potential accidents as the conflict points are reduced, see Figure 8.

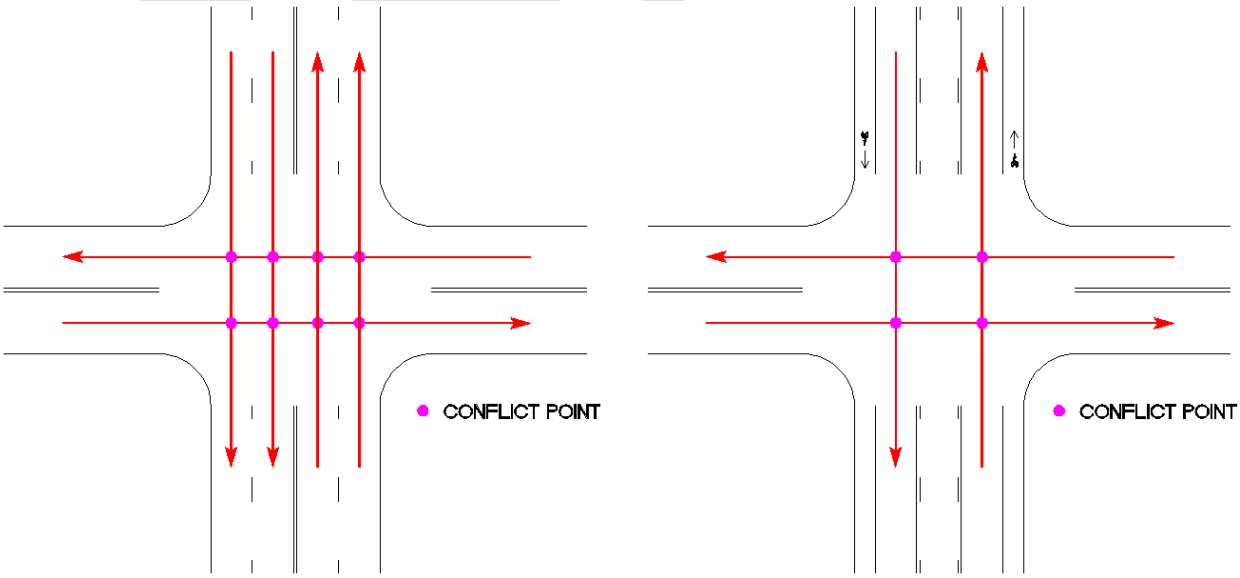

Figure 8 – Conflict Point Reduction with Restriping Project

Table 1 and 2 shows the 10-year accident history and post-project accident reductions. This is a relatively short study period but the accident trend is decreasing.

Table 1: 10-Year Accident History on Brockton Avenue

Type	Total	Estimated Reduced By
Rear End	87	58
Sideswipe	45	31
Broadside	142	17
Head-On	31	1
Pedestrian	13	13
Bicyclist Involved	15	15
Hit Object	22	0
Overturned	2	0
Other	5	1
Not Stated	5	1
Totals	**367**	**137**

Table 2 evaluates data collected over the past six months, 11/1/2014 and 4/23/2015, along Brockton Avenue following completion of the project.

Table 2: 6 Month Post-Construction Accident Analysis on Brockton Avenue

Type	Total	Average Accidents / 6 Months From 10 Yr. History	Post- Project vs. 6 Month Historical Average
Rear End	6	4.4	+ 1.6
Sideswipe	0	2.3	-2.3
Broadside	5	7.1	-2.1
Head-On	0	1.6	-1.6
Pedestrian	1	.7	+ .3
Bicyclist Involved	1	.8	+ .2
Hit Object	0	1.1	- 1.1
Overturned	0	.1	-.1
Other	0	.3	-.3
Not Stated	0	.3	-.3
Totals	**13**	**18.7**	**-5.7 (30% Reduction)**

Significantly, accidents were reduced by 30% following completion of the project. While this falls short of the expected reduction of 37%, this data was taken during a 6 month window immediately following the project completion. It is anticipated that the accident rate and severity will continue to decrease as drivers become more accustomed to the new lane configuration. Any increased rates shown may be the product of the short data collection window. Public Works Department will continue to monitor accident rates along Brockton Avenue. Through time, rear-end accidents are expected to decrease but during the six-month study period have increased compared to the 10-year history. Part of the increase may be attributed to drivers tailgating as they no longer have a passing lane, speeding, and distracted drivers who do not have a secondary lane to make a lane change to avoid a collision.

The initial staff report compared fatality statistics during the 10 years prior to the project with two parallel streets (Magnolia Avenue and Palm Avenue). The data showed that 2 fatal accidents occurred on Brockton Avenue during those 10 years, while Magnolia Avenue had 1 fatal accident and 2 fatal accidents occurred on Palm/ Redwood Avenue.

In the six months following the project, no fatalities have occurred along Brockton Avenue, Magnolia Avenue, or Palm Avenue. Due to the low rate of occurrence over the 10 years prior to project completion, analysis of this data is statistically insignificant although an FHWA Report noted that lane reduction projects reduce the number and severity of vehicle-to-vehicle crashes.

Level of Service (LOS) Standard

Level of Service (LOS) for intersections is defined in terms of average vehicle delay, which is a measure of driver discomfort, frustration, fuel consumption, and loss of travel time. LOS is stated in terms of the average control delay per vehicle for a peak 15-minute period within the hour analyzed. The average control delay includes initial deceleration delay, queue move-up time, and final acceleration time in addition to the stop delay. The LOS criteria for the various designations are summarized below.

LEVEL OF SERVICE CRITERIA FOR INTERSECTIONS

Los	Description	Signalized Intersection Delay (seconds per vehicle)	Unsignalized Intersection Delay (seconds per vehicle)
A	Excellent operation. All approaches to the intersection appear quite open, turning movements are easily made, and nearly all drivers find freedom of operation.	≤ 10	≤ 10
B	Very good operation. Many drivers begin to feel somewhat restricted within platoons of vehicles. This represents stable flow. An approach to an intersection may occasionally be fully utilized and traffic queues start to form.	>10 and ≤ 20	>10 and ≤ 15
C	Good operation. Occasionally drivers may have to wait more than 60 seconds, and back-ups may develop behind turning vehicles. Most drivers feel somewhat restricted.	>20 and ≤ 35	>15 and ≤ 25
D	Fair operation. Cars are sometimes required to wait more than 60 seconds during short peaks. There are no long-standing traffic queues.	>35 and ≤ 55	>25 and ≤ 35
E	Poor operation. Some long-standing vehicular queues develop on critical approaches to intersections. Delays may be up to several minutes.	>55 and ≤ 80	>35 and ≤ 50
F	Forced flow. Represents jammed conditions. Backups from locations downstream or on the cross street may restrict or prevent movement of vehicles out of the intersection approach lanes; therefore, volumes carried are not predictable. Potential for stop and go type traffic flow.	> 80	> 50

Source: 2010 *Highway Capacity Manual*

Exhibit 1

The City of Riverside's 2025 General Plan defined LOS D as the minimum adequate service level on roadway links for planning and design purposes. For the purpose of this study, the threshold is defined as any roadway segment that would have a volume/capacity ratio of 1.0 or higher at buildout. The roadway segments are considered to operate over-capacity when the future forecast daily traffic volume exceeds the daily capacity values. The daily capacity values, which are given in average daily traffic (ADT), for Brockton Avenue within the project limits is 21,999 ADT (4-lane 88' Arterial). Levels of Service A & B for Class II Arterials are defined by observed roadway speeds, with speeds between 28 and 35 MPH qualifying as Level of Service B, and speeds in excess of 35 MPH qualifying as LOS A.

Roadway Classification	Number of Lanes	Two-Way Traffic Volume (ADT)[2]		
		Service Level C	Service Level D	Service Level E
Local	2	2,500-2,799	2,800-3,099	3,100+
Collector (66' or 80')	2	9,900-11,199	11,200-12,499	12,500+
Arterial [3]	2	14,400-16,199	16,200-17,999	18,000+
Arterial (88')	4	16,800-19,399	19,400-21,199	22,000+
Arterial (100')	4	26,200-29,599	29,600-32,999	33,000+
Arterial (120')	6	38,700-44,099	44,100-49,499	49,500+
Arterial (144')	8	50,600-57,799	57,800-64,999	65,000+

Notes: (1) All capacity figures are based on optimum conditions and are intended as guidelines for planning purposes only
(2) Maximum two-way ADT values are based on the 1999 Modified Highway Capacity Manual Level of Service Tables
(3) Two-lane roadways designated as future arterials that conform to arterial design standards for vertical and horizontal alignments are analyzed as arterials.

Exhibit 2

A 1999 study titled *Road Diets: Fixing the Big Roads* by Dan Burden and Peter Lagerwey indicated there is a slight capacity reduction in a three-lane roadway configuration yet a lot of researchers "feel comfortable with 20,000-23,000 ADT's" on three-lane roads. FHWA's 2010 study titled *Evaluation of Lane Reduction "Road Diet" Measures on Crashes* made a similar conclusion that three-lane conversion projects have minimal effects on roadway capacity because the left-turning vehicles are accommodated in a common two-way left-turn lane. Furthermore, the project would provide dedicated left-turn lanes at several signalized intersections that currently do not have exclusive left-turn lanes including: Garden Home Court (southbound), Ramona Drive, Terracina Drive (southbound), and at Tenth Street.

In order to present a conservative estimate of roadway capacity, the daily volumes of Brockton Avenue was adjusted to that of a two lane Arterial with Level of Service E at 18,000+ ADT.

Project Impact Analysis Approach

This report addendum analyzes the following scenarios:

- 2014 Without Project, Four-Lane Configuration
- 2015 With Project , Three-Lane Configuration

Because the RCH Phase I project has been only partially occupied, and due to ongoing closures along the 91 HOV project, it is difficult to create a theoretical '2015 Without Project' scenario as not all

new or reduced trips can be directly attributed to the project. For this reason, the '2015 With Project' scenarios will be compared against the '2014 Without Project, No RCH Expansion' scenario, with the understanding that some growth due to cumulative and adjacent projects should be assumed when comparing the two level of service scenarios. Counts were taken before and after project implementation at all relevant study intersections.

The project implemented the following improvements that positively impact levels of service:

- Installation of Protected/Permissive Improvements at: Thirteenth Street, University Avenue, Tequesquite Avenue, and Bandini Avenue
- Synchronization and Retiming of the Brockton Avenue corridor within the project limits
- Right-turn overlap improvements at: northbound and southbound Jurupa Avenue, southbound Tequesquite Avenue, northbound Fourteenth Street, northbound and southbound University Avenue, and northbound Mission Inn Avenue

Study Intersections and Segments

The following signalized intersections were analyzed for this project:

- Brockton Avenue at Mission Inn Avenue
- Brockton Avenue at University Avenue
- Brockton Avenue at Fourteenth Street
- Brockton Avenue at Ramona Drive
- Brockton Avenue at Bandini Drive
- Brockton Avenue at Jurupa Avenue
- Brockton Avenue at Beatty Drive

Analysis Software

Synchro 8 software uses the 2010 Highway Capacity Manual (HCM) methodology to analyze the morning and evening peak hours at the signalized intersections to determine level of service (LOS) and intersection delay (seconds). In addition, the software generated 50th percentile queue lengths as listed on Tables 5, 7, 8, 11, and 12. The 50th percentile queue length is a standard metric used in the Highway Capacity Manual (HCM) to represent the average number of vehicles per lane estimated to stack during the red phase at signalized intersections during the peak hours.

Analysis Process

Using *Synchro 8* software, the study determined the level of service (LOS) for the study intersections, LOS for the roadway segments, intersection delay, and queue lengths for the morning and evening peak hours for 2014 and 2015 conditions.

Signalized Intersections

The 2010 Highway Capacity Manual (HCM) analyzes highway facilities for their ability to accommodate traffic volumes. The terminology "Level of Service" is used to provide a qualitative evaluation based on particular quantitative calculations. A Level of Service value has been calculated for the project's signalized intersections to evaluate their operational performance as it relates to the three and four-lane Brockton Ave configurations.

'Before and After' Conditions: 2014 Without Restriping Project and 2015 With Restriping Project

Intersection delay, roadway capacity, queue lengths, and levels of service for both the intersections and roadway segments are shown in Tables 3-6. Table 7 examines the number of pedestrians and bicyclists observed at the intersection of Brockton Avenue and Bandini Drive before and after the project. The analysis reflects the pre and post project configurations of Brockton Avenue. All scenarios labeled as 'without restriping' depict the previous 4-lane configuration as observed prior to project implementation in 2014. Background counts were scaled by a 1.5% annual rate to generate volumes for intersections without turning movement counts.

Because RCH Phase I has been partially completed, it is not possible to accurately compare data collected following project completion to the scenarios presented in the before project study. The prior study assumed completion of the RCH Phase I project, and did not contain a 2015 scenario.

Table 3 - Summary of Intersection Operations

BEFORE AND AFTER PROJECT CONDITIONS

INTERSECTION	PEAK HOUR	2014 WITHOUT RESTRIPING		2015 WITH RESTRIPING		DIFFERENCE IN DELAY (c)
		DELAY (a)	LOS (b)	DELAY (a)	LOS (b)	
Brockton Ave and Mission Inn Ave	AM	11.7	B	18.5	B	6.8
	PM	16.3	B	22.0	C	5.7
Brockton Ave and University Ave	AM	17.9	B	17.3	B	-0.6
	PM	28.4	C	22.0	C	-6.4
Brockton Ave and Fourteenth St	AM	17.8	B	22.3	C	4.5
	PM	35.6	D	25.7	C	-9.9
Brockton Ave and Ramona Dr	AM	8.7	A	15.9	B	7.2
	PM	4.8	A	9.4	A	4.6
Brockton Ave and Bandini Dr	AM	5.6	A	7.7	A	2.1
	PM	4.7	A	11.6	B	6.9
Brockton Ave and Jurupa Ave	AM	22.4	C	30.1	C	7.7
	PM	24.5	C	37.4	D	12.9
Brockton Ave and Beatty Dr	AM	7.0	A	11.7	B	4.7
	PM	11.4	B	14.2	B	2.8

Notes:

(a) Delay refers to the average control delay for the entire intersection, measured in seconds per vehicle. At a two-way stop-controlled intersection, delay refers to the worst movement.

(b) LOS calculations are based on the methodology outlined in the *2010 Highway Capacity Manual* and performed using Synchro 8.0 ** Ramona Dr & Beatty Dr were analyzed using HCM 2000 due to split phasing

(c) Change in delay, seconds, following Brockton Ave Restriping

The reduction in lane configuration capacity is not solely responsible for the minor increases in delay observed at most intersections. Part of the increased delay can be attributed to the overall increase in traffic volumes observed during the peak traffic hours on Brockton Avenue, illustrated below in Table 4.

Table 4: Peak Hour Vehicles Per Hour (VPH) by Intersection

Intersection	AM Before	AM After	MD Before	MD After	PM Before	PM After
Brockton at 14th	1775	1932	1512	1660	2076	2174
Brockton at Bandini	1157	1227	855	884	1402	1453
Brockton at Beatty	791	836	857	943	1160	1207
Brockton at Jurupa	2008	2239	1792	1916	2684	2698
Brockton at Mission Inn	1116	1152	952	1023	1505	1622
Brockton at Ramona	1215	1296	901	891	1350	1490
Brockton at University	1442	1485	1237	1132	1918	2089
TOTAL	9504	10167	8106	8449	12095	12733
	Increase 7.0%		**Increase** 4.2%		**Increase** 5.3%	
			Overall Peak Hour Traffic Increase		**5.5%**	

Table 5: Segment Conditions Before and After Project Construction

Roadway Segment	Roadway Classification (88')	85th% SPEED	LOS E Capacity	ADT	LOS
Brockton: University to 14th (2014)	4-Lane Arterial	38 mph	22,000	13,967	A
Brockton: University to 14th (2015)	3-Lane Arterial	36 mph	18,000	14,194	A
Brockton: Jurupa to Bandini (2014)	4-Lane Arterial	43 mph	22,000	13,341	A
Brockton: Jurupa to Bandini (2015)	3-Lane Arterial	39 mph	18,000	11,964	A
Brockton: Jurupa to Beatty (2014)	4-Lane Arterial	42 mph	22,000	9,800	A
Brockton: Jurupa to Beatty (2015)	3-Lane Arterial	39 mph	18,000	11,572	A

While the maximum capacity of Brockton Avenue was reduced from 22,000 vehicles per day to 18,000 vehicles per day, traffic along Brockton Avenue has experienced minor vehicular increase, although levels of service along key roadway segments remain unchanged after the project's implementation.

The 85th percentile speed is the speed that 85 percent of vehicles do not exceed. The 85th percentile speed is often used by engineers to assess driver behavior as most drivers behave in a safe and prudent manner. In addition, research has shown that vehicles traveling between the 50th and 90th percentile speed have the lowest risk of an accident due to speed. Laws are intended to protect the public by regulating unsafe or unreasonable speeds, thus the 85th percentile speed is a reasonable basis for adopting speed limits.

Brockton Avenue has a 35 mph posted speed limit and the data shows that the 85th percentile speed dropped approximately 3 mph on average across the measured segments of Brockton Avenue. The previous averaged 85th percentile speed was 41 mph, and the new averaged 85th percentile is 38 mph, closer to the posted speed limit and limiting the opportunities to travel at high speeds. The new configuration (one thru lane in each direction) discourages speeding as drivers cannot pass and are

limited by the speed of the lead vehicle. In turn, the slower vehicular travel speeds further encourage bicycling and walking on Brockton Avenue and can potentially reduce the number and severity of vehicle-to-vehicle crashes.

Table 6: Queue Analysis
YEAR 2014 WITHOUT BROCKTON RESTRIPING (4 LANES)

INTERSECTION	PEAK HOUR	(50%) (veh/ln)											
		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Brockton and Mission Inn Ave	AM	0.1	1.7	1.7	0.8	0.5	0.6	1.0	1.1	1.1	1.4	0.0	0.0
	PM	0.3	2.4	2.4	2.3	1.4	1.5	2.7	1.9	1.4	1.9	0.0	0.0
Brockton and University Ave	AM	0.1	2.5	3.2	0.9	0.7	0.7	0.7	3.0	2.9	0.7	0.0	3.9
	PM	0.2	4.0	3.9	2.9	1.9	2.0	3.7	4.6	4.6	0.7	0.0	8.4
Brockton and Fourteenth St	AM	0.6	0.0	2.4	2.7	0.9	0.9	0.2	7.2	6.9	1.4	1.1	1.2
	PM	0.6	0.0	2.0	12.2	1.8	1.8	0.1	4.3	4.5	1.6	6.7	6.9
Brockton and Bandini Dr	AM	4.4	0.0	0.0	0.6	0.0	0.0	0.2	0.2	0.2	0.0	0.2	0.2
	PM	3.1	0.0	0.0	1.2	0.0	0.0	0.2	0.1	0.1	0.1	0.4	0.4
Brockton and Jurupa Dr	AM	4.6	4.0	4.2	0.5	3.6	3.6	0.8	4.0	4.1	1.9	4.4	4.3
	PM	3.1	6.0	6.1	1.3	6.5	6.6	1.6	3.7	3.6	4.1	7.1	6.7

Notes:
50% Queue Length is the # of vehicles queued per lane during the Red Phase waiting for the Green Indication

Table 7: Queue Analysis
YEAR 2015 WITH BROCKTON RESTRIPING (3 LANES)

INTERSECTION	PEAK HOUR	(50%) (veh/ln)											
		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Brockton and Mission Inn Ave	AM	0.3	4.1	4.2	2.0	1.5	1.6	0.5	0.3	0.3	1.9	0.0	0.0
	PM	0.5	6.6	6.5	3.7	2.9	3.0	1.7	1.0	0.4	2.5	0.0	0.0
Brockton and University Ave	AM	0.2	4.8	6.1	2.3	1.3	1.3	0.8	0.6	0.2	0.3	1.4	0.0
	PM	0.4	7.3	6.9	3.9	3.2	3.3	3.4	2.1	0.2	0.9	4.7	0.1
Brockton and Fourteenth St	AM	0.9	0.0	4.9	7.2	1.9	1.9	0.2	12.1	6.1	3.2	2.0	0.0
	PM	0.8	0.0	3.4	9.9	4.9	4.7	0.5	10.2	5.8	3.0	5.5	0.1
Brockton and Bandini Dr	AM	6.0	0.0	0.0	1.0	0.0	0.0	0.2	0.6	0.0	0.0	0.3	0.0
	PM	2.5	0.0	0.0	1.8	0.0	0.0	0.2	5.4	0.1	0.0	10.4	0.7
Brockton and Jurupa Dr	AM	6.3	8.4	8.6	1.3	4.9	5.0	3.0	7.4	1.1	2.6	8.8	3.3
	PM	4.5	9.8	9.9	3.6	10.1	10.1	3.7	8.7	1.6	3.1	16.1	5.5

Notes:
50% Queue Length is the # of vehicles queued per lane during the Red Phase waiting for the Green Indication

Queues were calculated to increase by an average of less than one vehicle per lane during the AM Peak Hour of traffic, and by 1.0 vehicle (22-ft) per lane during the PM Peak Hour of Traffic. As indicated in Tables 6-7, Queue Lengths listed represent the number of vehicles queued per lane during the traffic signal's red phase. The highest calculated queue expected is 16 vehicles in the southbound through movement at Jurupa Avenue & Brockton Avenue during the PM Peak Hour. This particular movement receives up to 30 seconds of green time, which is sufficient to clear the average queue as observed in the field.

As noted in Tables 3-6, the Brockton Avenue corridor and respective signalized intersections currently operate at acceptable levels of service in both the morning and evening peak hours and are operating at acceptable levels of service following implementation of the project. An increase in queue lengths has been observed following implementation, but this can be further mitigated by additional signal coordination monitoring and adjustments in the field.

Delays marginally increased at most intersections, with Jurupa Avenue at Brockton Avenue seeing the highest increase of 12.9 seconds. At other intersections, changes to signal timing and coordination along with signal modifications reduced delay following the project implementation.

Table 8: Bicycle and Pedestrian Traffic

Roadway Segment	Number of Pedestrians	Number of Bicyclists
Brockton Avenue at Bandini Drive - BEFORE (4 lanes, 2014)	20	10
Brockton Avenue at Bandini Drive - AFTER (3 lanes, 2015)	60	20

A separate study was conducted by Traffic Staff to assess the project's impact on pedestrian and bicycle traffic. The specialized count was conducted at Brockton Avenue and Bandini Avenue, as this intersection is a central location of the project. Both the before and after counts were conducted on a Thursday while school was in session, between the hours of 10:15 AM and 1:15 PM. The amount of bicyclists observed doubled, while the amount of pedestrians observed tripled. FHWA's *Road Diet Information Guide* shows that a striping configuration project that reduces travel lanes makes it easier for pedestrians to cross the street as there are less travel lanes, makes vehicular speeds more predictable, the bike/parking lanes provide a buffer between pedestrians and moving vehicles. For bicyclists, the biggest benefit is the addition of the Class II bike lanes which makes bicyclists more visible and motorists know where to look for them. In addition, the project included 2-ft bike buffers that provide increased separation between moving vehicles and bicyclists thus increasing safety.

Parallel Route Analysis

At the request of residents, Public Works performed analysis of Average Daily Traffic levels on major parallel roadways and side-streets before and after project implementation. Analysis included Pine Street, Redwood Drive / Palm Avenue, Magnolia Avenue, and several minor roadways which intersect with Brockton Avenue.

Although the number of thru lanes was reduced, Brockton Avenue experienced a 2% growth in daily traffic. The adjacent Magnolia Avenue experienced 23% growth. The data indicates that the majority of regional growth occurred on Magnolia Avenue, a four-lane arterial that is better suited for commuter and goods movement. Traffic Staff notes that the observed increased traffic levels may have been impacted by ongoing closures along the State Route 91 HOV widening project, Riverside Avenue Grade Separation Project, Streeter Avenue Grade Separation Project, and RCH's Phase I Project. During the time of data collection, a multi-day ramp closure was in effect that routed traffic to Magnolia Avenue via the Central Avenue off-ramp. Table 9 illustrates the measured traffic levels along studied roadway segments before and after project implementation.

Table 9: Adjacent Roadway Volume and Capacity

Location	Average Daily Traffic (ADT)		% Increase	% Capacity
	Before (2014)	After (2015)		
Beechwood E Brockton	272	342	26%	11.0%
Merrill E Brockton	1101	2230	103%	17.8%
Sunnyside E Brockton	342	360	5%	11.6%
Beechwood W Brockton	299	343	15%	11.1%
Dewey W Brockton	1134	2726	140%	21.8%
Garden Home W Brockton	347	1101	217%	35.5%
Sunnyside W Brockton	489	604	24%	19.5%
Terracina E Brockton	1000	2689	169%	86.7%
Twelfth W Brockton	511	524	3%	16.9%
Pine S 13th	2542	3411	34%	27.3%
Redwood S 13th	2198	3181	45%	25.4%
Palm S Tequesquite	6578	9335	42%	51.9%
Palm N Beachwood	6797	9335	37%	51.9%
Palm N Central	7226	9916	37%	55.1%
Palm N Elmwood	7364	9537	30%	53.0%
Palm N Gardena	7105	9835	38%	54.6%
Palm S Beatty	8104	10993	36%	61.1%
Magnolia N Ramona	21142	23296	10%	70.6%
Magnolia N Oakwood	21037	25946	23%	52.4%
Magnolia S Elizabeth	22954	30958	35%	93.8%
Magnolia S Ramona	20673	24921	21%	50.3%
Brockton N Dewey	9800	11572	18%	64.3%
Brockton N Tenth	13967	14194	2%	78.9%
Brockton S Bandini	13341	11964	-10%	66.5%

Segments on Brockton Avenue have experienced an average growth in Average Daily Traffic of approximately 2%, operate at an average of 70% capacity, and have retained similar 85% speeds, Levels

of Service, and volumes to those prior to project completion. Adjacent roadways have also experienced growth in Average Daily Traffic, but utilize less of their total available capacity. Figure 8 (shown below) is a map containing volume-to-capacity ratios on major North-South roadways. Roadways such as Redwood Drive and Pine Street– which primarily serve local residential trips, utilize the least percentage of their available capacity. Palm Avenue utilizes only 54% of available capacity, despite having a similar cross-section to Brockton Avenue. Public Works will consider comparing ADTs in two years following the completion of the SR-91 HOV, Riverside Grade Separation, and the Streeter Grade Separation Projects as the construction phases have closed roads and detoured traffic. Many of the increases in traffic may be correlated to detoured traffic and those figures are anticipated to decreased as the projects are completed and motorists opt to stay on major arterials or freeway to traverse the City.

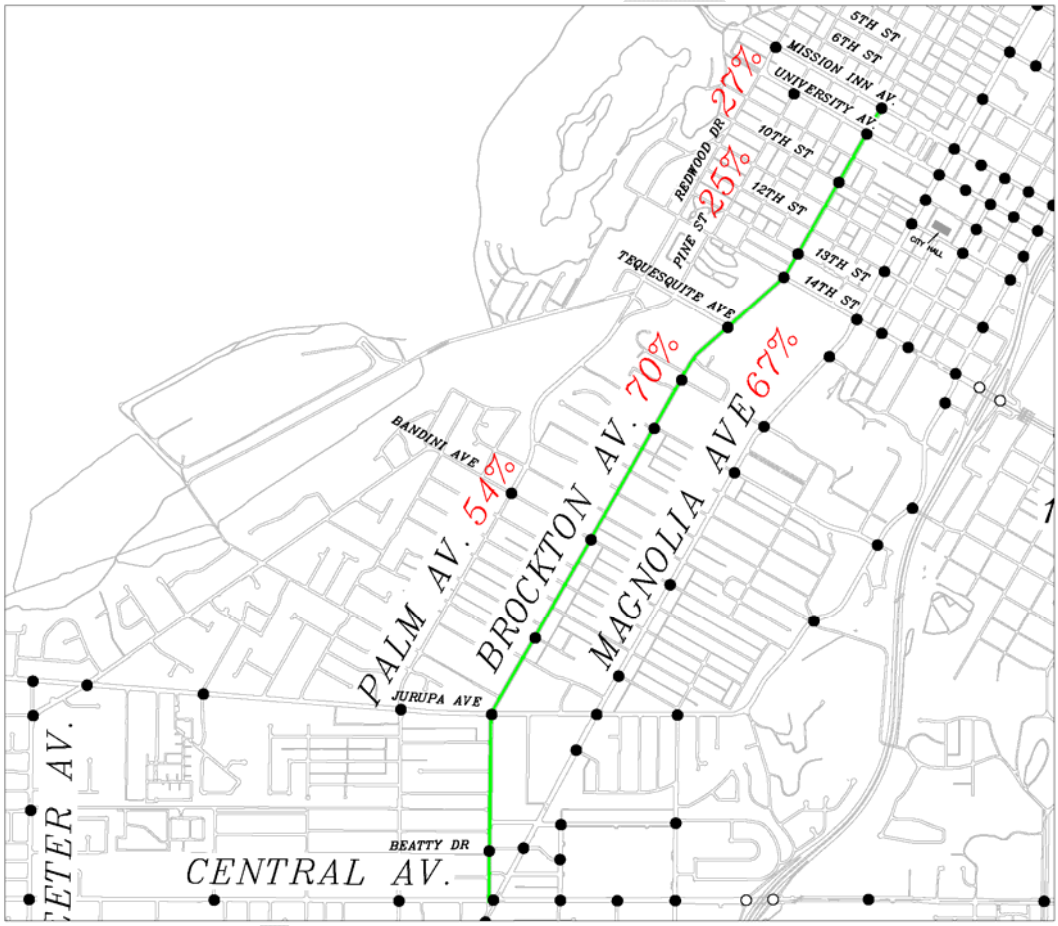

Figure 8: Percent of Roadway Capacity Utilized After Project (2015)

Summary

Brockton Avenue, from Mission Inn Avenue to Beatty Drive, was studied to determine if reconfiguring Brockton Avenue from a 4-lane roadway to a 3-lane roadway would accommodate present and future traffic growth including the traffic impacts from the Riverside Community Hospital Expansion Project.

This follow up-study makes several key findings following the Brockton Avenue Restriping Project:

- Reduction of Accidents
- Maintained acceptable intersection levels of service
- Roadway speeds and capacity maintained
- Significant increases in pedestrian and bicyclist usage

More predictable vehicle speeds and fewer points of conflict when crossing Brockton Avenue provide a much safer crossing environment for pedestrians and motorists alike.

The Public Works Department was pleased to observe that bicycle traffic had doubled and pedestrian volumes had tripled during the study period. The new Class II Bike lanes and sidewalk facilities provide comfortable and safer travel paths and have promoted increased biking and walking in the area.

The 85% speeds, roadway capacity, LOS at signalized intersections, and vehicular volumes on Brockton Avenue have remained relatively unchanged. In addition, preliminary findings indicate that accidents have decreased by 30%. Increased use of Brockton Avenue by motorists suggest they find comfort and acceptable operations thus discouraging them from utilizing adjacent parallel streets to reach their destination. Public Works will continue to monitor Brockton Avenue to make signal timing changes and/or striping improvements to ensure Brockton Avenue continues to serve all road users.