

**KERN COUNCIL OF GOVERNMENTS**  
**Congestion Mitigation and Air Quality (CMAQ) Program**  
**PROJECT APPLICATION – Due Thursday, July 17, 2025**

\*Please note this is a PDF fillable form so responses may be typed. Items 1, 2, 7, and 22 are drop downs. Totals in item 6 will automatically calculate.

- (1) Is the project included in a local agency-adopted resolution supporting the project? Yes
- (2) Does the proposed project meet basic eligibility requirements? Yes
- (3) Project background and justification: Explain the project in terms of the existing infrastructure, its impact for service, safety or any other issue that is relevant to the project (attach to application). If the project scope relates to fueling infrastructure please provide a 3-year fleet conversion plan.
- (4) Lead Agency: City of Bakersfield
- (5) Project description [(Location:) + (Limits) + (;) + (Improvement/Activity)]  
Downtown Grid: F St, H St, L St, Q St from Truxtun Ave to 21st St, and Eye St from Truxtun Ave to 18th St; Adaptive Signal Coordination

(6)	Funding Type	PE	R/W	Const.	Total
Local	Gas Tax	\$	\$	\$ 311,422	\$ 311,422
Local		\$	\$	\$	\$ 0
State		\$	\$	\$	\$ 0
Federal	CMAQ	\$	\$	\$ 2,403,678	\$ 2,403,678
	Total	\$ 0	\$ 0	\$ 2,715,100	\$ 2,715,100

- (7) Programming Year by Phase: PE: FY 27-28 R/W: FY 27-28 Const: FY 27-28
- (8) VMT Reduction (annual miles): 4,054,636
- (9) VOC Reduction (kg/day): 0.13 Additional documentation required. See instructions.
- (10) NOx Reduction (kg/day): 0.65 Additional documentation required. See instructions.
- (11) PM<sub>10</sub> Reduction (kg/day): 0 Additional documentation required. See instructions.
- (12) PM<sub>2.5</sub> Reduction (Kg/day): .01 Additional documentation required. See instructions.
- (13) CO Reduction (kg/day): 0.30 Additional documentation required. See instructions.
- (14) Cost-Effectiveness (\$/lb): 683.60 Additional documentation required. See instructions.
- (15) Livability and Safety: Describe how project provides the six benefits; limit to half page per benefit.
- (16) Hwy Peak Period LOS Before Project (AM/PM average): B
- (17) Hwy Peak period LOS After Project (AM/PM average): A
- (18) Bikeway Peak Period LOS Before Project (AM/PM average): N/A
- (19) Bikeway Peak period LOS After Project (AM/PM average): N/A
- (20) Pedestrian Peak period LOS Before Project (AM/PM average): N/A
- (21) Pedestrian Peak period LOS After Project (AM/PM average): N/A
- (22) Is the project identified as a RACM/BACM? No

Application completed by: Edgar Santana

Date Completed: 7/17/2025

E-mail: esantana@bakersfieldcity.us

Phone Number: 661-326-3581

Agency: City of Bakersfield

Address: 1501 Truxtun Ave, Bakersfield, CA, 93300

Send completed application electronically on a flash drive with transmittal letter on agency letterhead to:

Attn: Ceasar Valle ❖ Kern Council of Governments, 1401 19th Street, Suite 300, Bakersfield, CA 93301

OR send Digitally via [Dropbox, click here.](#)

## ENGINEER'S ESTIMATE OF PROJECT COSTS

revised Feb 20, 2013

Project Title: Adaptive Signal Coordination: Downtown Grid  
 Project Limits: Various Locations: F St, H St, L St, & Q St  
 Project Number: \_\_\_\_\_  
 Prepared by: Edgar Santana  
 Date Prepared: 27-May-25  
 Approved by: \_\_\_\_\_

File Name\Sheet Name: S:\Traffic\_Ops\CMAQ\Project\_26\_28\5\_Adaptive Signal Coordination Downtown Grid\7\_Engr Est Bid  
 Tab\_ Downtown Grid Signal Coordination.xlsx\Engineer's Estimate (0.2)

### CONSTRUCTION COSTS

Item No.	Estimated Quantity	Unit Measure	Item	Unit Price	Extension Price
1	1	LS	Mobilization	\$20,000.00	\$20,000
2	1	LS	Maintaining Traffic	\$20,000.00	\$20,000
3	1	LS	Testing	\$6,000.00	\$6,000
4	20	EA	2070 LX Controller and Software (installed)	\$15,000.00	\$300,000
5	20	EA	Adaptive licenses	\$1,000.00	\$20,000
6	20	EA	Adaptive & Management Software configuration	\$10,000.00	\$200,000
7	1	LS	Network Configuration & Endpoint Troubleshooting	\$10,000.00	\$10,000
8	60	EA	Turning Movement Counts (AM, Midday, PM)	\$1,000.00	\$60,000
9		EA	Detectors (Type E)	\$6,000.00	\$0
10		EA	Detector Lead-In Cable	\$15.00	\$0
11	20	EA	Vantage Apex Sensors with Cabinet Interface Unit	\$50,000.00	\$1,000,000
12	11693	LF	48 Single Mode Fiber Optic (SMFO)	\$10.00	\$116,930
13	2000	LF	12 Single Mode Fiber Optic (SMFO)	\$10.00	\$20,000
14	25	EA	Splice Vault	\$5,000.00	\$125,000
15	25	EA	Splice Enclosure	\$5,000.00	\$125,000
16	25	EA	Corning Single Panel Housing	\$3,000.00	\$75,000
17	25	EA	Hardened Gigabit Ethernet Switch	\$3,500.00	\$87,500
18	50	EA	SC to LC Patch Cords	\$300.00	\$15,000
19	25	EA	Isobar Surge Protector	\$600.00	\$15,000
20	9	EA	PTZ Cameras (Q6075-E)	\$20,000.00	\$180,000
21	0	EA	2" conduit	\$45.00	\$0
22					
23					
24					
				Sub-total:	\$2,395,500
				Contingency: 10%	\$239,600
				<b>CONSTRUCTION COSTS:</b>	<b>\$2,635,100</b>

### OTHER COSTS

Regular Salaries & Wages	\$80,000
Professional / Consultant Fees	\$0
Land Acquisition, Project Permitting, Utility Connection/Extension Fees	\$0
Fleet / Equipment	\$0
Sub-total:	\$80,000
Contingency: 0%	\$0
<b>OTHER COSTS:</b>	<b>\$80,000</b>

**ENGINEER'S ESTIMATE OF TOTAL PROJECT COST: \$2,715,100**

## F Street Emissions Reductions Calculations <sup>1</sup>

<sup>1</sup> based on ARB Methods to Find the Cost-Effectiveness of Funding Air Quality Projects

### F St: Truxtun Ave to 21st

Project Segment Length (mi)	0.34	mile
Operating Days per Year:	250	days
Average Annual Daily Traffic:	11,002	
Ave. Speed Before Coordination (mph)	17	mph
Ave. Speed After Coordination (mph)	32	mph
Annual Project Segment VMT <sup>2</sup> :	925,168	miles/year

<sup>2</sup> Annual Project VMT = Operating Days per Year \* Project Length \* AADT

Emissions	ROG	CO	NOx	PM2.5 Ex
Before Speed Factor <sup>3</sup> (g/mi)	0.0471	1.5928	0.2948	0.004
After Speed Factor <sup>3</sup> (g/mi)	0.0214	1.189	0.171	0.0021
Annual Emission Reduction <sup>4</sup> (lbs/yr)/mi	26	411	126	2
Annual Emission Reduction <sup>5</sup> (kg/day)/mi	0.03	0.51	0.16	0.00

<sup>3</sup> Emissions factors are referenced from Table 3 of Methods to Find the Cost-Effectiveness of Funding Air Quality Projects, Emission Factor Tables, December 2022

<sup>4</sup> Annual Emissions Reductions (lbs/yr) = [(0.50)\*(VMT)\*(Before Speed Factor - After Speed Factor)]/454 grams per lb.

<sup>5</sup> Annual Emissions Reductions (kg/yr) = [Annual Emissions Reductions (lbs/yr)]\*2.2 kg per lb.

## F Street LOS Analysis (HCM 2016 Methodology)

### F St: Truxtun Ave to 21st

#### Before Proposed Improvements

Base Free Flow Speed	$f_{LW}$	$f_{TLC}$	$f_M$	$f_A$
17	0	0.9	0	2.5
<b>Free Flow Speed (FFS) = 13.6</b>				
Note: FFS calculation is based on HCM 2016 Eq. 12-3. Adjustment factors $f_{LW}$ , $f_{TLC}$ , $f_M$ , and $f_A$ are referenced from HCM 2016 Exhibits 12-21, 12-22, 12-23, and 12-24, respectively. See HCM 2016 References on following page.				
Heavy Vehicle Factor	$E_T$	$P_T$		
	1.5	4		
$f_{HV} = 0.980$				
Note: $f_{HV}$ calculation is based on HCM 2016 Eq. 12-19. Factors $P_T$ and $E_T$ are referenced from Exhibits 12-25 in HCM 2016. See HCM 2016 References on following page.				
Service Flow Rate	V (veh/hr)	N (lanes)	PHF	
	550	3	0.92	
$v_p = 203$				
Note: Demand Volume, $V$ , is based on 10% of half of the two-way AADT				
<b>Density (D) = <math>V(p)/FFS</math> = 15</b>				
<b>Level Of Service (LOS) = B</b>				
from HCM 2016 Exhibit 12-15				

### F St: Truxtun Ave to 21st

#### After Proposed Improvements

Base Free Flow Speed	$f_{LW}$	$f_{TLC}$	$f_M$	$f_A$
32	0	0.9	0	2.5
<b>Free Flow Speed (FFS) = 28.6</b>				
<i>Note: FFS calculation is based on HCM 2016 Eq. 12-3. Adjustment factors <math>f_{LW}</math>, <math>f_{TLC}</math>, <math>f_M</math>, and <math>f_A</math> are referenced from HCM 2016 Exhibits 12-21, 12-22, 12-23, and 12-24, respectively. See HCM 2016 References on following page.</i>				
Heavy Vehicle Factor	$E_T$	$P_T$		
	1.5	4		
$f_{HV}$	<b>0.980</b>			
<i>Note: <math>f_{HV}</math> calculation is based on HCM 2016 Eq. 12-19. Factors <math>P_T</math> and <math>E_T</math> are referenced from Exhibits 12-25 in HCM 2016. See HCM 2016 References on following page.</i>				
Service Flow Rate	V (veh/hr)	N (lanes)	PHF	
	550	3	0.92	
$v_p$	<b>203</b>			
<i>Note: Demand Volume, <math>V</math>, is based on 10% of half of the two-way AADT</i>				
<b>Density (D) = V(p)/FFS = 7</b>				
<b>Level Of Service (LOS) = A</b>				
from HCM 2016 Exhibit 12-15				

## H St Emissions Reductions Calculations <sup>1</sup>

<sup>1</sup> based on ARB Methods to Find the Cost-Effectiveness of Funding Air Quality Projects

### H St: Truxtun Ave to 21st

Project Segment Length (mi)	0.34	mile
Operating Days per Year:	250	days
Average Annual Daily Traffic:	10,851	
Ave. Speed Before Coordination (mph)	17	mph
Ave. Speed After Coordination (mph)	32	mph
Annual Project Segment VMT <sup>2</sup> :	912,470	miles/year

<sup>2</sup> Annual Project VMT = Operating Days per Year \* Project Length \* AADT

Emissions	ROG	CO	NOx	PM2.5 Ex
Before Speed Factor <sup>3</sup> (g/mi)	0.0471	1.5928	0.2948	0.004
After Speed Factor <sup>3</sup> (g/mi)	0.0214	1.189	0.171	0.0021
Annual Emission Reduction <sup>4</sup> (lbs/yr)/mi	26	406	124	2
Annual Emission Reduction <sup>5</sup> (kg/day)/mi	0.03	0.51	0.15	0.00

<sup>3</sup> Emissions factors are referenced from Table 3 of Methods to Find the Cost-Effectiveness of Funding Air Quality Projects, Emission Factor Tables, December 2022

<sup>4</sup> Annual Emissions Reductions (lbs/yr) = [(0.50)\*(VMT)\*(Before Speed Factor - After Speed Factor)]/454 grams per lb.

<sup>5</sup> Annual Emissions Reductions (kg/yr) = [Annual Emissions Reductions (lbs/yr)]\*2.2 kg per lb.

## H St LOS Analysis (HCM 2016 Methodology)

### H St: Truxtun Ave to 21st

#### Before Proposed Improvements

Base Free Flow Speed	$f_{LW}$	$f_{TLC}$	$f_M$	$f_A$
17	0	0.9	0	2.5
Free Flow Speed (FFS) = 13.6				

Note: FFS calculation is based on HCM 2016 Eq. 12-3. Adjustment factors  $f_{LW}$ ,  $f_{TLC}$ ,  $f_M$ , and  $f_A$  are referenced from HCM 2016 Exhibits 12-21, 12-22, 12-23, and 12-24, respectively. See HCM 2016 References on following page.

Heavy Vehicle Factor	$E_T$	$P_T$
	1.5	4

$$f_{HV} = 0.980$$

Note:  $f_{HV}$  calculation is based on HCM 2016 Eq. 12-19. Factors  $P_T$  and  $E_T$  are referenced from Exhibits 12-25 in HCM 2016. See HCM 2016 References on following page.

Service Flow Rate	V (veh/hr)	N (lanes)	PHF
	543	3	0.92

$$v_p = 201$$

Note: Demand Volume,  $V$ , is based on 10% of half of the two-way AADT

$$\text{Density (D)} = V(p)/FFS = 15$$

$$\text{Level Of Service (LOS)} = B \quad \text{from HCM 2016 Exhibit 12-15}$$

### H St: Truxtun Ave to 21st

#### After Proposed Improvements

Base Free Flow Speed	$f_{LW}$	$f_{TLC}$	$f_M$	$f_A$
32	0	0.9	0	2.5
Free Flow Speed (FFS) = 28.6				

Note: FFS calculation is based on HCM 2016 Eq. 12-3. Adjustment factors  $f_{LW}$ ,  $f_{TLC}$ ,  $f_M$ , and  $f_A$  are referenced from HCM 2016 Exhibits 12-21, 12-22, 12-23, and 12-24, respectively. See HCM 2016 References on following page.

Heavy Vehicle Factor	$E_T$	$P_T$
	1.5	4

$$f_{HV} = 0.980$$

Note:  $f_{HV}$  calculation is based on HCM 2016 Eq. 12-19. Factors  $P_T$  and  $E_T$  are referenced from Exhibits 12-25 in HCM 2016. See HCM 2016 References on following page.

Service Flow Rate	V (veh/hr)	N (lanes)	PHF
	543	3	0.92

$$v_p = 201$$

Note: Demand Volume,  $V$ , is based on 10% of half of the two-way AADT

$$\text{Density (D)} = V(p)/FFS = 7$$

$$\text{Level Of Service (LOS)} = A \quad \text{from HCM 2016 Exhibit 12-15}$$

## Eye St Emissions Reductions Calculations <sup>1</sup>

<sup>1</sup> based on ARB Methods to Find the Cost-Effectiveness of Funding Air Quality Projects

### Eye St: Truxtun Ave to 18th St

Project Segment Length (mi)	0.14	mile
Operating Days per Year:	250	days
Average Annual Daily Traffic:	1,083	
Ave. Speed Before Coordination (mph)	17	mph
Ave. Speed After Coordination (mph)	32	mph
Annual Project Segment VMT <sup>2</sup> :	36,664	miles/year

<sup>2</sup> Annual Project VMT = Operating Days per Year \* Project Length \* AADT

Emissions	ROG	CO	NOx	PM2.5 Ex
Before Speed Factor <sup>3</sup> (g/mi)	0.0471	1.5928	0.2948	0.004
After Speed Factor <sup>3</sup> (g/mi)	0.0214	1.189	0.171	0.0021
Annual Emission Reduction <sup>4</sup> (lbs/yr)/mi	1	16	5	0
Annual Emission Reduction <sup>5</sup> (kg/day)/mi	0.00	0.02	0.01	0.00

<sup>3</sup> Emissions factors are referenced from Table 3 of Methods to Find the Cost-Effectiveness of Funding Air Quality Projects, Emission Factor Tables, December 2022

<sup>4</sup> Annual Emissions Reductions (lbs/yr) = [(0.50)\*(VMT)\*(Before Speed Factor - After Speed Factor)]/454 grams per lb.

<sup>5</sup> Annual Emissions Reductions (kg/yr) = [Annual Emissions Reductions (lbs/yr)]\*2.2 kg per lb.

## Eye St LOS Analysis (HCM 2016 Methodology)

### Eye St: Truxtun Ave to 18th St

#### Before Proposed Improvements

Base Free Flow Speed	$f_{LW}$	$f_{TLC}$	$f_M$	$f_A$
17	0	0.9	0	2.5

Free Flow Speed (FFS) = 13.6

Note: FFS calculation is based on HCM 2016 Eq. 12-3. Adjustment factors  $f_{LW}$ ,  $f_{TLC}$ ,  $f_M$ , and  $f_A$  are referenced from HCM 2016 Exhibits 12-21, 12-22, 12-23, and 12-24, respectively. See HCM 2016 References on following page.

Heavy Vehicle Factor	$E_T$	$P_T$
	1.5	4

$f_{HV} = 0.980$

Note:  $f_{HV}$  calculation is based on HCM 2016 Eq. 12-19. Factors  $P_T$  and  $E_T$  are referenced from Exhibits 12-25 in HCM 2016. See HCM 2016 References on following page.

Service Flow Rate	V (veh/hr)	N (lanes)	PHF
	54	3	0.92

$v_p = 20$

Note: Demand Volume,  $V$ , is based on 10% of half of the two-way AADT

Density (D) =  $V(p)/FFS = 1$

Level Of Service (LOS) = A from HCM 2016 Exhibit 12-15

### Eye St: Truxtun Ave to 18th St

#### After Proposed Improvements

Base Free Flow Speed	$f_{LW}$	$f_{TLC}$	$f_M$	$f_A$
32	0	0.9	0	2.5

Free Flow Speed (FFS) = 28.6

Note: FFS calculation is based on HCM 2016 Eq. 12-3. Adjustment factors  $f_{LW}$ ,  $f_{TLC}$ ,  $f_M$ , and  $f_A$  are referenced from HCM 2016 Exhibits 12-21, 12-22, 12-23, and 12-24, respectively. See HCM 2016 References on following page.

Heavy Vehicle Factor	$E_T$	$P_T$
	1.5	4

$f_{HV} = 0.980$

Note:  $f_{HV}$  calculation is based on HCM 2016 Eq. 12-19. Factors  $P_T$  and  $E_T$  are referenced from Exhibits 12-25 in HCM 2016. See HCM 2016 References on following page.

Service Flow Rate	V (veh/hr)	N (lanes)	PHF
	54	3	0.92

$v_p = 20$

Note: Demand Volume,  $V$ , is based on 10% of half of the two-way AADT

Density (D) =  $V(p)/FFS = 1$

Level Of Service (LOS) = A from HCM 2016 Exhibit 12-15

## L St & Branch-Off Segments: Emissions Reduction Calculations & LOS Analyses

### Emissions Reductions Calculations <sup>1</sup>

<sup>1</sup> based on ARB Methods to Find the Cost-Effectiveness of Funding Air Quality Projects

L St between Truxtun and 21st	
Project Segment Length (mi)	0.33
Operating Days per Year:	250
Average Annual Daily Traffic:	7,061
Ave. Speed Before Coordination (mph)	17
Ave. Speed After Coordination (mph)	32
Annual Project Segment VMT <sup>2</sup> :	588,417

<sup>2</sup> Annual Project VMT = Operating Days per Year \* Project Length \* AADT

Emissions	ROG	CO	NOx	PM2.5 Ex
Before Speed Factor <sup>3</sup> (g/mi)	0.0471	1.5928	0.2948	0.004
After Speed Factor <sup>3</sup> (g/mi)	0.0214	1.189	0.171	0.0021
Annual Emission Reduction <sup>4</sup> (lbs/yr)/mi	17	262	80	1
Annual Emission Reduction <sup>5</sup> (kg/day)/mi	0.02	0.33	0.10	0.00

<sup>3</sup> Emissions factors are referenced from Table 3 of Methods to Find the Cost-Effectiveness of Funding Air Quality Projects, Emission Factor Tables, December 2022

<sup>4</sup> Annual Emissions Reductions (lbs/yr) = [(0.50)\*(VMT)\*(Before Speed Factor - After Speed Factor)]/454 grams per lb.

<sup>5</sup> Annual Emissions Reductions (kg/yr) = [Annual Emissions Reductions (lbs/yr)]\*2.2 kg per lb.

### Branch-Off Segments

### Emissions Reductions Calculations <sup>1</sup>

<sup>1</sup> based on ARB Methods to Find the Cost-Effectiveness of Funding Air Quality Projects

18th St between L St and M St	
Project Segment Length (mi)	0.06
Operating Days per Year:	250
Average Annual Daily Traffic:	4,716
Ave. Speed Before Coordination (mph)	17
Ave. Speed After Coordination (mph)	32
Annual Project Segment VMT <sup>2</sup> :	74,804

<sup>2</sup> Annual Project VMT = Operating Days per Year \* Project Length \* AADT

Emissions	ROG	CO	NOx	PM2.5 Ex
Before Speed Factor <sup>3</sup> (g/mi)	0.0471	1.5928	0.2948	0.004
After Speed Factor <sup>3</sup> (g/mi)	0.0214	1.189	0.171	0.0021
Annual Emission Reduction <sup>4</sup> (lbs/yr)/mi	2,1172	33,2664	10,1990	0.1730
Annual Emission Reduction <sup>5</sup> (kg/day)/mi	0.0026	0.0414	0.0127	0.0002

<sup>3</sup> Emissions factors are referenced from Table 3 of Methods to Find the Cost-Effectiveness of Funding Air Quality Projects, Emission Factor Tables, December 2022

<sup>4</sup> Annual Emissions Reductions (lbs/yr) = [(0.50)\*(VMT)\*(Before Speed Factor - After Speed Factor)]/454 grams per lb.

<sup>5</sup> Annual Emissions Reductions (kg/yr) = [Annual Emissions Reductions (lbs/yr)]\*2.2 kg per lb.

### Emissions Reductions Calculations <sup>1</sup>

<sup>1</sup> based on ARB Methods to Find the Cost-Effectiveness of Funding Air Quality Projects

19th St between L St and N St	
Project Segment Length (mi)	0.13
Operating Days per Year:	250
Average Annual Daily Traffic:	2,051
Ave. Speed Before Coordination (mph)	17
Ave. Speed After Coordination (mph)	32
Annual Project Segment VMT <sup>2</sup> :	67,978

<sup>2</sup> Annual Project VMT = Operating Days per Year \* Project Length \* AADT

Emissions	ROG	CO	NOx	PM2.5 Ex
Before Speed Factor <sup>3</sup> (g/mi)	0.0471	1.5928	0.2948	0.004
After Speed Factor <sup>3</sup> (g/mi)	0.0214	1.189	0.171	0.0021
Annual Emission Reduction <sup>4</sup> (lbs/yr)/mi	1,9241	30,2308	9,2684	0.1572
Annual Emission Reduction <sup>5</sup> (kg/day)/mi	0.0024	0.0376	0.0115	0.0002

<sup>3</sup> Emissions factors are referenced from Table 3 of Methods to Find the Cost-Effectiveness of Funding Air Quality Projects, Emission Factor Tables, December 2022

<sup>4</sup> Annual Emissions Reductions (lbs/yr) = [(0.50)\*(VMT)\*(Before Speed Factor - After Speed Factor)]/454 grams per lb.

<sup>5</sup> Annual Emissions Reductions (kg/yr) = [Annual Emissions Reductions (lbs/yr)]\*2.2 kg per lb.

### LOS Analysis (HCM 2016 Methodology)

L St between Truxtun and 21st					After Proposed Improvements				
Before Proposed Improvements					After Proposed Improvements				
Base Free Flow Speed	$f_{LW}$	$f_{TLC}$	$f_M$	$f_A$	Base Free Flow Speed	$f_{LW}$	$f_{TLC}$	$f_M$	$f_A$
17	0	0.9	0	2.5	32	0	0.9	0	2.5
Free Flow Speed (FFS) <sup>1</sup> = 13.6					Free Flow Speed (FFS) = 28.6				
Heavy Vehicle Factor <sup>2</sup>					Heavy Vehicle Factor <sup>2</sup>				
$f_{HV}$ = 0.980					$f_{HV}$ = 0.994				
Service Flow Rate					Service Flow				
$v_p$ = 130					$v_p$ = 129				
Density (D) = V(p)/FFS = 10					Density (D) = V(p)/FFS = 4				
Level Of Service (LOS) = B					Level Of Service (LOS) = A				

<sup>1</sup> FFS calculation is based on HCM 2016 Eq. 12-3. Adjustment factors  $f_{LW}$ ,  $f_{TLC}$ ,  $f_M$ , and  $f_A$  are referenced from HCM 2016 Exhibits 12-21, 12-22, 12-23, and 12-24, respectively. See HCM 2016 References on following page.

<sup>2</sup>  $f_{HV}$  calculation is based on HCM 2016 Eq. 12-19. Factors PT and ET are referenced from Exhibits 12-25 in HCM 2016. See HCM 2016 References on following page.

### LOS Analysis (HCM 2016 Methodology)

18th St between L St and M St					After Proposed Improvements				
Before Proposed Improvements					After Proposed Improvements				
Base Free Flow Speed	$f_{LW}$	$f_{TLC}$	$f_M$	$f_A$	Base Free Flow Speed	$f_{LW}$	$f_{TLC}$	$f_M$	$f_A$
17	0	0.9	0	2.5	32	0	0.9	0	2.5
Free Flow Speed (FFS) <sup>1</sup> = 13.6					Free Flow Speed (FFS) = 28.6				
Heavy Vehicle Factor <sup>2</sup>					Heavy Vehicle Factor <sup>2</sup>				
$f_{HV}$ = 0.980					$f_{HV}$ = 0.994				
Service Flow Rate					Service Flow				
$v_p$ = 130					$v_p$ = 129				
Density (D) = V(p)/FFS = 10					Density (D) = V(p)/FFS = 4				
Level Of Service (LOS) = B					Level Of Service (LOS) = A				

<sup>1</sup> FFS calculation is based on HCM 2016 Eq. 12-3. Adjustment factors  $f_{LW}$ ,  $f_{TLC}$ ,  $f_M$ , and  $f_A$  are referenced from HCM 2016 Exhibits 12-21, 12-22, 12-23, and 12-24, respectively. See HCM 2016 References on following page.

<sup>2</sup>  $f_{HV}$  calculation is based on HCM 2016 Eq. 12-19. Factors PT and ET are referenced from Exhibits 12-25 in HCM 2016. See HCM 2016 References on following page.

### LOS Analysis (HCM 2016 Methodology)

19th St between L St and N St					After Proposed Improvements				
Before Proposed Improvements					After Proposed Improvements				
Base Free Flow Speed	$f_{LW}$	$f_{TLC}$	$f_M$	$f_A$	Base Free Flow Speed	$f_{LW}$	$f_{TLC}$	$f_M$	$f_A$
17	0	0.9	0	2.5	32	0	0.9	0	2.5
Free Flow Speed (FFS) <sup>1</sup> = 13.6					Free Flow Speed (FFS) = 28.6				
Heavy Vehicle Factor <sup>2</sup>					Heavy Vehicle Factor <sup>2</sup>				
$f_{HV}$ = 0.980					$f_{HV}$ = 0.994				
Service Flow Rate					Service Flow				
$v_p$ = 130					$v_p$ = 129				
Density (D) = V(p)/FFS = 10					Density (D) = V(p)/FFS = 4				
Level Of Service (LOS) = B					Level Of Service (LOS) = A				

<sup>1</sup> FFS calculation is based on HCM 2016 Eq. 12-3. Adjustment factors  $f_{LW}$ ,  $f_{TLC}$ ,  $f_M$ , and  $f_A$  are referenced from HCM 2016 Exhibits 12-21, 12-22, 12-23, and 12-24, respectively. See HCM 2016 References on following page.

<sup>2</sup>  $f_{HV}$  calculation is based on HCM 2016 Eq. 12-19. Factors PT and ET are referenced from Exhibits 12-25 in HCM 2016. See HCM 2016 References on following page.

### Emissions Reductions Calculations <sup>1</sup>

<sup>1</sup> based on ARB Methods to Find the Cost-Effectiveness of Funding Air Quality Projects

M St between 19th and 20th St	
Project Segment Length (mi)	0.07
Operating Days per Year:	250
Average Annual Daily Traffic:	856
Ave. Speed Before Coordination (mph)	17
Ave. Speed After Coordination (mph)	32
Annual Project Segment VMT <sup>2</sup> :	14,186

<sup>2</sup> Annual Project VMT = Operating Days per Year \* Project Length \* AADT

Emissions	ROG	CO	NOx	PM2.5 Ex
Before Speed Factor <sup>3</sup> (g/mi)	0.0471	1.5928	0.2948	0.004
After Speed Factor <sup>3</sup> (g/mi)	0.0214	1.189	0.171	0.0021
Annual Emission Reduction <sup>4</sup> (lbs/yr)/mi	0.4015	6.3085	1.9341	0.0328
Annual Emission Reduction <sup>4</sup> (kg/day)/mi	0.0005	0.0079	0.00241	0.0000

<sup>3</sup> Emissions factors are referenced from Table 3 of Methods to Find the Cost-Effectiveness of Funding Air Quality Projects, Emission Factor Tables, December 2022

<sup>4</sup> Annual Emissions Reductions (lbs/yr) = [(0.50)\*(VMT)\*(Before Speed Factor - After Speed Factor)]/454 grams per lb.

<sup>5</sup> Annual Emissions Reductions (kg/yr) = [Annual Emissions Reductions (lbs/yr)]\*2.2 kg per lb.

### Emissions Reductions Calculations <sup>1</sup>

<sup>1</sup> based on ARB Methods to Find the Cost-Effectiveness of Funding Air Quality Projects

21 St between L St and M St	
Project Segment Length (mi)	0.07
Operating Days per Year:	250
Average Annual Daily Traffic:	5,618
Ave. Speed Before Coordination (mph)	17
Ave. Speed After Coordination (mph)	32
Annual Project Segment VMT <sup>2</sup> :	93,101

<sup>2</sup> Annual Project VMT = Operating Days per Year \* Project Length \* AADT

Emissions	ROG	CO	NOx	PM2.5 Ex
Before Speed Factor <sup>3</sup> (g/mi)	0.0471	1.5928	0.2948	0.004
After Speed Factor <sup>3</sup> (g/mi)	0.0214	1.189	0.171	0.0021
Annual Emission Reduction <sup>4</sup> (lbs/yr)/mi	2.6351	41.4034	12.6938	0.2153
Annual Emission Reduction <sup>4</sup> (kg/day)/mi	0.0033	0.0516	0.0158	0.0003

<sup>3</sup> Emissions factors are referenced from Table 3 of Methods to Find the Cost-Effectiveness of Funding Air Quality Projects, Emission Factor Tables, December 2022

<sup>4</sup> Annual Emissions Reductions (lbs/yr) = [(0.50)\*(VMT)\*(Before Speed Factor - After Speed Factor)]/454 grams per lb.

<sup>5</sup> Annual Emissions Reductions (kg/yr) = [Annual Emissions Reductions (lbs/yr)]\*2.2 kg per lb.

### LOS Analysis (HCM 2016 Methodology)

Before Proposed Improvements					After Proposed Improvements				
Base Free Flow Speed	$f_{LW}$	$f_{TLC}$	$f_M$	$f_A$	Base Free Flow Speed	$f_{LW}$	$f_{TLC}$	$f_M$	$f_A$
17	0	0.9	0	2.5	32	0	0.9	0	2.5
Free Flow Speed (FFS) <sup>1</sup> = 13.6					Free Flow Speed (FFS) = 28.6				
Heavy Vehicle Factor <sup>2</sup>	$E_T$	$P_T$			Heavy Vehicle Factor <sup>2</sup>	$E_T$	$P_T$		
	1.5	4				1.5	1.2		
$f_{HV}$ = 0.980					$f_{HV}$ = 0.994				
Service Flow Rate	V (veh/hr)	N (lanes)	PHF		Service Flow	V (veh/hr)	N (lanes)	PHF	
	353	3	0.92			353	3	0.92	
$v_p$ = 130					$v_p$ = 129				
Density (D) = V(p)/FFS = 10					Density (D) = V(p)/FFS = 4				
Level Of Service (LOS) = B					Level Of Service (LOS) = A				

<sup>1</sup>FFS calculation is based on HCM 2016 Eq. 12-3. Adjustment factors f<sub>LW</sub>, f<sub>TLC</sub>, f<sub>M</sub>, and f<sub>A</sub> are referenced from HCM 2016 Exhibits 12-21, 12-22, 12-23, and 12-24, respectively. See HCM 2016 References on following page.

<sup>2</sup> f<sub>HV</sub> calculation is based on HCM 2016 Eq. 12-19. Factors P<sub>T</sub> and E<sub>T</sub> are referenced from Exhibits 12-25 in HCM 2016. See HCM 2016 References on following page.

### LOS Analysis (HCM 2016 Methodology)

Before Proposed Improvements					After Proposed Improvements				
Base Free Flow Speed	$f_{LW}$	$f_{TLC}$	$f_M$	$f_A$	Base Free Flow Speed	$f_{LW}$	$f_{TLC}$	$f_M$	$f_A$
17	0	0.9	0	2.5	32	0	0.9	0	2.5
Free Flow Speed (FFS) <sup>1</sup> = 13.6					Free Flow Speed (FFS) = 28.6				
Heavy Vehicle Factor <sup>2</sup>	$E_T$	$P_T$			Heavy Vehicle Factor <sup>2</sup>	$E_T$	$P_T$		
	1.5	4				1.5	1.2		
$f_{HV}$ = 0.980					$f_{HV}$ = 0.994				
Service Flow Rate	V (veh/hr)	N (lanes)	PHF		Service Flow	V (veh/hr)	N (lanes)	PHF	
	353	3	0.92			353	3	0.92	
$v_p$ = 130					$v_p$ = 129				
Density (D) = V(p)/FFS = 10					Density (D) = V(p)/FFS = 4				
Level Of Service (LOS) = B					Level Of Service (LOS) = A				

<sup>1</sup>FFS calculation is based on HCM 2016 Eq. 12-3. Adjustment factors f<sub>LW</sub>, f<sub>TLC</sub>, f<sub>M</sub>, and f<sub>A</sub> are referenced from HCM 2016 Exhibits 12-21, 12-22, 12-23, and 12-24, respectively. See HCM 2016 References on following page.

<sup>2</sup> f<sub>HV</sub> calculation is based on HCM 2016 Eq. 12-19. Factors P<sub>T</sub> and E<sub>T</sub> are referenced from Exhibits 12-25 in HCM 2016. See HCM 2016 References on following page.

## LOS Analysis (HCM 2016 Methodology)

### From 14th St & 21st St

#### Before Proposed Improvements

Base Free Flow Speed	$f_{LW}$	$f_{TLC}$	$f_M$	$f_A$
18	0	0.9	0	2.5
<b>Free Flow Speed (FFS) = 14.6</b>				

Note: FFS calculation is based on HCM 2016 Eq. 12-3. Adjustment factors  $f_{LW}$ ,  $f_{TLC}$ ,  $f_M$ , and  $f_A$  are referenced from HCM 2016 Exhibits 12-21, 12-22, 12-23, and 12-24, respectively. See HCM 2016 References on following page.

Heavy Vehicle Factor	$E_T$	$P_T$
	1.5	4
$f_{HV} =$	<b>0.980</b>	

Note:  $f_{HV}$  calculation is based on HCM 2016 Eq. 12-19. Factors  $P_T$  and  $E_T$  are referenced from Exhibits 12-25 in HCM 2016. See HCM 2016 References on following page.

Service Flow Rate	V (veh/hr)	N (lanes)	PHF
	500	3	0.92
$v_p =$	<b>185</b>		

Note: Demand Volume,  $V$ , is based on 10% of half of the two-way AADT

**Density (D) =  $V(p)/FFS$  = 13**

**Level Of Service (LOS) = B** from HCM 2016 Exhibit 12-15

### From 14th St & 21st St



### After Proposed Improvements

Base Free Flow Speed	$f_{LW}$	$f_{TLC}$	$f_M$	$f_A$
30	0	0.9	0	2.5
Free Flow Speed (FFS) = 26.6				

*Note: FFS calculation is based on HCM 2016 Eq. 12-3. Adjustment factors  $f_{LW}$ ,  $f_{TLC}$ ,  $f_M$ , and  $f_A$  are referenced from HCM 2016 Exhibits 12-21, 12-22, 12-23, and 12-24, respectively. See HCM 2016 References on following page.*

Heavy Vehicle Factor

$E_T$	$P_T$
1.5	4
$f_{HV} = 0.980$	

*Note:  $f_{HV}$  calculation is based on HCM 2016 Eq. 12-19. Factors  $P_T$  and  $E_T$  are referenced from Exhibits 12-25 in HCM 2016. See HCM 2016 References on following page.*

Service Flow Rate

V (veh/hr)	N (lanes)	PHF
500	3	0.92

## Project Total Emissions Reduction & Cost-Benefit Analysis <sup>1</sup>

<sup>1</sup> based on ARB Methods to Find the Cost-Effectiveness of Funding Air Quality Projects

### Downtown Grid Adaptive

F St, H St, L St: Truxtun to 21st; Eye St: Truxtun to 18th St; Q St: 14th St to 21st	
Total Project Length (mi)	2.01
Operating Days per Year	250
Total Average Annual Daily Traffic	53,245
Total Project VMT	4,054,636
Effective Life of Project (n), years	5
Discount Rate (i)	3%
Capital Recovery Factor (A/P, 3%, 5) <sup>2</sup>	0.22
<b>CMAQ Funding Dollars</b>	<b>\$2,403,678</b>
<b>CoFund Dollars</b>	<b>\$311,422</b>
<b>CMAQ + CoFund Funding Dollars</b>	<b>\$2,715,100</b>

Local Match

11.47%

<sup>2</sup> CRF =  $((1+i)^n - 1) / (i * ((1+i)^n - 1))$

### AADT Totals

Segment	AADT	VMT <sup>3</sup>
F St: Truxtun Ave to 21st	11,002	925,168
H Street: Truxtun Ave to 21st St	10,851	912,470
Eye St between Truxtun 18th St	1,083	36,664
L St between Truxtun and 21st	7,061	588,417
18th St between L St and M St	4,716	74,804
19th St between L St and N St	2,051	67,978
M St between 19th and 20th St	856	14,186
21 St between L St and M St	5,618	93,101
Q St between 14th St & 21st St	10,007	1,341,848
	<b>53,245</b>	<b>4,054,636</b>

<sup>3</sup> Annual Project VMT = Operating Days per Year \* Project Length \* AADT

### Emission Reductions Totals

Kg/day

Segment	ROG	CO	NOx	PM2.5 Ex
F St: Truxtun Ave to 21st	0.0326	0.5124	0.1571	0.0027
H Street: Truxtun Ave to 21st St	0.0322	0.5053	0.1549	0.0026
Eye St between Truxtun 18th St	0.0013	0.0203	0.0062	0.0001
L St between Truxtun and 21st	0.0207	0.3259	0.0999	0.0017
18th St between L St and M St	0.0026	0.0414	0.0127	0.0002
19th St between L St and N St	0.0024	0.0376	0.0115	0.0002
M St between 19th and 20th St	0.0005	0.0079	0.0024	0.0000
21 St between L St and M St	0.0033	0.0516	0.0158	0.0003
Q St between 14th St & 21st St	0.0386	0.6023	0.1853	0.0033
	<b>0.1343</b>	<b>0.3007</b>	<b>0.6459</b>	<b>0.0111</b>

lbs/yr

Segment	ROG	CO	NOx	PM2.5 Ex
F St: Truxtun Ave to 21st	26.2	411.4	126.1	2.1
H Street: Truxtun Ave to 21st St	25.8	405.8	124.4	2.1
Eye St between Truxtun 18th St	1.0	16.3	5.0	0.1
L St between Truxtun and 21st	16.7	261.7	80.2	1.4
18th St between L St and M St	2.1	33.3	10.2	0.2
19th St between L St and N St	1.9	1.9	1.9	1.9
M St between 19th and 20th St	0.4	6.3	1.9	0.0
21 St between L St and M St	2.6	41.4	12.7	0.2
Q St between 14th St & 21st St	31.0	483.7	148.8	2.7
	<b>107.8</b>	<b>237.4</b>	<b>511.3</b>	<b>10.7</b>

dollars per lb. dollars per ton

<b>CMAQ Cost-Effectiveness<sup>4</sup></b>	<b>\$605.19</b>	<b>\$1,210,375</b>
<b>Total Cost-Effectiveness<sup>5</sup></b>	<b>\$683.60</b>	<b>\$1,367,192</b>

<sup>4</sup> Cost-Effectiveness of CMAQ Funding Dollars = (CRF \* CMAQ Funding Dollars) / (ROG + CO + NOx + PM10)

<sup>5</sup> Cost-Effectiveness of Total Funding Dollars = (CRF \* Total Funding Dollars) / (ROG + CO + NOx + PM10)

## **PROJECT BACKGROUND AND JUSTIFICATION**

### **Adaptive Signal Coordination Downtown Grid:**

#### **F St, H St, L St, Q St: Truxtun to 21<sup>st</sup>, Eye St: Truxtun to 18<sup>th</sup> St**

The proposed project will install new communication equipment along within the downtown grid along various segments: along F St, H St, L St, and Q St from Truxtun Ave to 21<sup>st</sup> St, and along Eye St from Truxtun Ave to 18<sup>th</sup> St. This new fiber optic communication system will enable transportation professionals to proactively manage traffic flow and promote mobility through real-time traffic data collection and management tools. New software and signal controller units will allow for optimal signal timing across the arterial network by adjusting cycle lengths, phase splits, and offsets based on prevailing traffic. It offers local agencies a viable and cost-effective migration path to modern technology. The robust data collection and control strategies help reduce congestion and harmful emissions.

The purpose of this project is to improve signal timing along the above-referenced corridor. The improved signal timing will reduce overall vehicle stops and starts and limit delays in travel time. This reduction in vehicle stops and starts will improve the corridor's average speed, thereby reducing the air-polluting gases generated by vehicles at low speeds and when idling. All vehicle engines are less efficient when traveling at low speeds or idling for long periods of time at a traffic signal. Also, most of the pollutants a vehicle discharges occur when the vehicle accelerates after sitting at a traffic signal for a short period of time. If a vehicle must routinely stop and start in a specified corridor, it will generate more air-polluting gases than if the same vehicle were allowed to travel down the specified corridor at a constant speed with minimal slowing or accelerating. The interconnected traffic signal corridor will be connected to the City of Bakersfield's Traffic Operations Center (TOC) to better enable City staff to monitor and improve corridor timing and traffic flow. Traffic signals connected to the City's TOC will also warn City staff when a signal is not functioning properly, allowing a quicker repair response time so the corridor in question can return to peak operating performance quickly.

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## **PROJECT LIVABILITY BENEFITS**

### **Livability Benefit #1**

***Will enhance or reduce the average cost of user mobility through the creation of more convenient transportation options for travelers.***

This project will reduce the average cost of user mobility through the creation of a more streamlined street corridor system utilizing traffic signal intersection control and progressive signal timing to keep traffic at a steady pace and reduce the number of stops. A motorized vehicle is at its most inefficient when the engine is idling or accelerating. During these periods of inactivity or acceleration, a vehicle's engine is burning through much more fuel than when that same vehicle is traveling at a consistent cruising speed. By installing traffic signal interconnect/synchronization equipment, these street segments can then be timed as corridors (or series of traffic signals linked together and communicating with one another) increasing the average speed along this street while simultaneously reducing the number of stops at this intersection. Motor vehicles traveling along this newly created corridor will significantly reduce their fuel consumption and increase their average miles per gallon, thereby saving them money by not having to purchase fuel as often.

### **Livability Benefit #2**

***Will improve existing transportation choices by enhancing points of modal connectivity, increasing the number of modes accommodated on existing assets, or reducing congestion on existing modal assets.***

This project will reduce congestion on existing street systems by the implementation of traffic signal interconnect and synchronization technologies. By linking the other nearby traffic signals together, they can then "talk" to one another using software and the City of Bakersfield's existing Traffic Operations Center (TOC). More importantly, all of the individual clocks within the traffic signal controllers will be synchronized so the implementation of corridor timing is possible. By having motor vehicles travel at a consistent speed along a stretch of roadway, congestion will be reduced, allowing more vehicles to travel along the same street at the same time. These improvements will also reduce the amount of time it takes for a driver to reach his destination, removing the vehicle from the street system quicker. These interconnect and synchronization improvements utilize the existing street and traffic signal systems that are already in place throughout the City of Bakersfield.

**Livability Benefit #3**

***Will improve travel between residential areas and commercial centers and jobs.***

This project will improve travel within the southwestern part of the City of Bakersfield. By installing traffic signal interconnect/synchronization, these streets will become more efficient. This increased efficiency will translate to both residential and commercial areas. Typically, drivers leave their homes located on residential streets and then enter onto some type of Multi-lane Street network to travel to work, shopping, or other leisure activities. By improving the corridor timing along signalized streets, the delay will be reduced and travel between different areas will be more seamless. The movement of goods and people via the City's existing street system will take less time, become more efficient, and reduce the amount of pollutants placed into our air.

**Livability Benefit #4**

***Will improve accessibility and transportation services for economically disadvantaged populations, non-drivers, senior citizens, and persons with disabilities, or make goods, commodities, and services more readily available to these groups.***

For Bakersfield citizens who do not or cannot drive due to various circumstances, this project will greatly enhance their quality of life. The City of Bakersfield has an agreement with the Golden Empire Transit District (GET) to use interconnect and synchronization infrastructure to improve bus services. In our community, a large number of economically disadvantaged and elderly individuals rely on GET to meet their basic needs and improve their quality of life. If the bus service is not able to keep to a timely schedule, then their life suffers. By building a partnership between the City of Bakersfield and GET, together we can make bus services throughout the metropolitan area more efficient and timelier. Utilizing existing interconnect and synchronization technology, when a bus is running behind schedule by a preset amount, certain traffic signal phases can be preempted. This preemption allows GET buses to get through a specified corridor quicker than if this system was not in place. However, these improvements can only be implemented on traffic signals where interconnect and synchronization is installed. The City's goal is to eventually connect all traffic signals to the Traffic Operations Center (TOC) with interconnect and synchronization improvements. This will allow the City and GET to continue to expand this partnership and create a more reliable and environmentally friendly mass transit network throughout the Bakersfield metropolitan area.

**Livability Benefit #5**

***Is the existing Accident Rate higher than the average rate for a similar activity, and does the project reduce the Accident Rate to the average rate or lower?***

Yes. Based on studies for similar projects, the installation of traffic signal interconnect/synchronization provides for an orderly flow of traffic when timed correctly. Movements at intersections are better coordinated thus resulting in both driver and pedestrian confidence and safety.

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2024-26 Congestion Mitigation / Air Quality (CMAQ) Program

**Livability Benefit #6**

***Is the existing Fatality Rate higher than the average rate for a similar activity, and does the project reduce the Fatality Rate to the average rate or lower?***

Yes. Based on studies for similar projects, the installation of traffic signal interconnect/synchronization provides for an orderly flow of traffic when timed correctly. Movements at intersections are better coordinated thus resulting in both driver and pedestrian confidence and safety. An increase in confidence and safety translates to a reduction in fatal accidents.

## HCM 2016 References

### Exhibits

LOS	Density (pc/mi/in)	Exhibit 12-15 LOS Criteria for Basic Freeway and Multilane Highway Segments
A	≤11	
B	>11-18	
C	>18-26	
D	>26-35	
E	>35-45	
F	Demand exceeds capacity OR density > 45	

Average Lane Width (ft)	Reduction in FFS, $f_{LW}$ (mi/h)	Exhibit 12-20 Adjustment to FFS for Average Lane Width for Basic Freeway and Multilane Highway Segments
≥12	0.0	
≥11-12	1.9	
≥10-11	6.6	

Right-Side Lateral Clearance (ft)	Lanes in One Direction				Exhibit 12-21 Adjustment to FFS for Right- Side Lateral Clearance, $f_{RLC}$ (mi/h), for Basic Freeway Segments
	2	3	4	≥5	
≥6	0.0	0.0	0.0	0.0	
5	0.6	0.4	0.2	0.1	
4	1.2	0.8	0.4	0.2	
3	1.8	1.2	0.6	0.3	
2	2.4	1.6	0.8	0.4	
1	3.0	2.0	1.0	0.5	
0	3.6	2.4	1.2	0.6	

Note: Interpolate for noninteger values of right-side lateral clearance.

Exhibit 12-22 Adjustment to FFS for Lateral Clearances for Multilane Highways	Four-Lane Highways		Six-Lane Highways	
	TLC (ft)	Reduction in FFS, $f_{RLC}$ (mi/h)	TLC (ft)	Reduction in FFS, $f_{RLC}$ (mi/h)
	12	0.0	12	0.0
	10	0.4	10	0.4
	8	0.9	8	0.9
	6	1.3	6	1.3
	4	1.8	4	1.7
	2	3.6	2	2.8
	0	5.4	0	3.9

Note: Interpolation to the nearest 0.1 is recommended.

Exhibit 12-23 Adjustment to FFS for Median Type for Multilane Highways	Median Type	Reduction in FFS, $f_M$ (mi/h)
	Undivided	1.6
	TWLT	0.0
	Divided	0.0

Access Point Density (access points/mi)	Reduction in FFS, $f_A$ (mi/h)	Exhibit 12-24 Adjustment to FFS for Access Point Density for Multilane Highways
0	0.0	
10	2.5	
20	5.0	
30	7.5	
≥40	10.0	

Note: Interpolation to the nearest 0.1 is recommended.

Exhibit 12-8 LOS Criteria: Motorized Vehicle Mode	Control Delay (s/veh)	LOS by Volume-to-Capacity Ratio <sup>a</sup>	
		≤1.0	>1.0
	≤10	A	F
	>10-20	B	F
	>20-35	C	F
	>35-55	D	F
	>55-80	E	F
	>80	F	F

Note: <sup>a</sup> For approach-based and intersectionwide assessments, LOS is defined solely by control delay.

### Equations

$$FFS = BFFS - f_{LW} - f_{TLC} - f_M - f_A$$

Equation 12-3

$$f_{HV} = \frac{1}{1 + P_T(E_T - 1)}$$

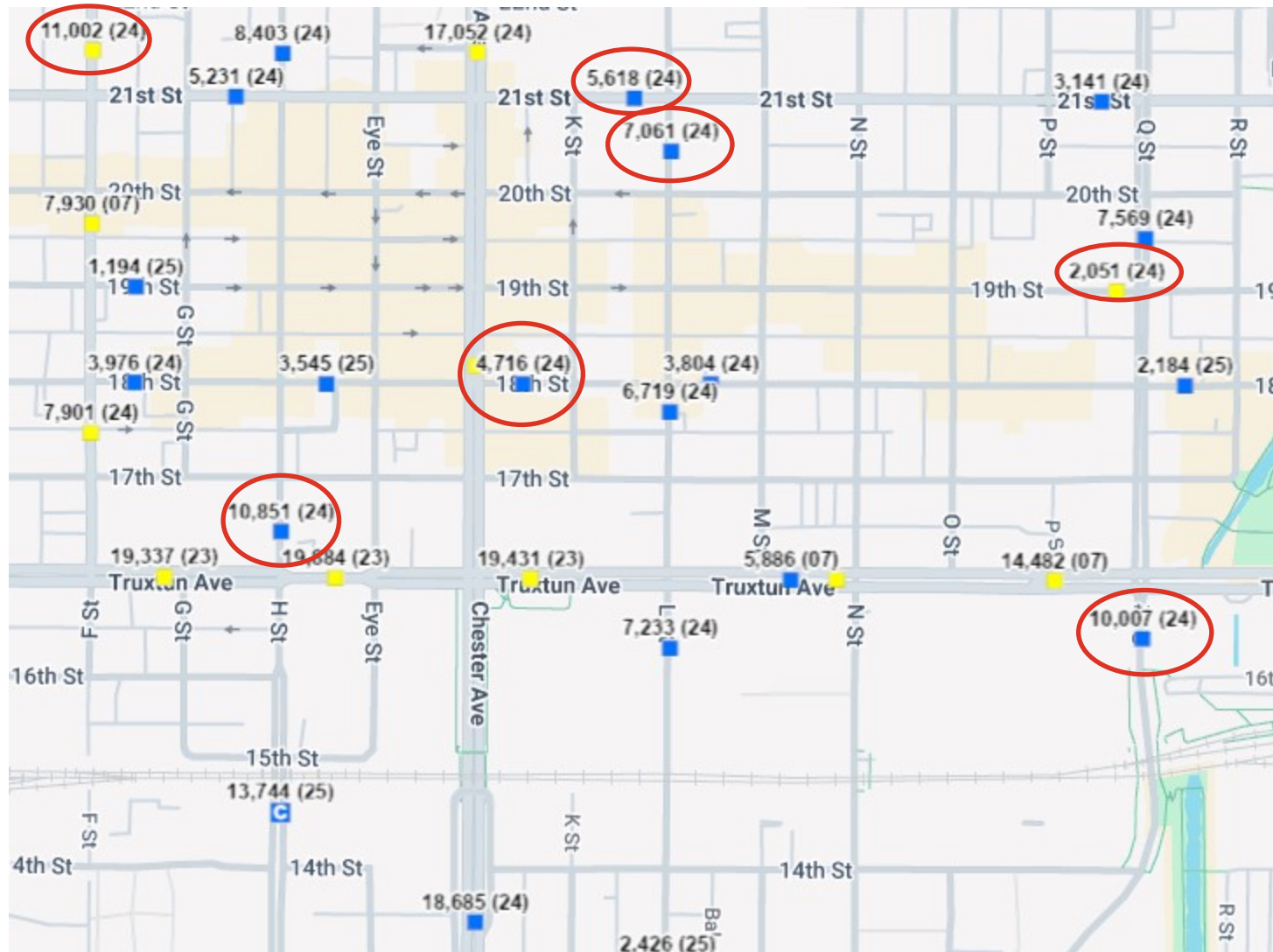
Equation 12-10

$$v_p = \frac{V}{PHF \times N \times f_{HV}}$$

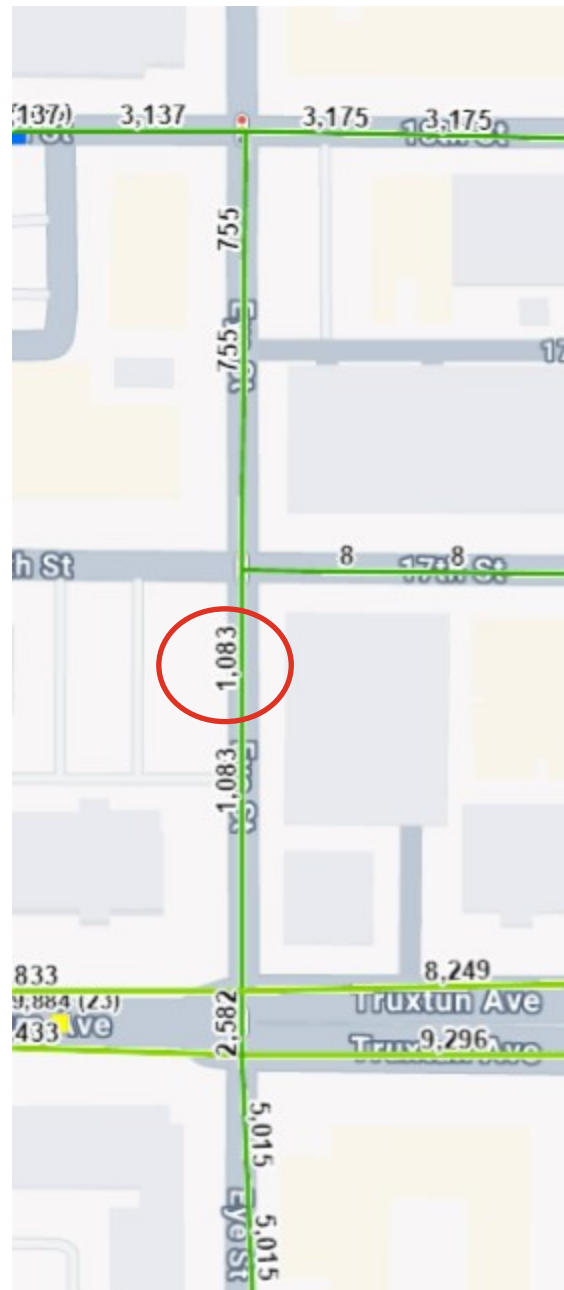
Equation 12-9

$$D = \frac{v_P}{S}$$

Equation 12-11









## **City of Bakersfield CMAQ 24-26 Adaptive Project Applications:**

**Downtown Grid: F St, H St, L St from Truxtun Ave to 21st St, Eye St from Truxtun Ave to 18th St, and Q St from 14th St to 21 St**

### **Background<sup>1</sup>:**

Adaptive traffic-signal control (ATSC) is a traffic management strategy in which traffic-signal timings change, or adapt, based on observed traffic demand. Although ATSC can improve mobility, it also has the potential to reduce crashes because mainline stops should be reduced. This paper aims to evaluate the safety effectiveness of ATSC using the empirical Bayes method. This analysis examines 47 urban or suburban intersections where ATSC was deployed in Virginia using 235 site-years of before data and 66 site-years of after data. Installing ATSC was found to produce a crash modification factor **(CMF) for total intersection crashes of 0.83** with a standard error of 0.05. This CMF was statistically significant at a 95 percent confidence level. Fatal and injury crashes did not change by a statistically significant amount, indicating that the primary safety benefit of ATSC was reduction in property damage crashes. Analyses of ATSC safety effects by crash type, by traffic volume level, and by operational improvement magnitude were also performed. All crash types were found to be reduced, but safety benefits varied from corridor to corridor and by volume levels. It was concluded that ATSC installation can potentially reduce total crashes at highway intersections and that public agencies should consider ATSC's safety and mobility benefits when justifying ATSC projects.

<sup>1</sup> **Estimation of Crash Modification Factors for an Adaptive Traffic-Signal Control System, Abstract**, Ma, Fontaine, et al., ASCE Library, Journal of Transportation Engineering, Volume 142, Issue 12, [https://ascelibrary.org/doi/abs/10.1061/\(ASCE\)TE.1943-5436.0000890](https://ascelibrary.org/doi/abs/10.1061/(ASCE)TE.1943-5436.0000890).

## Statewide Average Collision Rate<sup>1</sup> (Base Rate):

4/30/2025

**2023 BASIC AVERAGE CRASH RATE TABLE FOR HIGHWAYS**

GROUP	RATE	BASE RATE	+ ADT FACTOR	PCT FAT	PCT INJ	PCT F+I	HIGHWAY TYPE	TERRAIN OR ADT	DESIGN SPEED	AREA	CRASH COSTS (\$1,000)	
											F+I	ALL
H 01	1.09	0.00000	3.0	40.7	43.7	CONVENTIONAL 2 LANES OR LESS	FLAT	<=55	RURAL	1349.9	594.6	
H 02	0.78	0.00000	3.2	39.4	42.6	CONVENTIONAL 2 LANES OR LESS	FLAT	>55	RURAL	1446.7	621.1	
H 03	1.28	0.18800 /	2.3	43.6	45.9	CONVENTIONAL 2 LANES OR LESS	ROLL	<=55	RURAL	1072.2	496.7	
H 04	0.65	0.61300 /	3.8	40.3	44.1	CONVENTIONAL 2 LANES OR LESS	ROLL	>55	RURAL	1612.3	715.7	
H 05	1.89	0.20800 /	2.6	45.7	48.3	CONVENTIONAL 2 LANES OR LESS	MTN	<=55	RURAL	1127.9	549.1	
H 06	0.72	0.87400 /	3.1	40.8	43.9	CONVENTIONAL 2 LANES OR LESS	MTN	>55	RURAL	1379.3	610.2	
H 07	1.68	0.00000	0.9	37.7	38.6	CONVENTIONAL 2 LANES OR LESS		<45	SUBURBAN	638.2	253.0	
H 08	1.24	0.00000	1.7	43.2	44.9	CONVENTIONAL 2 LANES OR LESS		45-55	SUBURBAN	843.2	384.5	
H 09	0.65	0.02000 *	1.6	38.9	40.5	CONVENTIONAL 2 LANES OR LESS		>55	SUBURBAN	866.4	357.3	
H 10	1.07	0.00000	1.1	43.9	45.0	CONVENTIONAL 2 LANES OR LESS		<45	URBAN	659.6	302.0	
H 11	0.61	0.00000	1.5	47.2	48.7	CONVENTIONAL 2 LANES OR LESS		>=45	URBAN	750.4	370.3	
H 12	1.28	0.00000	3.2	39.2	42.4	CONVENTIONAL 3 LANES			RURAL	1452.0	620.5	
H 13	1.31	0.00000	2.4	39.7	42.1	CONVENTIONAL 3 LANES			SUBURBAN	1112.9	474.8	
H 14	1.61	0.00000	1.8	43.8	45.6	CONVENTIONAL 3 LANES			URBAN	874.4	403.9	
H 15	0.67	0.00000	2.0	36.7	38.7	EXPRESSWAY 3 LANES OR LESS	FLAT		RURAL	1095.7	429.2	
H 16	0.60	0.00000	3.2	35.2	38.4	EXPRESSWAY 3 LANES OR LESS	ROLL		RURAL	1569.8	608.0	
H 17	1.03	0.00000	2.8	41.2	44.0	EXPRESSWAY 3 LANES OR LESS	MTN		RURAL	1274.8	565.6	
H 18	0.94	0.00000	2.8	34.2	37.0	EXPRESSWAY 3 LANES OR LESS		<=55	SUBURBAN	1376.0	515.9	
H 19	1.16	0.00000	1.5	32.3	33.8	EXPRESSWAY 3 LANES OR LESS		>55	SUBURBAN	935.0	323.2	
H 20	0.44	0.00000	1.6	38.3	39.9	EXPRESSWAY 3 LANES OR LESS			URBAN	883.3	358.2	
H 21	1.29	0.00000	2.9	36.0	38.9	UNDIVIDED 4 LANES	FLAT		RURAL	1438.2	564.6	
H 22	0.84	0.00000	2.9	29.0	31.9	UNDIVIDED 4 LANES	ROLL/MTN		RURAL	1683.3	542.7	
H 23	0.96	0.00000	1.8	29.3	31.1	UNDIVIDED 4 LANES		<=55	SUBURBAN	1125.2	357.4	
H 24	1.40	0.00000	3.8	39.8	43.6	UNDIVIDED 4 LANES		>55	SUBURBAN	1537.8	676.6	
H 25	0.66	0.00000	1.3	35.1	36.4	UNDIVIDED 4 LANES		<45	URBAN	820.6	304.8	
H 26	0.77	0.00000	1.0	42.7	43.7	UNDIVIDED 4 LANES		>=45	URBAN	637.3	283.8	
H 27	1.11	0.00000	2.8	27.8	30.6	UNDIVIDED 5-6 LANES	FLAT		RURAL	1692.2	523.6	
H 28	1.11	0.00000	2.8	27.8	30.6	UNDIVIDED 5-6 LANES	ROLL/MTN		RURAL	1692.2	523.6	
H 29	0.47	0.00000	2.6	83.3	85.9	UNDIVIDED 5-6 LANES		<=55	SUBURBAN	736.2	633.9	
H 30	0.47	0.00000	2.6	83.3	85.9	UNDIVIDED 5-6 LANES		>55	SUBURBAN	736.2	633.9	
H 31	1.00	0.00000	1.0	20.0	21.0	UNDIVIDED 5-6 LANES		<45	URBAN	990.8	215.6	
H 32	0.31	0.00000	0.4	66.7	67.1	UNDIVIDED 5-6 LANES		>=45	URBAN	395.5	268.5	

<sup>1</sup>2023 Crash Data on California State Highways (road miles, travel, crashes/crash rates), Caltrans, <https://dot.ca.gov/-/media/dot-media/programs/research-innovation-system-information/documents/annual-collision-data/dor-guidance-2023-crash-data-on-cshwy-book.pdf>

## Local Collision Report(Downtown Grid, var. routes):

### CRASH DIAGRAM

Primary Street:  
Downtown Grid (F St, H St, Eye S)  
Secondary Street:

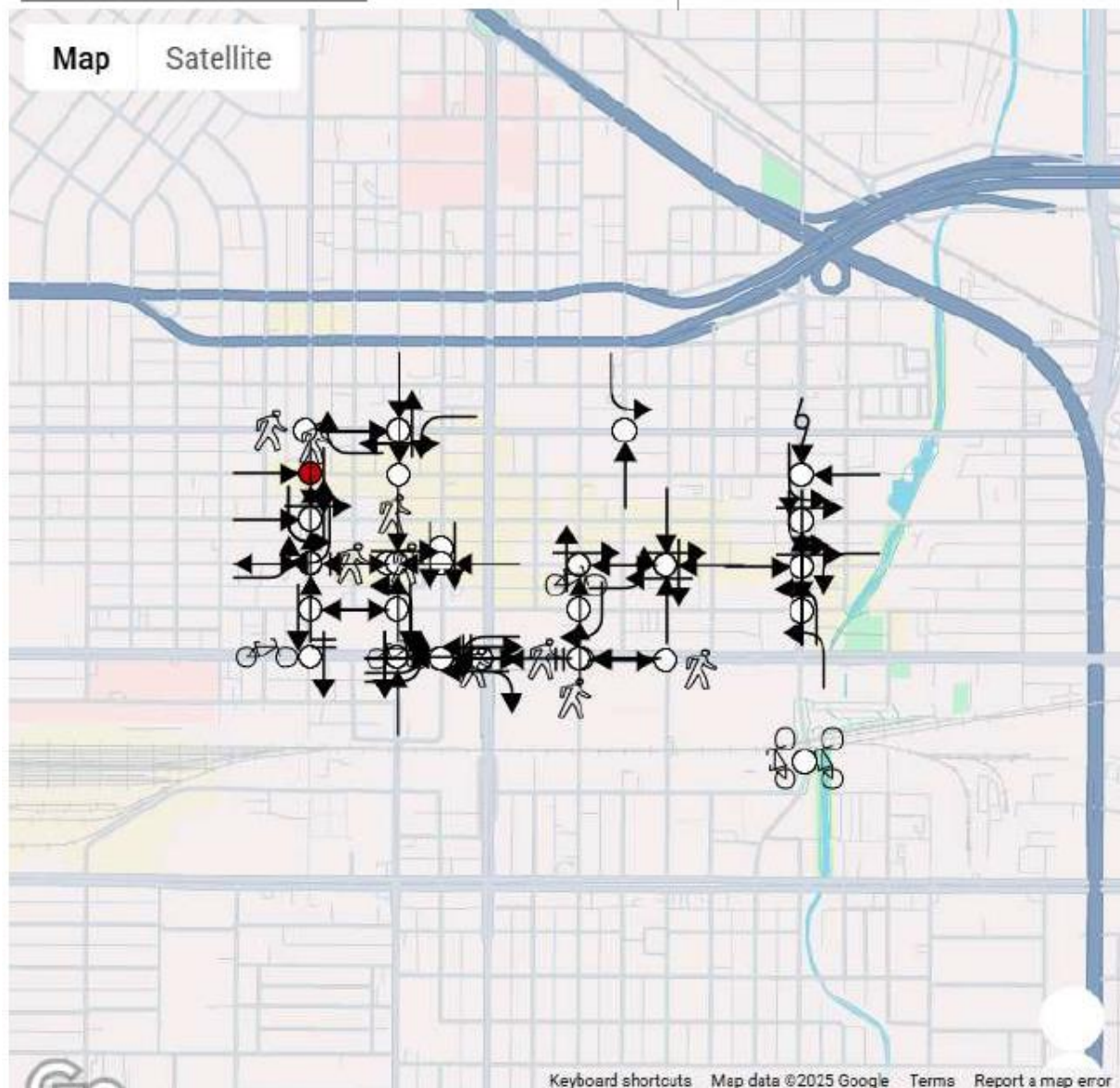
Time Period:  
01/01/2022 - 03/31/2025

Agency Name:  
City of Bakersfield

#### Mapping Summary:

Fatal Crash	1
Injury Crash	56
Mapped	57
Not Drawn	10
Total	67

- |                |                |
|----------------|----------------|
| → Straight     | 🚶 Pedestrian   |
| ↶ Left Turn    | 🚲 Bicycle      |
| ↷ Right Turn   | 📦 Object       |
| ↺ U-Turn       | ● Fatal Crash  |
| ↩ Overturned   | ○ Injury Crash |
| ↘ Ran Off Road |                |
| ⏸ Stopped      |                |
| 🅑🅓 Parked      |                |



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**Before-After Adaptive Signal Technology Implementation Collision-Rates Results:**

**(See Next Page)**

**Before-After Adaptive Traffic Signal Technology Collision Rate Analysis**

No.	Street Name Project Limits	2022-2025 Collisions	Killed	Injury	AADT	Length (mi)	Days per Year	Years of Data	Collision Rate Before <sup>1</sup>	Collision Rate After (CMF=0.83)	Stewide Collision Rate (2024)
1	California Ave Oak St to MLK Blvd	120	6	86	53245	2.01	365	3	1.02	0.85	1.61
2	Olive Dr Fronteir HS to Coffee Rd	31	4	22	19986	3.46	365	3	0.41	0.34	1.24
3	Union Ave/Memorial Medical Chester Ave to Union Ave, Union Ave to Espee/Monterey St	59	1	46	37362	1.4	365	3	1.03	0.85	1.68
4	Wilson Rd Edgemont St to Chester Ave	77	1	53	14498	2.95	365	3	1.64	1.36	1.68
5	Planz Rd Wilson Rd to Union Ave	58	0	44	10678	3.2	365	3	1.55	1.29	1.68
6	Downtown Grid (F St, H St, Eye St, L St, & Q St) F St, H St, Eye St, L St:Truxtun Ave to 21st St; Q St: 14th St to 21st St	67	1	56	53245	2.01	365	3	0.57	0.47	1.07
7	Southwest Adaptive Expansion Gosford Rd, White Ln to Target Entrance	67	3	53	73200	4.31	365	3	0.19	0.16	1.31

$$^1 \text{ Collision Rate} = \frac{\text{Number of Collisions X 1 Million}}{(\text{Segment Length}) (\text{AADT}) (\text{Years of Data}) (365 \text{ Days})}$$