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Appendix A1: Southern Gateway Study and System Analysis Study

In the mid-2000s, Santa Clara Valley Transportation Authority (VTA) studied travel in the northern San Benito County – southern Santa Clara County area with the purpose of identifying projects that would make travel through the region more efficient. To do this, VTA developed six conceptual roadway improvement alternatives and published the results in the *Southern Gateway Transportation and Land Use Study, Final Report* (SGS) in August 2006.

VTA's alternatives were the basis for the scenarios studied in the *System Analysis Study* (SAS). However, the SGS alternatives were modified for three main reasons:

1. Interchanges and alignments were relocated to meet Caltrans' spacing standards,
2. Roadway capacity (lanes) were reduced when model runs showed there was unnecessary, extra capacity, and
3. New programmed project information was included in the SAS.

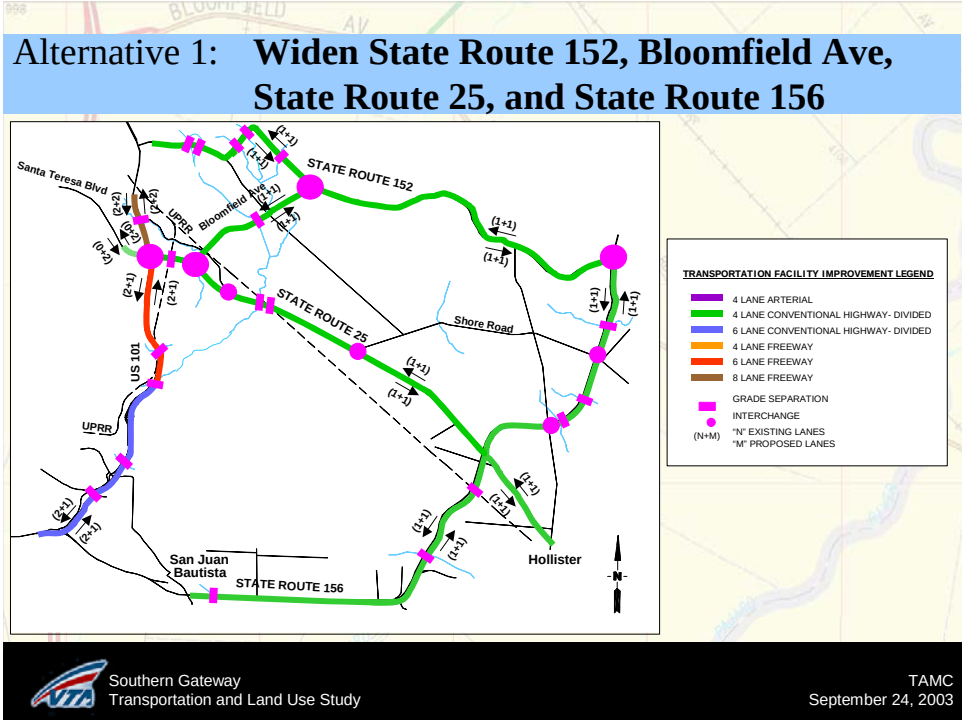
Further, the SAS did not study SGS Alternative 3 as explained below. Finally, the SAS included additional improvement scenarios that looked at truck-only lanes as well as a new scenario (Scenario 7 that only widens US 101 and SR 152).

In the following, each of the SGS alternatives is compared with the corresponding SAS scenario.

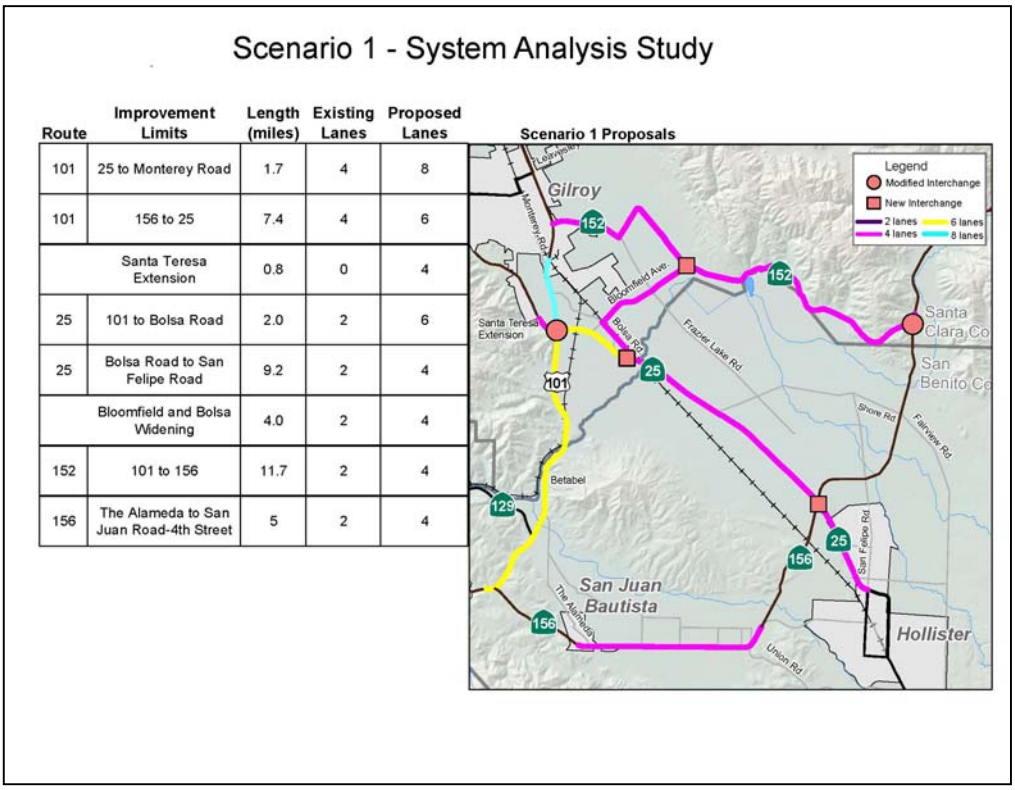
Note:
1. The SGS maps shown below use the term "conventional highway – divided." This facility type corresponds to Caltrans' expressway.
2. The maps shown below are from the August 2006 SGS report.

SGS Alternative 1 – SAS Scenario 1

SGS Alternative 1



SAS Scenario 1



Scenario 1 - System Analysis Study

Route	Improvement Limits	Length (miles)	Existing Lanes	Proposed Lanes
101	25 to Monterey Road	1.7	4	8
101	156 to 25	7.4	4	6
	Santa Teresa Extension	0.8	0	4
25	101 to Bolsa Road	2.0	2	6
25	Bolsa Road to San Felipe Road	9.2	2	4
	Bloomfield and Bolsa Widening	4.0	2	4
152	101 to 156	11.7	2	4
156	The Alameda to San Juan Road-4th Street	5	2	4

Scenario 1 Proposals

SGS Alternative 1 – SAS Scenario 1 Comparison

SGS Alternative 1 and SAS Scenario 1 both widen (portions of) all the state highways in the study area. However, the main differences are:

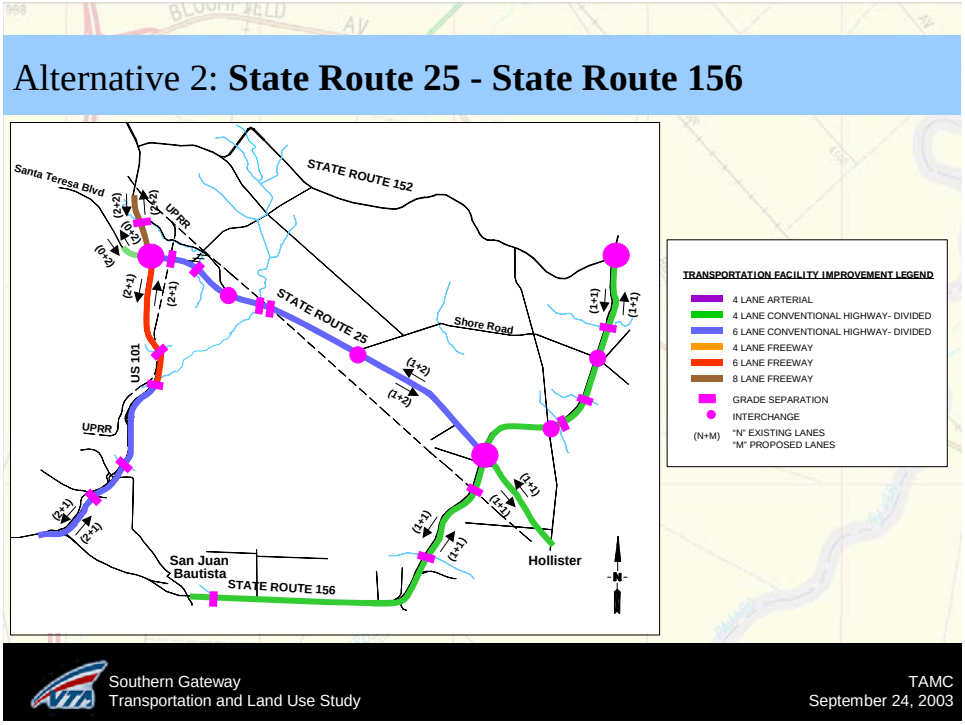
1. In contrast to SGS Alternative 1's widening of SR 156 to four lanes, SAS Scenario 1 does not widen SR 156 between San Juan/4th Street and SR 152. Preliminary model runs showed that widening this stretch to four lanes would lead to unused capacity when the other highways were widened. With the maximum volume-to-capacity ratio in the PM peak hour peak direction at 0.75, two lanes provide adequate service.
2. There are fewer interchanges in the SAS. Interchanges on SR 156 were removed where SR 156 was not widened, and interchanges on SR 25 correspond to the programmed SR 25 widening project. In particular, the SR 25 – Bloomfield Avenue interchange was removed because it did not meet interchange spacing standards.

SGS Alternative 1 – SAS Scenario 1 Comparison

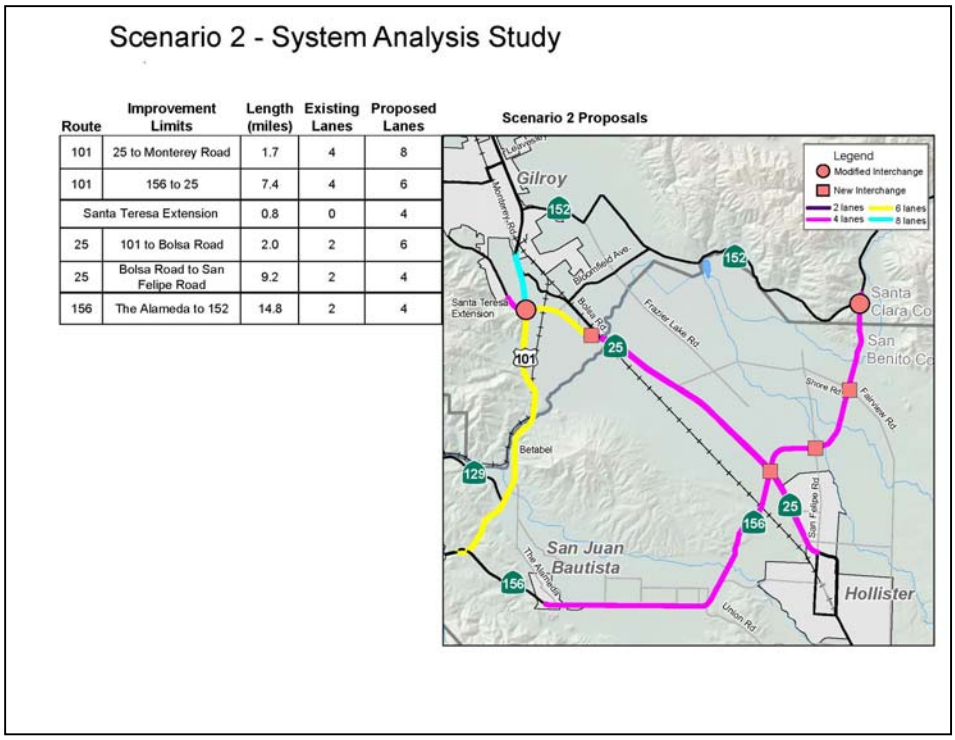
Location		SGS	SAS
Roadways			
101			
	SR 156 – San Benito/Santa Clara County line	6-lane expressway	6-lane freeway
	SR 25 – San Benito/Santa Clara County line	6-lane freeway	6-lane freeway
	SR 25 – Monterey Rd	8-lane freeway	8-lane freeway (2 HOV)
152			
	US 101 – SR 156	4-lane expressway	4-lane expressway
156			
	The Alameda – San Juan/4th St	4-lane expressway	4-lane expressway
	San Juan/4th St – SR 152	4-lane expressway	2-lane conventional
25			
	San Felipe/Bolsa "Y" – Bolsa Rd	4-lane expressway	4-lane expressway
	Bolsa Rd – US 101	4-lane expressway	6-lane expressway
Interchanges			
25			
	SR 156	None	Present
	Shore	Present	None
	Bolsa	Present	Present
	Bloomfield	Present	None
	US 101	Present	Present
152			
	Bloomfield	Present	Present
	SR 156	Present	Present
156			
	San Felipe	Present	None
	Shore-Fairview	Present	None

SGS Alternative 2 – SAS Scenario 2

SGS Alternative 2



SAS Scenario 2



Scenario 2 - System Analysis Study

Route	Improvement Limits	Length (miles)	Existing Lanes	Proposed Lanes
101	25 to Monterey Road	1.7	4	8
101	156 to 25	7.4	4	6
Santa Teresa Extension		0.8	0	4
25	101 to Bolsa Road	2.0	2	6
25	Bolsa Road to San Felipe Road	9.2	2	4
156	The Alameda to 152	14.8	2	4

Scenario 2 Proposals

SGS Alternative 2 – SAS Scenario 2 Comparison

SGS Alternative 2 and SAS Scenario 2 are fairly similar in their widening of SRs 156 and 25 and US 101. The main differences between SGS Alternative 2 and SAS Scenario 2 are:

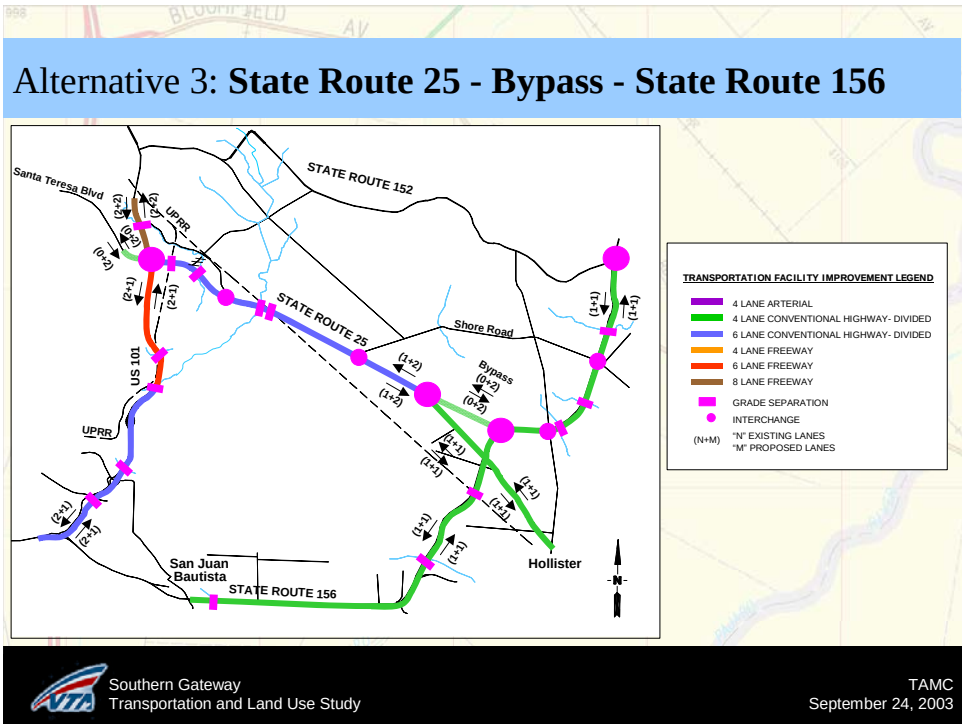
1. SR 25 between SR 156 and Bolsa Road is a 6-lane expressway in the SGS while it is only a 4-lane expressway in the SAS. The SAS corresponds to the programmed project.

2. The SGS includes an interchange at SR 25 and Shore Road, but the SAS does not in accordance with the programmed project.

SGS Alternative 2 – SAS Scenario 2 Comparison

Location		SGS	SAS
Roadways			
101			
	SR 156 – San Benito/Santa Clara County line	6-lane expressway	6-lane freeway
	SR 25 – San Benito/Santa Clara County line	6-lane freeway	6-lane freeway
	SR 25 – Monterey Rd	8-lane freeway	8-lane freeway (2 HOV)
152			
	US 101 – SR 156	2-lane conventional	2-lane conventional
156			
	The Alameda – SR 152	4-lane expressway	4-lane expressway
25			
	San Felipe/Bolsa "Y" – SR 156	4-lane expressway	4-lane expressway
	SR 156 – Bolsa Rd	6-lane expressway	4-lane expressway
	Bolsa Rd – US 101	6-lane expressway	6-lane expressway
Interchanges			
25			
	SR 156	Present	Present
	Shore	Present	None
	Bolsa	Present	Present
	US 101	Present	Present
152			
	SR 156	Present	Present
156			
	San Felipe	Present	Present
	Shore-Fairview	Present	Present

SGS Alternative 3



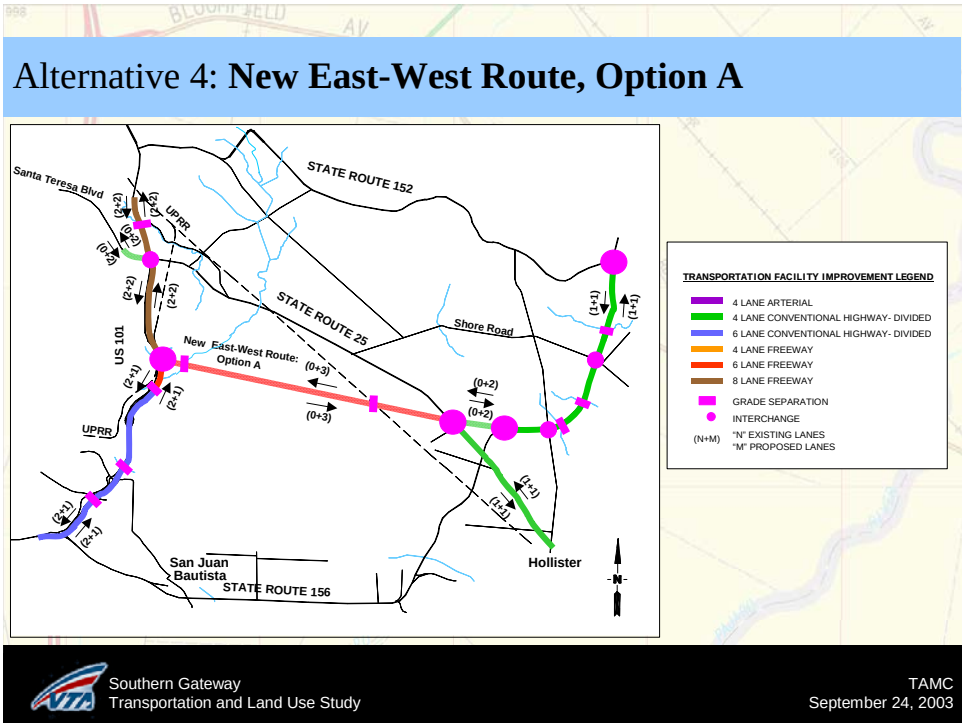
SGS Alternative 3 Comparison Comments

A variation on SGS Alternative 2, SGS Alternative 3 includes a new connection between SR 25 and SR 156. The new connection is north of SR 25 and extends SR 156 from about San Felipe Road west to SR 25.

The SAS study does not have a separate scenario that corresponds to SGS Alternative 3. The new interchange proposed in SGS Alternative 3 does not meet Caltrans' interchange spacing standards. Revisions to the alternative that met spacing standards resulted in scenarios that resembled closely other scenarios already being considered in the SAS. Therefore, the SAS did not include a separate scenario that matched SGS Alternative 3 exactly.

SGS Alternative 4 – SAS Scenario 4

SGS Alternative 4

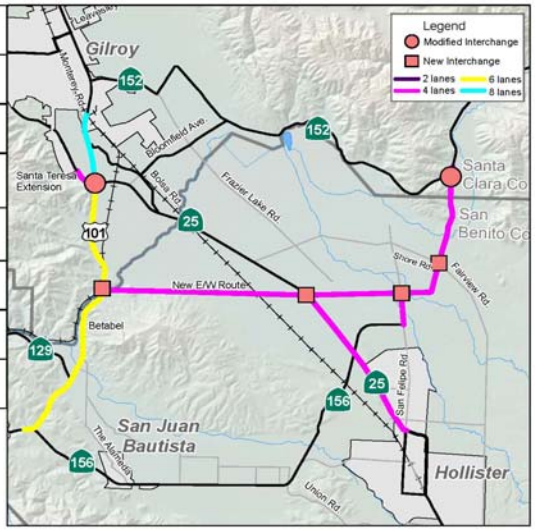


SAS Scenario 4

Scenario 4 - System Analysis Study

Route	Improvement Limits	Length (miles)	Existing Lanes	Proposed Lanes
101	25 to Monterey Road	4.6	4	8
101	156 to 25	4.5	4	6
Santa Teresa Extension		0.8	0	4
New E/W Route 101 to San Felipe Road		8.0	0	4
New E/W Route San Felipe Road east to 156		0.9	0	4
25	New E/W Route to San Felipe Road	4.6	2	4
156	New E/W Route to 152	3.3	2	4
San Felipe Road New E/W Route to 156		0.9	2	4

Scenario 4 Proposals



SGS Alternative 4 – SAS Scenario 4 Comparison

SGS Alternative 4 and SAS Scenario 4 are similar to each other but have these main differences:

1. The new East-West route is a 6-lane freeway in SGS Alternative 4 but is a 4-lane freeway in SAS Scenario 4. The four-lane freeway has a maximum volume-to-capacity ratio of only 0.35 in the PM peak hour peak direction, thus providing adequate capacity for the expected traffic flows.

2. US 101 is an 8-lane freeway north of the new East-West interchange in SGS Alternative 4. However, it is only a 6-lane freeway from the new East-West connection to SR 25 in SAS Scenario 4. The 6-lane freeway is consistent with Caltrans' route concept for this stretch of US 101 as well as the proposed widening project for this section of US 101.

3. In SAS Scenario 4, minor modifications were made to SGS Alternative 4 at the new East-West route, SR 156, and San Felipe intersections in order to meet Caltrans' spacing standards.

SGS Alternative 4 – SAS Scenario 4 Comparison

Location		SGS	SAS
Roadways			
101			
	SR 156 – New E-W Route	6-lane expressway	6-lane freeway
	New E-W Rte – SR 25	8-lane freeway	6-lane freeway
	SR 25 – Monterey Rd	8-lane freeway	8-lane freeway (2 HOV)
152			
	US 101 – SR 156	2-lane conventional	2-lane conventional
156			
	The Alameda – New E-W Rte (SAS: The Alameda – San Felipe)	2-lane conventional	2-lane conventional
	New E-W Rte – SR 152	4-lane expressway	4-lane expressway
25			
	San Felipe/Bolsa "Y" – New E-W Rt	4-lane expressway	4-lane expressway
	New E-W Rte – US 101	2-lane conventional	2-lane conventional
New East-West Route			
	US 101 – SR 25	6-lane freeway	4-lane freeway
	SR 25 – SR 156	4-lane expressway	4-lane freeway
Interchanges			
25			
	US 101	Present	Present
152			
	SR 156	Present	Present
156			
	San Felipe	Present	Present
	Fairview-Shore	Present	Present
New East-West Route			
	US 101	Present	Present
	SR 25	Present	Present
	SR 156	Present	Present

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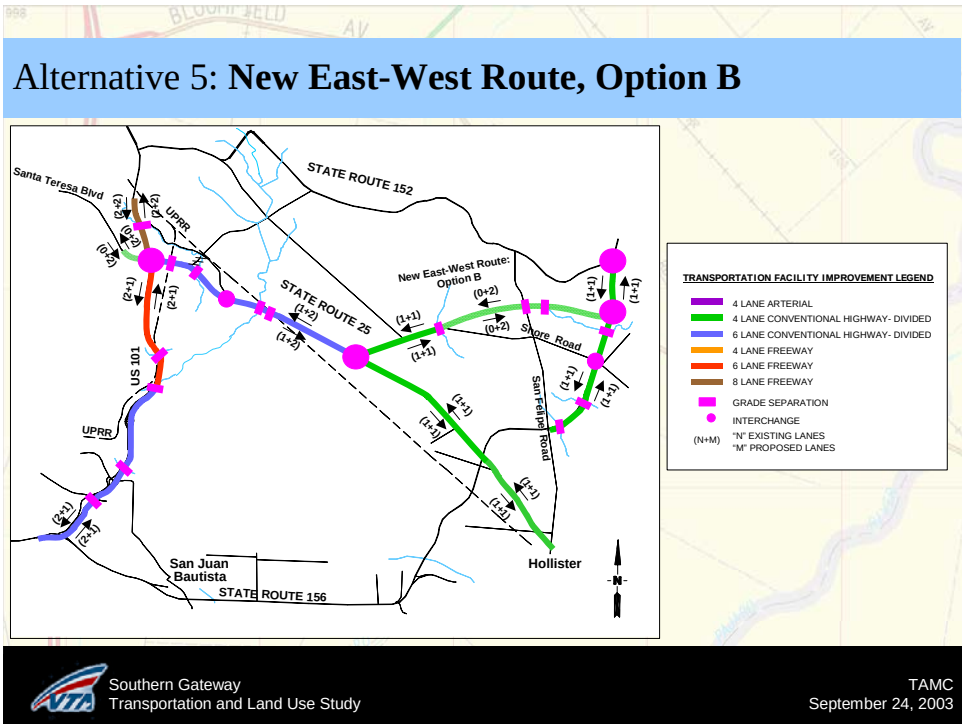
SGS Alternative 5 – SAS Scenario 5

SGS Alternative 5

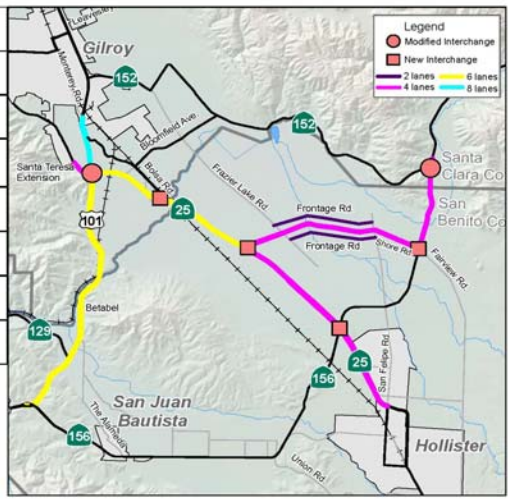


SAS Scenario 5

Scenario 5 - System Analysis Study

Route	Improvement Limits	Length (miles)	Existing Lanes	Proposed Lanes
101	25 to Monterey Road	1.7	4	8
101	156 to 25	7.4	4	6
Santa Teresa Extension		0.8	0	4
New E/W Route 25 to 156 via Shore Road		5.2	2	4
25	101 to Shore Road	4.9	2	6
25	Shore Road to San Felipe Road	6.3	2	4
New E/W Frontage Roads North and South		3.3-2.6	0	2
156	Fairview Road to 152	2.5	2	4

Scenario 5 Proposals



SGS Alternative 5 - SAS Scenario 5 Comparison

While both SGS Alternative 5 and SAS Scenario 5 meet SR 25 at Shore Road, they differ in how they connect with SR 156. SGS Alternative 5 proposes a new alignment that follows Shore Road but then veers north of Shore Road with a connection to SR 156 between Fairview Road and SR 152. However, this connection would not meet Caltrans' spacing standards. Therefore, in keeping with the spirit of SGS Alternative 5, SAS Scenario 5 examined an improvement along the existing Shore Road alignment.

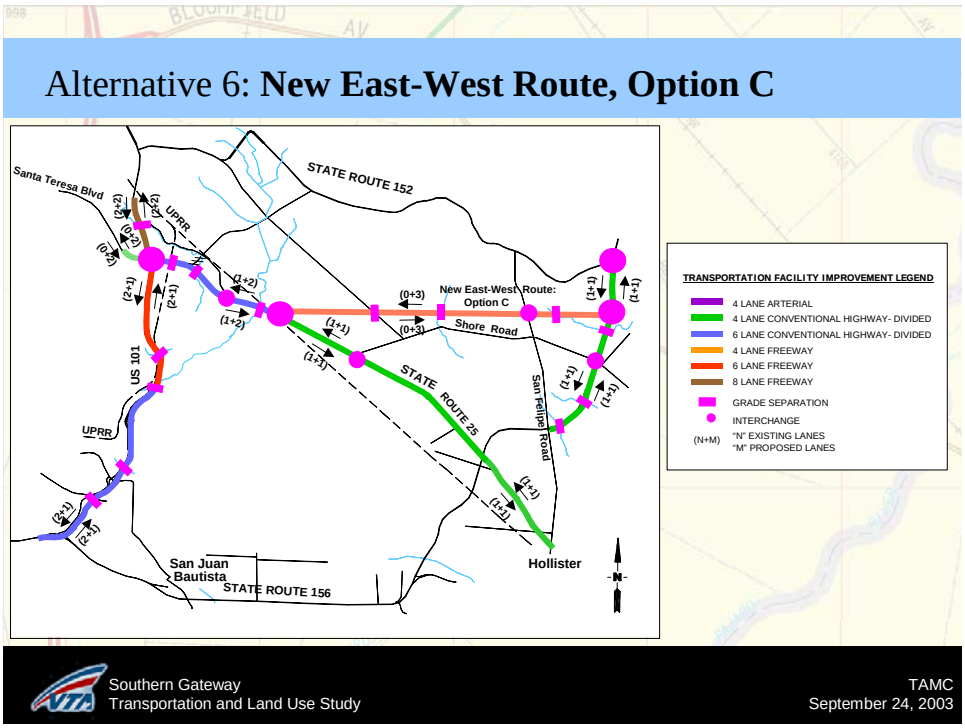
Other minor differences between the scenarios include slightly more widening of SR 156 in SGS Alternative 5 and an additional interchange at SR 25/SR 156 in SAS Scenario 5.

SGS Alternative 5 – SAS Scenario 5 Comparison

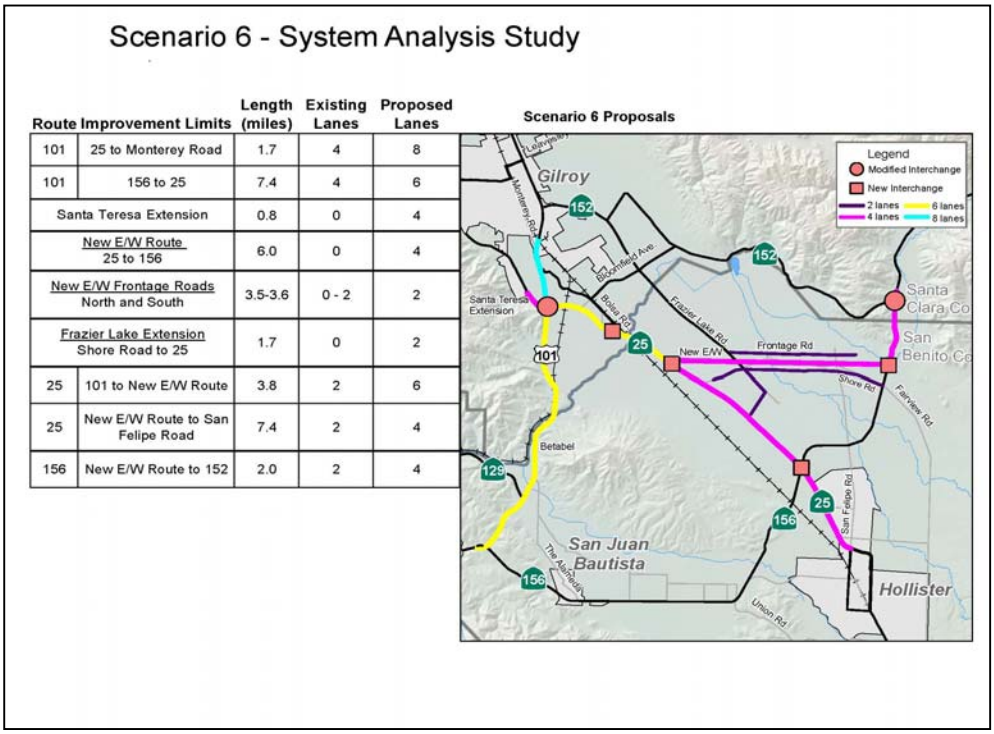
Location		SGS	SAS
Roadways			
101			
	SR 156 – San Benito/Santa Clara County Line	6-lane expressway	6-lane freeway
	San Benito/Santa Clara County Line – SR 25	6-lane freeway	6-lane freeway
	SR 25 – Monterey Rd	8-lane freeway	8-lane freeway
152			
	US 101 – SR 156	2-lane conventional	2-lane conventional
156			
	The Alameda – San Felipe	2-lane conventional	2-lane conventional
	San Felipe – Fairview-Shore	4-lane expressway	2-lane conventional
	Fairview-Shore – SR 152	4-lane expressway	4-lane expressway
25			
	San Felipe/Bolsa "Y" – Shore Rd	4-lane expressway	4-lane expressway
	Shore Rd – US 101	6-lane expressway	6-lane expressway
New East-West Route			
	SR 25 – SR 156	4-lane expressway	4-lane expressway
Interchanges			
25			
	SR 156	None	Present
	Bolsa Rd	Present	Present
	US 101	Present	Present
152			
	SR 156	Present	Present
156			
	Fairview-Shore	Present	Present
New East-West Route			
	SR 25	Present	Present
	SR 156	Present	N/A

SGS Alternative 6 – SAS Scenario 6

SGS Alternative 6



SAS Scenario 6



Scenario 6 - System Analysis Study

Route	Improvement Limits	Length (miles)	Existing Lanes	Proposed Lanes
101	25 to Monterey Road	1.7	4	8
101	156 to 25	7.4	4	6
Santa Teresa Extension		0.8	0	4
New E/W Route 25 to 156		6.0	0	4
New E/W Frontage Roads North and South		3.5-3.6	0 - 2	2
Frazier Lake Extension Shore Road to 25		1.7	0	2
25	101 to New E/W Route	3.8	2	6
25	New E/W Route to San Felipe Road	7.4	2	4
156	New E/W Route to 152	2.0	2	4

Scenario 6 Proposals

SGS Alternative 6 – SAS Scenario 6 Comparison

SGS Alternative 6 differs from SAS Scenario 6 mainly in the location of the new East-West route and in the new facility's size.

1. SGS Alternative 6 proposes an alignment north of Shore Road connecting with SR 156 about halfway between Fairview Road and SR 152. However, this connection would not meet Caltrans' interchange spacing standards. Therefore, SAS Scenario 6 connects the new East-West route with SR 156 about two miles south of the SR 152/ SR 156 interchange and then extends the new route directly west to meet SR 25. SAS Scenario 6 assumes a system of frontage roads, precluding the need for an interchange at San Felipe Road.

2. At four lanes, the new East-West route has adequate capacity, with a maximum volume-to-capacity ratio of about 0.25 in the peak direction in the PM peak hour. Therefore, SAS Scenario 6 assumes four lanes instead of the six lanes proposed in SGS Alternative 6.

SGS Alternative 6 – SAS Scenario 6 Comparison

Location		SGS	SAS
Roadways			
101			
	SR 156 – San Benito/Santa Clara County Line	6-lane expressway	6-lane freeway
	San Benito/Santa Clara County Line – SR 25	6-lane freeway	6-lane freeway
	SR 25 – Monterey Rd	8-lane freeway	8-lane freeway
152			
	US 101 – SR 156	2-lane conventional	2-lane conventional
156			
	The Alameda – San Felipe	2-lane conventional	2-lane conventional
	San Felipe – New E-W Rte	4-lane expressway	2-lane conventional
	New E-W Rte – SR 152	4-lane expressway	4-lane expressway
25			
	San Felipe/Bolsa "Y" – New E-W Rt	4-lane expressway	4-lane expressway
	New E-W Rte – US 101	6-lane expressway	6-lane expressway
New East-West Route			
	SR 25 – SR 156	6-lane freeway	4-lane freeway
Interchanges			
25			
	SR 156	None	Present
	Shore	Present	None
	Bolsa	Present	Present
	US 101	Present	Present
152			
	SR 156	Present	Present
156			
	Fairview-Shore	Present	None
New East-West Route			
	SR 25	Present	Present
	San Felipe Rd	Present	None
	SR 156	Present	Present

Appendix A2: Scenario Tables

US 101 NORTH CORRIDOR – SEGMENTS
(COCHRANE RD TO MONTEREY RD)

US 101 North Corridor – SEGMENTS											
					Proposed Transporta-tion Facility				Grade Separations		
Seg ment No.	Segment Description (Location) (IC = Interchange)	Post Mile (PM)	New Lanes (Each Direct ion)	Seg-ment Length (Miles)	Freeway	Expressway (Divided)	Arterial	Interchange (IC) Locations & Descriptions	Railroad Crossing Locations	Creek Crossing Locations	Roadway Over/undercross ing Locations
					Total Lanes						
1	**US 101 Widening** Cochrane Rd IC – Tennant Ave IC	SCl-101 PM R17.8 SCl-101 PM R15.1	1	2.7	8			**Cochrane Rd/US 101 IC** • Existing IC (PM R17.8) **Dunne Ave/US 101 IC** • Existing IC (PM R16.0) **Tennant Ave/US 101 IC** • Existing full diamond IC (PM R15.1) • Add partial clover-leaf (one loop EB to NB) • Widen existing bridge			East Main Ave OC (PM R16.8)
2	**US 101 Widening** Tennant Ave IC – Buena Vista Ave IC	SCl-101 PM R15.1 SCl-101 PM R9.1	1	6.0	8			**San Martin/US 101 IC** • Existing IC (PM R12.5) **Masten Ave/US 101 IC** • Existing IC (PM R10.3) **Buena Vista Ave/US 101 IC** • New full diamond IC (PM R9.1) • Existing overcrossing		Llagas Creek (PM R10.6)	Church Ave OC (PM R11.1) Middle Ave OC (PM R13.7)
3	**US 101 Widening** Buena Vista Ave IC – Monterey Rd	SCL-101 PM R9.1 SCl-101 PM R4.9	1	4.2	8			**Leavesley-152 W/US 101 IC** • Existing IC (PM R7.5) **152 E/US 101 IC** • Existing IC (PM R6.1) **Monterey Rd/US 101 IC** • Existing IC (PM R4.9)	S Gilroy OH (PM R5.1)	Llagas Creek (west branch)	Luchessa Ave OC (PM R5.3) 6th St/Gilman OC (PM R6.6)
4	**Butterfield Blvd Extension** Tennant Ave – Monterey/Watsonville Rd		2	0.8			4		Butterfield Extension (new roadway)		

Scenario 1: Widen US 101, State Route 152, Bloomfield Ave, State Route 25, and State Route 156 (Gap only)

Scenario 1 – SEGMENTS											
					Proposed Transporta-tion Facility				Grade Separations		
Seg ment No.	Segment Description (Location) (IC = Interchange)	Post Mile (PM)	New Lanes (Each Direc-tion)	Seg-ment Length (Miles)	Freeway	Expressway (Divided)	Arterial	Interchange (IC) Locations & Descriptions	Railroad Crossing Locations	Creek Crossing Locations	Roadway Over/undercross ing Locations
					Total Lanes						
1	**US 101 Widening** Monterey Rd – SR 25 IC	SCl-101 PM R4.9 SCl-101 PM 3.2	2	1.7	8					Carnadero Creek (PM 4.2)	
2	**US 101 Widening** SR 25 IC – SR 156 IC	SCl-101 PM 3.2 SBt-101 PM 3.0	1	7.4	6			**Betabel-Lomerias/US 101 IC** • Existing IC (PM 6.5) **SR 129/US 101 IC** • Existing IC (PM R4.9) **SR 156/US 101 IC** • Existing IC (PM 3.0)	Sargent OH (Tar Creek) (SCl-101 PM R0.8)	Tar Creek (Sargent OH) (SCl PM R0.8) Pajaro River (SBtPM 0.0/7.5) San Benito River (SBt PM 5.2) San Juan Creek (SBt PM 4.9)	Anzar Rd (SBt PM R4.3)
3	**SR 156 Widening** The Alameda – San Juan Rd/4th Street	SBt-156 PM 3.0 SBt-156 PM R8.0	1	5.0		4				San Juan Creek (PM 3.6)	
4	**SR 25 Widening** US 101/25 IC – Bolsa Rd/25 IC	SCl-25 PM 2.6 SCl-25 PM 0.6	2	2.0		6		**US 101/SR 25/Santa Teresa** • New diamond, cloverleaf IC **Bolsa Rd/25 IC** • New diamond IC	East of 101/25 (SCl PM 2.1)	Carnadero Creek (SCl PM 1.5)	
5	**SR 25 Widening** Bolsa Rd/25 IC – SR 156/25 IC	SCl-25 PM 0.6 SBt-25 PM 54.1	1	6.6		4		**SR 156/SR 25 IC** • New diamond IC	East of Pajaro River (SBt PM R59.9)	Pajaro River (SBt PM 60.1)	

Scenario 1 – SEGMENTS											
					Proposed Transporta-tion Facility				Grade Separations		
Seg Ment No.	Segment Description (Location) (IC = Interchange)	Post Mile (PM)	New Lanes (Each Direc-tion)	Seg-ment Length (Miles)	Freeway	Expressway (Divided)	Arterial	Interchange (IC) Locations & Descriptions	Railroad Crossing Locations	Creek Crossing Locations	Roadway Over/undercross ing Locations
					Total Lanes						
6	**SR 25 Widening** SR 156/25 IC – San Felipe Rd	SBt-25 PM 54.1 SBt-25 PM 51.5	1	2.6		4					
7	**Santa Teresa Blvd Extension**		2	0.8		4					
8	**Bloomfield Ave & Bolsa Rd Widening** SR 152/Bloomfield IC – Bloomfield/Bolsa IS – Bolsa Rd/SR 25 IC	SCl-152 PM 14.9 – SCl-25 PM 0.6	1	4.0			4		On Bloomfield Ave 0.4 mile NE of SR 25	Llagas Creek (1.4 miles SW of SR 152) Uvas Creek (0.4 Mile NE of SR 25)	
9	**SR 152 Widening** Near US 101 – Bloomfield Ave IC	SCl-152 PM 10.3 SCl-152 PM 14.9	1	4.6		4		**Bloomfield Ave IC/SR 152 IC** ▪ New trumpet IC		Miller Slough (PM 10.8) Llagas Creek (PM 11.2) Old Llagas Creek (PM 11.3) Dexter Creek (PM 12.3) Jones Creek (PM 12.6) San Ysidro Creek (PM 13.8)	
10	**SR 152 Widening** Bloomfield Ave IC – SR 156 IC	SCl-152 PM 14.9 SCl-152 PM R22.0	1	7.1		4		**SR 152/SR 152 IC** • Modify for 4 lanes ▪ No new structures		Ortega Creek (PM R19.3)	

Scenario 2: Widen US 101, State Route 25, & State Route 156

Scenario 2 – SEGMENTS											
					Proposed Transporta-tion Facility				Grade Separations		
Seg ment No.	Segment Description (Location) (IC = Interchange)	Post Mile (PM)	New Lanes (Each Direct ion)	Seg-ment Length (Miles)	Freeway	Expressway (Divided)	Arterial	Interchange (IC) Locations & Descriptions	Railroad Crossing Locations	Creek Crossing Locations	Roadway Over/undercross ing Locations
					Total Lanes						
1	**US 101 Widening** Monterey Rd – SR 25 IC	SCl-101 PM R4.9 SCl-101 PM 3.2	2	1.7	8					Carnadero Creek (PM 4.2)	
2	**US 101 Widening** SR 25 IC – SR 156 IC	SCl-101 PM 3.2 SBt-101 PM 3.0	1	7.4	6			**Betabel-Lomerias/US 101 IC** • Existing IC (PM 6.5) **SR 129/US 101 IC** • Existing IC (PM R4.9) **SR 156/US 101 IC** • Existing IC (PM 3.0)	Sargent OH (Tar Creek) (SCl-101 PM R0.8)	Tar Creek (Sargent OH) (SCl PM R0.8) Pajaro River (PM 0.0/7.5) San Benito River (SBt PM 5.2) San Juan Creek (SBt PM 4.9)	Anzar Rd (SBt PM R4.3)
3	**SR 156 Widening** The Alameda – SR 25	SBt-156 PM 3.0 SBt-156 PM R11.4	1	8.4		4			Hudner OH (PM R10.5)	San Juan Creek (PM 3.6) San Benito River (PM R8.5)	
4	**SR 156 Widening** SR 25 – SR 152/156 IC	SBt-156 PM R11.4 SCl-156 PM R0.6	1	6.4		4		**San Felipe Rd/156 IC** • New diamond IC SBt R13.2 **Fairview-Shore Rd/156 IC** • New diamond IC SBt R16.5 **SR 152/SR 156 IC** SCl 0.6 • Modify for 4 lanes • No new structures		Santa Ana Creek (SBt PM R13.4) Arroyos Dos Picachos (Tequisquito Slough) (SBt PM R15.4) Pacheco Creek (SBt PM R17.3)	Zanger Eqpt UC (SBt PM R17.7)

Scenario 2 – SEGMENTS											
					Proposed Transporta-tion Facility				Grade Separations		
Seg ment No.	Segment Description (Location) (IC = Interchange)	Post Mile (PM)	New Lanes (Each Direct ion)	Seg-ment Length (Miles)	Freeway	Expressway (Divided)	Arterial	Interchange (IC) Locations & Descriptions	Railroad Crossing Locations	Creek Crossing Locations	Roadway Over/undercross ing Locations
					Total Lanes						
5	**SR 25 Widening** US 101/25 IC – Bolsa Rd/25 IC	SCl-25 PM 2.6 SCl-25 PM 0.6	2	2.0		6		**US 101/SR 25/Santa Teresa** • New diamond, cloverleaf IC **Bolsa Rd/25 IC** • New diamond IC	East of 101/25 (SCl PM 2.1) East of Pajaro River (SBt PM R59.9)	Carnadero Creek (SCl PM 1.5) Pajaro River (SBt PM 60.1)	
6	**SR 25 Widening** Bolsa Rd/25 IC – San Felipe Rd	SCl-25 PM 0.6 SBt-25 PM 51.5	1	9.2		4		**SR 156/SR 25 IC** New diamond IC			
7	**Santa Teresa Blvd Extension**		2	0.8		4					

Scenario 4: New East-West Route with New US 101 Connection South of State Route 25

Scenario 4 – SEGMENTS											
					Proposed Transporta-tion Facility				Grade Separations		
Seg ment No.	Segment Description (Location) (IC = Interchange)	Post Mile (PM)	New Lanes (Each Direct ion)	Seg-ment Length (Miles)	Freeway	Expressway (Divided)	Arterial	Interchange (IC) Locations & Descriptions	Railroad Crossing Locations	Creek Crossing Locations	Roadway Over/undercross ing Locations
					Total Lanes						
1	**US 101 Widening** Monterey Rd – New E-W Route IC north of existing Betabel IC	SCl-101 PM R4.9 SBt-101 PM R7.6	1	4.6	6			**US 101/SR 25/Santa Teresa** • Existing IC • Modify to incl. Santa Teresa	Sargent OH (Tar Creek) (SCl PM R0.8)	Carnadero Creek (SCl PM 4.2) Tar Creek (Sargent OH) (SCl PM R0.8) Pajaro River (PM 0.0/7.5)	
2	**US 101 Widening** New E-W Route IC north of existing Betabel IC – SR 156 IC	SBt-101 PM R7.6 SBt-101 PM 3.0	1	4.5	6			**SR 129/US 101 IC** • Existing IC **SR 156/US 101 IC** • Existing IC		San Benito River (PM 5.2) San Juan Creek (PM 4.9)	Anzar Rd (PM R4.3)
3a	**New East-West Route** New US 101 IC (New E-W Route IC north of existing Betabel IC) – SR 25	SBt-101 PM R7.6 SBt-25 PM 56.1	2	5.5	4			**US 101/New E-W Route IC** • New trumpet IC **SR 25/New E-W Route IC** • New diamond IC	West of SR 25 IC (new)	Pajaro River (new)	
3b	**Betabel IC** Close down 101 ramps										
4	**New East-West Route** SR 25 – San Felipe Rd	SBt-25 PM 56.1 New PM (on San Felipe 0.9 miles north of San Felipe/SR 156 IS)	2	2.5	4			**San Felipe/New E-W Route** • New Diamond IC		Santa Ana Creek (new)	

Scenario 4 – SEGMENTS											
					Proposed Transporta-tion Facility				Grade Separations		
Seg ment No.	Segment Description (Location) (IC = Interchange)	Post Mile (PM)	New Lanes (Each Direc-tion)	Seg-ment Length (Miles)	Freeway	Expressway (Divided)	Arterial	Interchange (IC) Locations & Descriptions	Railroad Crossing Locations	Creek Crossing Locations	Roadway Over/undercross ing Locations
					Total Lanes						
5	**New East –West Route** San Felipe Rd – SR 156	PM on New E-W Rt at San Felipe Rd SBt-156 PM R15.7	2	0.9		4					
6	**SR 156 Widening** New E-W Rt connection – SR 152 IC	SBt-156 PM R15.7 SCl-156 PM R0.6	1	3.3		4		**Fairview-Shore/SR 156 IC** • New Diamond IC **SR 152/SR 156 IC** • Modify for 4 Lanes • No new structures		Pacheco Creek (SBt PM R 17.3)	Zanger Eqpt UC SBt PM R 17.7)
7	**SR 156 Relinquishment** PM R13.2- R15.7 and Cul-de-sac (R15.7)	SBt-156 PM R13.2 SBt-156 PM R15.7		1.3							
8	**San Felipe Road** Improvement (extension)	SR 156 (PM R13.2) to New East-West Route	1	0.9			4				
9	**SR 25 Widening** New E-W Route IC – San Felipe Rd	SBt-25 PM 51.5 SBt-25 PM 56.1	1	4.6		4					
10	**Santa Teresa Blvd Extension**		2	0.8		4					

Scenario 5: New East-West Route along Shore Road

Scenario 5 – SEGMENTS											
					Proposed Transporta-tion Facility				Grade Separations		
Seg ment No.	Segment Description (Location) (IC = Interchange)	Post Mile (PM)	New Lanes (Each Direct ion)	Seg-ment Length (Miles)	Freeway	Expressway (Divided)	Arterial	Interchange (IC) Locations & Descriptions	Railroad Crossing Locations	Creek Crossing Locations	Roadway Over/undercross ing Locations
					Total Lanes						
1	**US 101 Widening** Monterey Rd – SR 25 IC	SCl-101 PM R4.9 SCl-101 PM 3.2	2	1.7	8					Carnadero Creek (PM 4.2)	
2	**US 101 Widening** SR 25 IC – SR 156 IC	SCl-101 PM 3.2 SBt-101 PM 3.0	1	7.4	6			**Betabel-Lomerias/US 101 IC** • Existing IC (PM 6.5) **SR 129/US 101 IC** • Existing IC (PM R4.9) **SR 156/US 101 IC** • Existing IC (PM 3.0)	Sargent OH (Tar Creek) (SCl-101 PM R0.8)	Tar Creek (Sargent OH) (SCl PM R0.8) Pajaro River (PM 0.0/7.5) San Benito River (SBt PM 5.2) San Juan Creek (SBt PM 4.9)	Anzar Rd (SBt PM R4.3)
3	**SR 156 Widening** Fairview IC – SR 152/156 IC	SBt-156 PM R16.5 SCl-156 PM R0.6	1	2.5		4		**SR 152/SR 156 IC** • Modify for 4 lanes • No new structures		Pacheco Creek (SBt PM R17.3)	Zanger Eqpt UC (SBt PM R17.7)
4	**SR 25 Widening** US 101/25 IC – Shore Rd IC	SCl-25 PM 2.6 SBt-25 PM 57.8	2	4.9		6		**US 101/SR 25/Santa Teresa** • New diamond, cloverleaf IC **Bolsa Rd/25 IC** • New diamond IC	East of 101/25 (SCl PM 2.1) East of Pajaro River (SBt PM R59.9)	Carnadero Creek (SCl PM 1.5) Pajaro River (SBt PM 60.1)	
5	**SR 25 Widening** Shore Rd IC – SR 156 IC	SBt-25 PM 57.8 SBt-25 PM 54.1	1	3.7		4		**SR 156/SR 25 IC** • New diamond IC			

Scenario 5 – SEGMENTS											
					Proposed Transporta-tion Facility				Grade Separations		
Seg ment No.	Segment Description (Location) (IC = Interchange)	Post Mile (PM)	New Lanes (Each Direct ion)	Seg-ment Length (Miles)	Freeway	Expressway (Divided)	Arterial	Interchange (IC) Locations & Descriptions	Railroad Crossing Locations	Creek Crossing Locations	Roadway Over/undercross ing Locations
					Total Lanes						
6	**SR 25 Widening** SR 156 IC – San Felipe Rd	SBt-156 PM 54.1 SBt-156 PM 51.5	1	2.6		4					
7	**New East-West Route (Shore Rd Widening)** SR 25 – SR 156	SBt-25 PM 57.8 SBt-156 PM R16.5	1	5.2		4		**Shore Rd/SR 25 IC** • New diamond IC **Fairview-Shore/SR 156 IC** • New diamond IC			
7a	**New Frontage Road North of Shore Road**-close off Lake Rd and Lovers Lane; build new road connecting Frazier Lake, Lake Rd, Lovers Ln, and San Felipe Rd-Dunne Ln.		1	3.3			2				
7b	**New Frontage Road South of Shore Road**- close off Frye Ln; build new road connecting Frazier Lake, Frye Ln, and San Felipe Rd.		1	2.6			2				
8	**Santa Teresa Blvd Extension**		2	0.8		4					

Scenario 6: New East-West Route North of State Route 25

Scenario 6 – SEGMENTS											
					Proposed Transporta-tion Facility				Grade Separations		
Seg ment No.	Segment Description (Location) (IC = Interchange)	Post Mile (PM)	New Lanes (Each Direct ion)	Seg-ment Length (Miles)	Freeway	Expressway (Divided)	Arterial	Interchange (IC) Locations & Descriptions	Railroad Crossing Locations	Creek Crossing Locations	Roadway Over/undercross ing Locations
					Total Lanes						
1	**US 101 Widening** Monterey Rd – SR 25 IC	SCl-101 PM R4.9 SCl-101 PM 3.2	2	1.7	8					Carnadero Creek (PM 4.2)	
2	**US 101 Widening** SR 25 IC – SR 156 IC	SCl-101 PM 3.2 SBt-101 PM 3.0	1	7.4	6			**Betabel-Lomerias/US 101 IC** • Existing IC (PM 6.5) **SR 129/US 101 IC** • Existing IC (PM R4.9) **SR 156/US 101 IC** • Existing IC (PM 3.0)	Sargent OH (Tar Creek) (SCl-101 PM R0.8)	Tar Creek (Sargent OH) (SCl PM R0.8) Pajaro River (PM 0.0/7.5) San Benito River (SBt PM 5.2) San Juan Creek (SBt PM 4.9)	Anzar Rd (SBt PM R4.3)
3	**SR 156 Widening** New E-W Route IC – SR 152/156 IC	SBt-156 PM R17.0 SCl-156 PM R0.6	1	2.0		4		**SR 152/SR 156 IC** • Modify for 4 lanes • No new structures		Pacheco Creek (SBt PM R17.3)	Zanger Eqpt UC (SBt PM R17.7)
4	**SR 25 Widening** US 101/25 IC – New E-W Route IC	SCl-25 PM 2.6 SBt-25 PM 58.9	2	3.8		6		**US 101/SR 25/Santa Teresa** • New diamond, cloverleaf IC **Bolsa Rd/25 IC** • New diamond IC	East of 101/25 (SCl PM 2.1) East of Pajaro River (SBt PM R59.9)	Carnadero Creek (SCl PM 1.5) Pajaro River (SBt PM 60.1)	
5	**SR 25 Widening** New E-W Route IC – SR 156 IC	SBt-25 PM 58.9 SBt-25 PM 54.1	1	4.8		4		**SR 156/SR 25 IC** • New diamond IC			
6	**SR 25 Widening** SR 156 IC – San Felipe Rd	SBt-156 PM 54.1 SBt-156 PM 51.5	1	2.6		4					

Scenario 6 – SEGMENTS											
					Proposed Transporta-tion Facility				Grade Separations		
Seg ment No.	Segment Description (Location) (IC = Interchange)	Post Mile (PM)	New Lanes (Each Direct ion)	Seg-ment Length (Miles)	Freeway	Expressway (Divided)	Arterial	Interchange (IC) Locations & Descriptions	Railroad Crossing Locations	Creek Crossing Locations	Roadway Over/undercross ing Locations
					Total Lanes						
7	**New East-West Route** SR 25 – SR 156	SBt-25 PM 58.9 SBt-156 PM R17.0	3	6.0	4			**New E-W Route/SR 25 IC** • New diamond IC **New E-W Route/SR 156 IC** • New diamond IC		Santa Ana Creek	Frazier Lake Road (new) San Felipe Road (new)
8a	**New Frontage Roads – north side** Frazier Lake – East of San Felipe		1	3.5			2			Santa Ana Creek	
8b	**New Frontage Roads – south side utilizing Shore** Cul-de-sac Shore at 25 Realign-build new road between Frazier Lake and San Felipe		1	3.6			2				
9	**Frazier Lake** Extend Frazier Lake 1 mile southeast past Shore, then 0.7 mile southwest to new 25 frontage road		1	1.7			2				
10	**Santa Teresa Blvd Extension**		2	0.8		4					

APPENDIX B: COST ESTIMATES

Project Cost Estimates

Caltrans contracted with Kimley-Horn & Associates, Inc., in 2006/2007 to estimate costs for each of the main scenarios of the *System Analysis Study* (SAS). The costs were to be planning level estimates in 2006 dollars and would be used in the SAS' benefit-cost analysis to evaluate the relative advantages/disadvantages of each of the scenarios.

After conducting a field review with Caltans District 5 staff (D5 staff), Kimley-Horn & Associates, Inc. (K-H) identified major cost items and proposed the following methodology for cost estimation:

1. For State Routes (SR) 25 and 156, any scenario improvements would be based on Caltrans' estimates for its programmed projects.
2. Recent information from other major projects in the area such as the SR 25 Hollister Bypass would be incorporated into the cost estimates.
3. Costs and percentages used in the estimation process would otherwise be consistent with the most recent Caltrans guidelines.
4. Scenario costs would take into account roadway items, structure items, right of way items, contingency costs, and engineering, construction management, and administration costs.

Roadway items included costs for earthwork, pavement structural section, drainage, specialty items, traffic items, minor items, roadway mobilization items, and roadway additions. Structure items included bridge widening, new bridge, and bridge railing as well as railroad-related items. Right of Way items included acquisition, utility relocation, and clearance/demolition.

A list of scenario components (about 60 sub-projects in all) was developed from Scenarios 1, 2, 4, 4A, 5, and 6, and K-H provided cost estimates for most sub-projects. Providing component cost estimates allows D5 staff to vary the scenarios and develop variation cost estimates that are consistent with the main scenario costs. K-H provided cost information electronically and in a hard copy report. Details can be obtained by contacting D5 staff.

D5 staff augmented and amended the sub-project list in the following ways. For the US 101 North Corridor component of each scenario, Caltrans D5 staff escalated the Santa Clara Valley Transportation Authority's August 2006 *Southern Gateway Transportation and Land Use Study, Final Report* cost estimate to 2006 dollars. In addition, the new East-West Route in Scenario 6 was estimated based on average lane-mile costs for Scenario 4's new East-West Route, excluding interchanges. Finally, D5 staff re-

estimated sub-project costs for State Route 25 based on recent, actual project cost estimates from the Caltrans SR 25 project team that were obtained after K-H completed its estimates.

Scenario costs are summarized below.

SUMMARY ESTIMATE OF PROBABLE COSTS - SCENARIO 1
PLANNING LEVEL – INCLUDES CONSTRUCTION AND SUPPORT

ID No	Description	Length (miles)	Lanes	Est. of Cost M$
1	Widen US 101 to 8 lanes between Monterey Rd & SR 25	1.7	8	45.9
2	Widen US 101 to 6 lanes between SR 25 & SR 156	7.4	6	139.2
3A	Widen SR 156 to 4 lanes between The Alameda & San Juan Rd/4th St	5.0	4	88.3
7	Modify SR 152/156 IC to 4 lanes	na	na	7.0
8	Widen SR 25 to 6 lanes between US 101 and Bolsa Rd	2.0	6	110.7
9	Construct new diamond, cloverleaf IC at US 101/SR25/Santa Teresa	na	na	70.0
10	Construct new diamond IC at Bolsa Rd/SR 25	na	na	35.0
11	Widen SR 25 to 4 lanes between Bolsa Rd and SR 156	6.6	4	196.0
12	Construct new diamond IC at SR 156/SR 25	na	na	35.0
13	Widen SR 25 to 4 lanes between SR 156 and San Felipe Rd	2.6	4	74.4
14	Extend Santa Teresa Blvd	0.8	4	13.2
15	Widen Bloomfield Ave & Bolsa Rd to 4 lanes between SR 152 and SR 25	4.0	4	52.3
16	Widen SR 152 to 4 lanes between US 101 and Bloomfield Ave	4.6	4	81.6
17	Construct new partial diamond IC at Bloomfield Ave/SR 152	na	na	35.0
18	Widen SR 152 to 4 lanes between Bloomfield Ave and SR 156 IC	7.1	4	114.7
	Sub-total			$1,097.0
	Widen US 101 to 8 lanes (incl HOV) between Monterey Rd & Cochrane Rd	13.7	8	285.2
	Total			$1,382.2

SUMMARY ESTIMATE OF PROBABLE COSTS - SCENARIO 2
PLANNING LEVEL - INCLUDES CONSTRUCTION AND SUPPORT

ID No	Description	Length (miles)	Lanes	Est. of Cost M$
1	Widen US 101 to 8 lanes between Monterey Rd & SR 25	1.7	8	45.9
2	Widen US 101 to 6 lanes between SR 25 & SR 156	7.4	6	139.2
3	Widen SR 156 to 4 lanes between The Alameda and SR 25	8.4	4	148.4
4	Widen SR 156 to 4 lanes between SR 25 and SR 152	6.4	4	110.3
5	Construct new diamond IC at SR 156 and San Felipe Rd	na	na	25.0
6	Construct new diamond IC at SR 156 and Fairview-Shore Rd	na	na	25.0
7	Modify SR 152/156 IC to 4 lanes	na	na	7.0
8	Widen SR 25 to 6 lanes between US 101 and Bolsa Rd	2.0	6	110.7
9	Construct new diamond, cloverleaf IC at US 101/SR25/Santa Teresa	na	na	70.0
10	Construct new diamond IC at Bolsa Rd/SR 25	na	na	35.0
11	Widen SR 25 to 4 lanes between Bolsa Rd and SR 156	6.6	4	196.0
12	Construct new diamond IC at SR 156/SR 25	na	na	35.0
13	Widen SR 25 to 4 lanes between SR 156 and San Felipe Rd	2.6	4	74.4
14	Extend Santa Teresa Blvd	0.8	4	13.2
	Sub-total			$1,035.1
	Widen US 101 to 8 lanes (incl HOV) between Monterey Rd & Cochrane Rd	13.7	8	285.2
	Total			$1,320.3

SUMMARY ESTIMATE OF PROBABLE COSTS - SCENARIO 4
PLANNING LEVEL - INCLUDES CONSTRUCTION AND SUPPORT

ID No	Description	Length (miles)	Lanes	Est. of Cost M$
6	Construct new diamond IC at SR 156 and Fairview-Shore Rd	na	na	25.0
7	Modify SR 152/156 IC to 4 lanes	na	na	7.0
14	Extend Santa Teresa Blvd	0.8	4	13.2
22A	Widen US 101 to 6 lanes between Monterey Rd and new E-W Route	4.6	6	58.2
23	Modify US 101 and Santa Teresa IC	na	na	15.0
24	Widen US 101 to 6 lanes between new E-W Route and SR 156	4.5	6	81.0
25	Construct new 4 lane E-W Route between US 101 and SR 25	5.5	4	170.2
26	Construct new trumpet IC at US 101 and new E-W Route	na	na	60.0
27	Construct new diamond IC at SR 25 and new E-W Route	na	na	60.0
28	Demolish US 101 ramps at Betabel	na	na	0.5
29	Construct new 4 lane E-W Route between SR 25 and San Felipe Rd	2.5	4	79.1
30	Construct new diamond IC at new E-W Route and San Felipe Rd	na	na	35.0
31	Construct new 4 lane E-W Route from San Felipe Rd to SR 156	0.9	4	27.5
32	Widen SR 156 to 4 lanes between new E-W Route and SR 152	3.3	4	56.8
33	Relinquish SR 156 (PM 13.2 - PM R15.7) and construct new cul-de-sac	na	na	0.5
34	Widen San Felipe Rd to 4 lanes between new E-W Route and SR 156	0.9	4	11.1
35	Widen SR 25 to 4 lanes between new E-W Route and San Felipe Rd	4.6	4	131.6
	Sub-total			$831.7
	Widen US 101 to 8 lanes (incl HOV) between Monterey Rd & Cochrane Rd	13.7	8	285.2
	Total			$1,116.9

SUMMARY ESTIMATE OF PROBABLE COSTS - SCENARIO 5
PLANNING LEVEL - INCLUDES CONSTRUCTION AND SUPPORT

ID No	Description	Length (miles)	Lanes	Est. of Cost M$
1	Widen US 101 to 8 lanes between Monterey Rd & SR 25	1.7	8	45.9
2	Widen US 101 to 6 lanes between SR 25 & SR 156	7.4	6	139.2
6	Construct new diamond IC at SR 156 and Fairview-Shore Rd	na	na	25.0
7	Modify SR 152/156 IC to 4 lanes	na	na	7.0
9	Construct new diamond, cloverleaf IC at US 101/SR25/Santa Teresa	na	na	70.0
10	Construct new diamond IC at Bolsa Rd/SR 25	na	na	35.0
12	Construct new diamond IC at SR 156/SR 25	na	na	35.0
13	Widen SR 25 to 4 lanes between SR 156 and San Felipe Rd	2.6	4	74.4
14	Extend Santa Teresa Blvd	0.8	4	13.2
21	Construct new diamond IC at SR 25 and Shore Rd	na	na	35.0
45	Widen SR 156 to 4 lanes between Fairview Rd and SR 152	2.5	4	43.9
46	Widen SR 25 to 6 lanes between US 101 and Shore Rd	4.9	6	224.8
47	Widen SR 25 to 4 lanes between Shore Rd and SR 156	3.7	4	105.9
48	Widen Shore Rd to 4 lanes between SR 25 and SR 156	5.2	4	82.7
49	Construct new 2 lane frontage rd n/of Shore Rd between SR 25 & SR 156	2.6	2	19.3
50	Construct new 2 lane frontage rd s/of Shore Rd between SR 25 & SR 156	2	2	15.2
	Sub-total			$971.5
	Widen US 101 to 8 lanes (incl HOV) between Monterey Rd & Cochrane Rd	13.7	8	285.2
	Total			$1,256.7

SUMMARY ESTIMATE OF PROBABLE COSTS - SCENARIO 6
PLANNING LEVEL - INCLUDES CONSTRUCTION AND SUPPORT

ID No	Description	Length (miles)	Lanes	Est. of Cost M$
1	Widen US 101 to 8 lanes between Monterey Rd & SR 25	1.7	8	45.9
2	Widen US 101 to 6 lanes between SR 25 & SR 156	7.4	6	139.2
7	Modify SR 152/156 IC to 4 lanes	na	na	7.0
9	Construct new diamond, cloverleaf IC at US 101/SR25/Santa Teresa	na	na	70.0
10	Construct new diamond IC at Bolsa Rd/SR 25	na	na	35.0
12	Construct new diamond IC at SR 156/SR 25	na	na	35.0
13	Widen SR 25 to 4 lanes between SR 156 and San Felipe Rd	2.6	4	74.4
14	Extend Santa Teresa Blvd	0.8	4	13.2
51	Widen SR 156 to 4 lanes between new E-W Route and SR 152	2.0	4	35.9
52	Widen SR 25 to 6 lanes between US 101 and new E-W Route	3.8	6	184.2
53	Widen SR 25 to 4 lanes between new E-W Route and SR 156	4.8	4	137.3
54	Construct new 2 lane frontage rd n/of new E-W Route	3.5	2	21.6
55	Construct new frontage rd s/of new E-W Route	3.6	2	21.0
56	Extend Frazier Lake Rd 1 mile se/of Shore Rd, then 0.7 mile sw to SR 25	1.7	2	10.1
57	Construct new 4 lane E-W Route between SR 25 and SR 156	6	4	185.7
58	Construct new diamond IC at SR 25 and new E-W Route	na	na	60.0
59	Construct new diamond IC at SR 156 and new E-W Route	na	na	60.0
	Sub-total			$1,135.5
	Widen US 101 to 8 lanes (incl HOV) between Monterey Rd & Cochrane Rd	13.7	8	285.2
	Total			$1,420.7

Operating and Maintenance Costs

Improvements to a facility will change its operating and maintenance costs, and this effect should be captured in a benefit-cost analysis. Therefore, Caltrans District 5 staff (D5 staff) estimated the operating and maintenance (O&M) costs for the *System Analysis Study* (SAS) No Build Scenario as well as Scenarios 1, 2, 4, 5, and 6. The estimation process is described below.

Based on historic data from 2004-2006, D5 staff calculated the average annual cost per lane mile for US 101, SR 156, and SR 25 in the SAS study area. D5 staff also calculated the average preventive maintenance cost per lane mile and per bridge for a ten-year cycle typical for this type of maintenance activity. These average costs are shown in the table below.

Average O&M Costs

Location	Facility Type	Type of Cost	Cost
Ongoing Operating & Maintenance			
US 101	Freeway	Average annual cost per lane mile	$2,000
SR 25	2-lane conventional	Average annual cost per lane mile	$3,000
SR 156	2-lane conventional	Average annual cost per lane mile	$5,000
Preventive Maintenance			
	Roadway	10-year cost per lane mile	$200,000
	Bridge	10-year cost per bridge	$50,000

These costs were then used to calculate O&M costs for the SAS scenarios using the following guidelines.

Facility Type	Type of Cost	Cost
Ongoing Operating & Maintenance		
Freeway or expressway	Average annual cost per lane mile	$2,000
2-lane conventional except SR 156	Average annual cost per lane mile	$3,000
SR 156 2-lane conventional	Average annual cost per lane mile	$5,000
Preventive Maintenance		
Roadway	10-year cost per lane mile	$200,000
Bridge	10-year cost per bridge	$50,000

Rehabilitation costs were assumed to be zero in the analysis period. This corresponds to Caltrans District 5 experience.

Combining the above with the scenario facility characteristics yields the following O&M costs for the SAS scenarios. In the SAS benefit-cost analysis, improvement scenarios are compared relative to the No Build scenario, so the incremental O&M costs relative to the No Build O&M costs are also reported in the table below.

2030 O&M Costs for SAS Benefit-Cost Analysis

Scenario	Annual Average O&M Costs (rounded)	Incremental Annual Average O&M Costs
No Build Scenario	$4,995,000	
Scenario 1	$7,461,000	$2,466,000
Scenario 2	$5,858,000	$2,179,000
Scenario 4	$7,090,000	$2,095,000
Scenario 5	$7,609,000	$2,614,000
Scenario 6	$7,310,000	$2,315,000

The calculation spreadsheet used for the O&M costs reported above is available upon request from D5 staff.

APPENDIX C: BENEFIT-COST ANALYSIS

Caltrans District 5 in association with a technical advisory committee developed the *System Analysis Study of Routes 101, 152, and 156* (SAS). These focus routes form what is commonly known as the Southern Gateway Corridor, which provides major east-west service for the interregional movement of goods and people. These routes connect the Central Valley, I-5, and State Route (SR) 99 to Monterey, Santa Cruz, and Santa Clara Counties. The routes already operate at capacity during a portion of the day, and traffic is expected to increase due to continued growth in population, jobs, and housing in the study area.

To investigate how to move traffic more efficiently through the region, the SAS developed and analyzed five improvement scenarios. For each scenario, the SAS examined traffic congestion in the year 2030 using a modified April 2004 version of the Association of Monterey Bay Area Government (AMBAG)'s regional travel demand model.[1] The SAS also developed costs for implementing each scenario. Congestion and cost results are discussed and shown in the main text and in Appendix B.

Each scenario had its advantages and disadvantages. In order to compare the scenarios, the SAS included a benefit-cost analysis. A benefit-cost analysis provides a systematic, economic evaluation of the relative advantages (benefits) and disadvantages (costs) of a set of investment alternatives.[2] The benefits considered in the SAS were user benefits and included mobility benefits (e.g., reduced travel time), vehicle operating benefits, and safety benefits. Costs included capital, right-of-way, and support expenditures and operating and maintenance costs. The benefit-cost (B/C) analysis accounted for the various trade-offs of these benefits and costs within an alternative, e.g., improved travel time and safety but increased vehicle operating costs due to longer distances, as well as the trade-offs across alternatives (e.g., improved overall travel times but higher capital costs).

The SAS B/C analysis assumed that full funding would be available and that any scenario could begin construction in 2010 and be open by 2013. The AMBAG regional travel demand model future year is 2030, and the results were extrapolated to 2035 for the benefit-cost analysis. Improvement scenarios were compared with the No Build scenario to obtain the incremental benefits and costs and to obtain the benefit-cost ratio and net

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[1] AMBAG makes no warranty, express or implied, on the results or opinions derived from these data for any PROJECT study not conducted by AMBAG.

[2] From the Minnesota Department of Transportation, Office of Investment Management

present value. The difference in cost between the most expensive and a considered scenario was assumed to earn the normal rate of return (discount rate).

To conduct the B/C analysis, Caltrans District 5 (D5) staff contracted with System Metrics Group, Inc., and Bernardin, Lochmueller & Associates, Inc., to assist with the analysis and to provide B/C analysis tools. System Metrics Group, Inc., was instrumental in developing Caltrans Headquarters' B/C tool, Cal-B/C, and Bernardin, Lochmueller & Associates, Inc., developed the NET_BC tool used in the SAS B/C analysis.

This appendix is comprised of three sections that describe the B/C analysis tools and methods and assumptions used in the SAS:

1. Selection of the benefit-cost model
2. Description of B/C analysis and use of the NET_BC tool
3. Comparison of NET_BC with Cal-B/C.

C1: Selection of Benefit-Cost Model

There are a number of computerized benefit-cost models that were available for use in the SAS. Based on an analysis by System Metrics Group, Inc., the Bernardin, Lochmueller & Associates, Inc., tool NET_BC was chosen for the SAS. This tool could be easily interfaced with the AMBAG regional travel demand model and could thereby capture the interaction effects from the intricate roadway network in the study area. NET_BC also had sophisticated mechanisms for capturing travel time savings, multiple components of vehicle operating costs, and safety benefits. These are described in the next section.

The details of the model comparison and selection are described in the memo attached below.

System Metrics Group, Inc.
244 California Street, Suite 607
San Francisco, California 94111
Phone: (415) 395-7000 Fax: (415) 397-1000

November 29, 2006

To: Claudia Espino – Caltrans D5
Judy Lang – Caltrans D5
Jeff Berkman – Caltrans D5

From: Chris Williges

Subject: **Review of Benefit-Cost Models for the System Analysis Study of Routes 101, 156, and 152**

Caltrans District 5 in association with Districts 4 and 10, as well as other local and regional public agency partners are developing Phase II of the System Analysis Study of Routes 101, 152, and 156. These focus routes form what is commonly known as the Southern Gateway Corridor, which provides major east-west service for the interregional movement of goods and people. These routes connect the Central Valley, I-5, and State Route 99 (SR-99) to Monterey, Santa Cruz, and Santa Clara Counties. The routes already operate at capacity during a portion of the day, and traffic is expected to increase due to continued growth in population, jobs, and housing in the study area.

This technical memorandum provides the results of Task B-2, which includes our review of corridor alternatives as well as our review and selection of an appropriate benefit-cost model:

- We have examined available information and preliminary scenario runs for each corridor alternative, but the consulting team needs to continue working with District 5 and the Study Advisory Group to choose a final set of corridors to analyze.

- We have also considered appropriate benefit-cost models, including the Cal-B/C model developed by Caltrans Headquarters, and recommend that the Study Advisory Group

select a version of NET_BC modified to be consistent with Cal-B/C. NET_BC was developed by Bernardin, Lochmueller & Associates and can estimate the benefits of improving multiple highway facilities simultaneously and provide an automated platform for using the results of the modified Association of Monterey Bay Area Governments (AMBAG) planning model developed in Phase I of the study. We will also run Cal-B/C for each final scenario to ensure that NET_BC is appropriately calibrated.

The rest of this technical memorandum provides our detailed findings.

Corridor Alternatives

The consulting team has been working with Caltrans District 5 and the Study Advisory Group to select corridor alternatives for analysis. District 5 staff is currently refining the alternatives. However, the study group is considering the following ten scenarios for benefit-cost analysis:

- *No Build* – existing configuration
- *Scenario 1* – widen State Route 152, Bloomfield and Bolsa Avenues, State Route 25, and State Route 156 to four lanes each
- *Scenario 2* – widen State Route 25 to a six-lane expressway between US 101 and Bolsa Avenue and to four-lane expressway between Bolsa Avenue and San Felipe, and widen State Route 156 to a four-lane expressway
- *Scenario 2A* – similar to Scenario 2, except that State Route 25 is a freeway rather than an expressway
- *Scenario 4* – construct a new east-west route (Option A) as a four-lane freeway connecting State Routes 25 and 156
- *Scenario 4A* – similar to Scenario 4, but the new route is a two-lane "freeway" for trucks only
- *Scenario 5* – widen Shore Road (Option B) to a four-lane expressway, widen State Route 156 to a four-lane expressway between Shore and State Route 152, and widen State Route 25 to variously a six-lane and four-lane expressway

- *Scenario 6* – construct a new east-west, four-lane freeway (Option C) just north of Shore Road

- *Scenario 6A* – similar to Scenario 6, but the route is a two-lane, truck only "freeway"

- *Scenario 7* – widen State Route 152 to a six-lane expressway.

District 5 has produced maps and initial model runs for each of these scenarios. Unless directed otherwise by Caltrans and the Study Advisory Group, the consulting team will assume that these are the alternatives to consider in the benefit-cost analysis. We expect District 5 to provide an updated overview of alternatives, once the scenarios are finalized, to assist in cost estimation.

Overview of Benefit-Cost Analysis

The purpose of a benefit-cost model in transportation analysis is to provide an organized way of comparing the life-cycle costs of a project to the life-cycle benefits that result from the project. Typically, benefit-cost analysis focuses on agency costs and user benefits, which are the benefits that accrue to the traveling public. Models may also consider disbenefits (negative impacts) as well as impacts on society at large. Although benefit-cost analysis can be conducted without the use of a computer model, benefit-cost models have become much more common since the advent of personal computers. A computer model becomes particularly useful when multiple scenarios are being considered, as in the System Analysis Study.

Transportation benefit-cost models typically consider three primary user benefits:

- *Travel time savings*, which are defined as the difference in travel times before and after the project

- *Vehicle operating cost reductions*, which include fuel consumption, break wear, tire wear, and vehicle depreciation

- *Safety improvements*, which reflect reductions in the number or severity of accidents after the project is built.

Some models also include other societal impacts, such as air quality or noise.

Our Assessment Criteria

As a result of conversations with District 5 staff, we developed the following criteria for considering the appropriateness of benefit-cost models in the System Analysis Study:

- *The model needs to follow a methodology consistent with Cal-B/C.* Caltrans Headquarters uses this model to assess State Transportation Improvement Program (STIP) projects. It is also currently being used to assess projects for the Corridor Mobility Improvement Account (CMIA). The model includes values appropriate for California, such as the California Air Resources Board's EMFAC emissions factors.

- *The model needs to consider congestion and travel during the peak period rather than rely only on all-day figures.* Travel can vary considerably across the day. The traffic counts collected in Phase I of the study illustrate that even the definition of the peak period varies considerably across the study area.

- *The model needs to consider network effects.* The study area includes an intricate network of routes used by local and through travelers. The proposed scenarios may impact some parts of the network disproportionately. These impacts cannot be captured simply by taking the network average.

- *The model needs to support the analysis of road additions.* Some of the proposed scenarios include the construction of new routes, such as the East-West connector.

- *The model needs to be adapted quickly for the System Analysis Study.* We have a number of scenarios to consider and each one will require detailed model runs and cost estimation.

Cal-B/C

Our contract asked us to consider the Caltrans Headquarters (HQ) Cal-B/C model. The model was developed to allow HQ to conduct over 100 benefit-cost evaluations in a short time for the STIP. The model has also been updated to handle many of the projects included in the State Highway Operations and Protection Program (SHOPP). It is currently being used to assess projects in consideration for the CMIA due to the recent passage of Proposition 1B.

An advantage of the model is that it is accepted statewide and by the California Transportation Commission (CTC). A disadvantage is that, while the model is flexible, it is corridor-based and may not be able to handle the complexity of traffic patterns in the

Southern Gateway Corridor. We could take the summary scenario results from each AMBAG model run and aggregate them to a single set of system-level data as shown in the exhibit below. However, this would not allow us to examine the user impacts on specific routes.

Cal-B/C Traffic Input Data from Regional Models

2A

HIGHWAY SPEED AND VOLUME INPUTS

	Calculated by Model	Changed by User	Used for Proj. Eval.	Reason for Change
Without Project				
Year 1				
Peak Period				
HOV Volume	0		0	
Non-HOV Volume	0		0	
Weaving Volume	0		0	
Truck Volume	0		0	
HOV Speed	55.0		55.0	
Non-HOV Speed	55.0		55.0	
Weaving Speed	55.0		55.0	
Truck Speed	55.0		55.0	
Non-Peak Period				
Non-HOV Volume	0		0	
Weaving Volume	0		0	
Truck Volume	0		0	
Non-HOV Speed	55.0		55.0	
Weaving Speed	55.0		55.0	
Truck Speed	55.0		55.0	
Year 20				
Peak Period				
HOV Volume	0		0	
Non-HOV Volume	0		0	
Weaving Volume	0		0	
Truck Volume	0		0	
HOV Speed	55.0		55.0	
Non-HOV Speed	55.0		55.0	
Weaving Speed	55.0		55.0	
Truck Speed	55.0		55.0	
Non-Peak Period				
Non-HOV Volume	0		0	
Weaving Volume	0		0	
Truck Volume	0		0	
Non-HOV Speed	55.0		55.0	
Weaving Speed	55.0		55.0	
Truck Speed	55.0		55.0	

It would also miscalculate some of the user benefits. Fuel consumption and emissions are U-shaped functions of speed. Both are at their maximum values at low and high speeds, while the lowest fuel consumption and emissions occur around 45 miles per hour (MPH). If we were to analyze a scenario that resulted in travel at free-flow on US 101 and 30 MPH on other routes, the fuel consumption and emissions rates would be high. However, averaging the speeds for the whole Southern Gateway Area may result in an average speed near 45 MPH, which has low fuel consumption and emissions. A network-level model would provide better estimates of the user benefits. The next few pages briefly describe Cal-B/C.

The model is an Excel spreadsheet that provides economic benefit and cost analysis for a range of capacity-expansion transportation projects. An advantage of this design is that the calculations and results are transparent to the user and intuitive to show

stakeholders. The model measures, in real-dollar terms, four primary categories of benefits that result from highway and transit projects:

- Travel time savings
- Vehicle operating cost savings
- Safety benefits (accident cost savings)
- Emission reductions.

Each benefit is estimated for a peak (or congested) period and an off-peak (or un-congested period). The distinction is intended to capture the difference in benefits during congested and free-flow conditions on the highway. It is understood that some travel demand models have set peak periods that do not necessarily correspond to the congested period on the highway. Cal-B/C can accept these data in lieu of congested period data.

Cal-B/C requires relatively few user inputs. Cells in the spreadsheets are color-coded. Green cells represent required data (i.e., users must input values in order for the model to work). Red cells provide default values, such as average vehicle occupancy, that users can change if needed. Blue cells reflect data items calculated by the model, but can be changed if more detailed data are available. Blue cells contain values that are likely to change from the base case.

Green Cells

- Type of project
- Project location (urban Southern California, urban Northern California, and rural California)
- Length of construction period
- Highway design
  - Number of general traffic and High Occupancy Vehicle (HOV) lanes
  - Free-flow speed
  - Segment length
- Average daily traffic (ADT) for current and forecast years
- Average hourly HOV traffic (HOV projects only)
- Truck speed (truck lane or passing lane projects only)
- Highway safety data (3-year statistics for facility and statewide average)
  - Fatal accidents
  - Injury accidents
  - Property damage only (PDO) accidents
- Project costs

- Support (e.g., engineering design and management costs)
- Right-of-way acquisition
- Construction
- Maintenance and operating
- Rehabilitation (e.g., pavement overlay)
- Mitigation
- Other

Red Cells

- Length of peak period
- Percent trucks (including recreational vehicles)
- Average vehicle occupancy (AVO) for peak, non-peak, and HOV lanes

Blue Cells

- Length of segment affected by project
- ADT for base (project opening) year

The *Model Inputs* page contains information about the highway speed, volume, and accident data used in the calculation of benefits. This sheet allows users to check the highway data estimated by the model from the project information sheet and override the calculated values with project-specific information, if such information is available. The model calculates speeds using speed/volume relationships found in the 2000 Highway Capacity Manual. Users can use peak and non-peak volumes and speeds from a regional demand model in lieu of corridor-specific data in this space.

Exhibit II-1 provides an example of the results produced by Cal-B/C. Several final investment measures and itemized first-year benefits are presented:

- Life-cycle costs (in millions of dollars)
- Life-cycle benefits (in millions of dollars)
- Net present value (in millions of dollars)
- Benefit/cost ratio (benefits divided by costs)
- Rate of return on investment (in percent return per year)
- Project payback period (in years).

Exhibit II-1
Cal-B/C Results Sheet

3

INVESTMENT ANALYSIS
SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$4.0
Life-Cycle Benefits (mil. $)	$8.1
Net Present Value (mil. $)	$4.1
Benefit / Cost Ratio:	2.0
Rate of Return on Investment:	15.8%
Payback Period:	7 years

ITEMIZED BENEFITS (mil. $)	1st Year	20 Years
Travel Time Savings	$0.5	$7.1
Veh. Op. Cost Savings	$0.0	$0.7
Accident Reductions	$0.0	$0.2
Emission Reductions	$0.0	$0.1
TOTAL BENEFITS	$0.6	$8.1

The Results Sheet allows users to include the effects of induced travel and vehicle emissions. Cal-B/C calculates induced travel benefits using consumer surplus theory.

In Task B-3, we will start to assemble the inputs and assumptions needed for the benefit-cost analysis, but the parameters in Cal-B/C are a good starting point. Users can override default parameters to produce tailored results if more detailed information is available for specific projects. The model requires inputs on only three worksheets, but more experienced users can access the parameters and detailed calculation sheets to change default values as needed for analyses.

The last sheet in Cal-B/C (*Parameters*) contains all the economic values and rate tables used by the model. Adjusting the economic update factor using the Gross Domestic Product (GDP) deflator changes the economic values contained in the model. Values in this sheet include the following unit costs:

- General economic values
  - Year of current dollars for model
  - Economic update factor (using the GDP deflator)
  - Real discount rate
- Highway operations measures
  - Maximum volume-capacity (v/c) ratio
  - Percent ADT in average peak hour
  - Capacity per lane (general)
  - Capacity per HOV lane
- Travel time values
  - Average hourly wage (for the Transportation and Utilities industry and all industries statewide)
  - Automobile, truck, and transit

- User operating costs
  - Fuel cost per gallon
  - Non-fuel cost per mile (automobile and truck)
- Highway accident costs
  - Cost of a fatality
  - Cost of an injury (Level A Severe, Level B Moderate, Level C Minor)
  - Cost of a highway accident (fatal, injury, and PDO)
  - Statewide highway accident rates (fatal, injury, and PDO)
- Fuel consumption rates (gallons per vehicle-mile for automobiles and trucks)
- Passing lane accident reduction factors
- Highway emissions rates
  - CO, NO_X, PM_{10}, and VOC
  - Automobile, truck, and bus
- Emissions costs
  - Urban Southern California, urban Northern California, and rural California
  - Automobile, truck, and bus.

Other Models

A number of other computerized benefit-cost models are available for our use in the System Analysis Study. Some of these models can be eliminated for focusing on non-highway modes. For example, the Federal Rail Administration (FRA) has a rail-only model called *RAILDEC* and the Federal Aviation Administration (FAA) has a Microsoft Access application called *ABC* that implements the Administration's procedures for State Airport System Plans.

A few other models, such as the ITS Decision Analysis System (*IDAS*) and *SCRITS* (SCReening for ITS) focus on the benefits of intelligent transportation systems (ITS). IDAS contains a database of typical improvements due to ITS projects and allows users to model how they impact traffic flows using an imported regional planning model. SCRITS is a Federal Highway Administration (FHWA) spreadsheet that allows users to conduct screening-level analyses of ITS improvements. Neither model is applicable to the Southern Gateway Corridor, since ITS improvements are not being considered as part of the alternatives. These tools do not handle capacity improvements.

The next set of benefit-cost models deal strictly with single highway corridors. These models are often called sketch planning models. For example, *MicroBENCOST* considers a number of highway corridor improvements, including capacity additions, intersections,

bypasses, and pavement rehabilitation. The model was developed in the early 1990s under the National Highway Cooperative Research Program (NCHRP). As one of the early computer models, the program is DOS-based and many of the assumptions are now outdated.

The FHWA developed a sketch planning model called *SPASM* as part of a National Highway Institute (NHI) course. The exhibit below shows a snapshot of the facility information entered into the model. As is typical for a sketch planning model, very little information is entered about a limited set of highways. Also, the model does not explicitly consider the impact of shifting traffic from one highway to another. These limitations make most sketch planning models not very useful for the System Analysis Study. Cal-B/C is essentially a sketch planning tool, but allows the user to import the results from a regional travel demand model.

SPASM Facility Information

BASE CASE			Free-Flow
	Length (miles)	Capacity (pce/hour)	Speed (mph)
Freeways			
1	10	12000	60
2			
3			
Arterials			
1	10		15
2			
3			
HOV			
Rail			
IMPROVEMENT CASE			Free-Flow
	Length (miles)	Capacity (pce/hour)	Speed (mph)
Freeways			
1	10	12000	60
2			
3			
Arterials			
1	10		15
2			
3			
HOV			
Rail			

System-level models address the limitations of sketch-planning tools by allowing users to consider entire highway networks. The first such model to consider is the Highway Economic Requirements System (*HERS*). FHWA developed HERS to estimate the current

condition and performance of the national highway system and the cost of the most effective improvements to bring the system to an established threshold. The Administration uses the model to report to Congress the national highway needs biennially.

A few years ago, FHWA developed a state version of HERS called *HERS-ST*. The model is intended to allow state departments of transportation (DOTs) to conduct analyses similar to those conducted by FHWA for Congress. The model can be used to assess statewide investments or the benefit of specific projects. The primary limitation of HERS and HERS-ST is they are linked to the federal Highway Performance Monitoring System (HPMS). As a result, the models cannot use data from the modified AMBAG model for the System Analysis Study, nor could they use the traffic counts collected by WILTEC without converting this information to HPMS format.

There are a few benefit-cost models available that allow users to use the output of regional planning models directly:

- NET_BC
- STEAM
- StratBENCOST.

One of our consulting team members, Bernardin, Lochmueller & Associates, developed *NET_BC* for conducting network benefit-cost analysis. The model considers the same three primary user benefits estimated in Cal-B/C: travel time, vehicle operating costs, and safety. The benefits are calculated directly from regional trip tables and account for differences in trip purpose and mode (automobile versus truck). The model functions as a post-processor add-on, so it could be attached directly to the modified AMBAG model and run as each scenario is considered in the travel demand model. The example below shows a subset of the results available from NET_BC.

Sample NET_BC Mobility Results

```
INDOT Specialized Planning Services Contract
The Benefit Cost Analysis for Alternative 3C_FI
Date: 2/22/2006
Time: 3:16:31 PM

********************************** MOBILITY BENEFIT **********************************

A. Daily Travel Time Benefit (in vehicle-hours)

                        Passenger Vehicle       Truck
   Base Year            6,057                   793
   Forecast Year        11,864                  2,509

B. Annual Travel Time Benefit by Trip Type

                        Auto Work       Auto Commute    Auto Non-Work   Single Truck    Heavy Truck
   Base Year            $3,092,194      $8,797,465      $20,268,508     $1,361,447      $5,352,464
   Forecast Year        $6,056,593      $17,231,343     $39,699,350     $4,306,776      $16,931,882

C. Total Mobility Benefit

   Base Year            $38,872,078
   Forecast Year        $84,225,944
```

Unlike Cal-B/C, NET_BC calculates travel time benefits from the travel demand model trip tables. As shown in the above exhibit, this means that trip purpose is also a factor. This may be a valuable feature for analyzing travel in the Southern Gateway, which includes local commutes, inter-regional travel, and goods movement. Like Cal-B/C, the estimates cover a base and forecast year with linear interpolation of values for intermediate years.

The model also estimates vehicle operating costs for the same categories as Cal-B/C: fuel consumption, oil consumption, tire wear, vehicle maintenance, and depreciation. NET_BC includes a more detailed set of vehicle types by differentiating between small and large automobiles and by the number of axles among trucks. Many of the built-in parameters and assumptions are consistent with HERS.

Other advantages of the NET_BC model are: the consulting team is familiar with the model, the model takes into account the growth in travel demand, and the model takes into account the effects of congestion, deceleration/acceleration and terrain on vehicle operating costs. However, the model does not directly calculate the impacts of uncertainty in model inputs and some of the current cost functions (e.g., vehicle operating costs) differ from Cal-B/C.

The *StratBENCOST* model was developed as part of NCHRP 2-18(4). It incorporates methodologies from the earlier HERS and MicroBENCOST models. StratBENCOST allows users to estimate the benefits associated with: 1) single highway segments that do not involve traffic diversion, and 2) highway investments that impact networks. In this way, the StratBENCOST is like Cal-BC – it supports corridor and network analysis, depending on the level of the input data.

StratBENCOST incorporates a Monte Carlo simulation that allows the model to consider explicitly the uncertainty in input parameters. This is a useful feature that acknowledges the potential for "errors" in regional travel demand modeling. StratBENCOST allows for the analysis of up to 20 scenarios, which is adequate for the System Analysis Study. For network modeling, StratBENCOST relies on external estimations in a travel demand model. Unlike NET_BC, StratBENCOST does not connect directly to the travel demand model. The user must manually enter the regional model output into StratBENCOST.

For a network-level analysis, StratBENCOST requires total vehicle-miles traveled (VMT), vehicle-hours travel (VHT), and total mileage for each functional class (i.e., freeways, expressways, major arterials minor arterials, and collectors). As a result, benefits are estimated at the aggregate level for each functional class. For example, StratBENCOST would be unable to differentiate impacts on SR-152 versus SR-156 as part of our benefit-cost analysis.

StratBENCOST includes all four user benefit categories that are in Cal-B/C. The model differs from Cal-B/C in its treatment of induced demand and its consideration of an up to 30-year life-cycle (20-years in Cal-B/C). StratBENCOST considers only construction costs rather than full life-cycle costs as part of benefit-cost calculation, and some of the default costs are from older sources than Cal-B/C.

The FHWA developed the Surface Transportation Efficiency Analysis Model (*STEAM*) to conduct corridor and network-level benefit-cost analyses. The SPASM spreadsheet model is a predecessor of STEAM. STEAM also includes a suite of supplementary analysis tools, including IMPACTS (to estimate modal impacts at the sketch planning level) and SMITE (to estimate the impacts of diverted traffic and induced demand).

Like StratBENCOST and NET_BC, STEAM can use outputs from travel demand models to estimate network impacts. STEAM uses network flows and trip matrices. However, multiple alternative analyses require multiple model runs, and unlike NET_BC, the inputs must be entered manually into STEAM after each run.

STEAM considers the same four user benefits as Cal-B/C, with the addition of noise impacts. The modeling includes a number of detailed features, such as peak spreading and the impact of variations in traffic levels and incident delays. Like StratBENCOST, STEAM includes Monte Carlo simulation to conduct risk analysis.

We can provide further information, such as user guides, on the models described above, if necessary.

Evaluation of Models

Given the need to assess the impacts on the entire Southern Gateway roadway system and the need to be consistent with other Caltrans evaluation methods, only four benefit-cost models are worth considering:

- Cal-B/C
- Net_BC
- STEAM
- StratBENCOST.

Cal-B/C is the tool that Caltrans Headquarters uses to assess projects for the STIP and SHOPP as well as the ongoing CMIA assessment. However, Cal-B/C is not able to capture network effects easily nor can it differentiate among impacts on study area roadways. STEAM and StratBENCOST support regional travel demand models and Monte Carlo simulation, but the input of AMBAG model outputs would be no simpler than with Cal-B/C. NET_BC could connect directly with the AMBAG model, which would allow us to conduct a number of simulations quickly. While NET_BC requires some up-front programming, we are likely to run the benefit analysis several times. Also, the programmers of NET_BC are part of our consulting team, so making the model consistent with Cal-B/C is easier than for STEAM or StratBENCOST.

Our recommended approach is to add NET_BC to the modified AMBAG model calibrated in Phase I of the study and make it consistent with Cal-B/C. We will use NET_BC to conduct the benefit-cost analyses. We will also estimate summary benefit-cost ratios with Cal-B/C to ensure that the NET_BC model produces consistent results.

I have included a copy of the NET_BC user's guide used by Indiana DOT as a reference. Please feel free to call me with questions or if additional information is needed.

CRW

Attachment

cc: Anush Nejad – Kimley Horn and Associates
Vince Bernardin – Bernardin, Lochmueller & Associates
Dean Munn – Bernardin, Lochmueller & Associates

C2: Description and Use of the NET_BC Tool

This section provides a brief description of benefit-cost analysis, the benefit-cost tool NET_BC used for the SAS, and assumptions used in the analysis.

NET_BC

Bernardin, Lochmueller & Associates, Inc., (BLA) developed a benefit-cost tool that is especially well-suited for long-range planning of intricate roadway networks. BLA adapted this tool for use by Caltrans for its SAS. In the following BLA document, BLA describes benefit-cost analysis and how the NET_BC tool addresses the various components of a benefit-cost (B/C) analysis. The document also includes some of the assumptions used in the B/C analysis, with additional assumptions described in the next section.

BLA NET_BC Program Documentation. The Program Documentation section of BLA's *NET_BC version 5, Program Documentation & User's Manual*, April 2007, provides a description of the mobility, vehicle operating, and safety benefits used in a B/C analysis and how NET_BC calculates these benefits. The section also describes how these benefits are combined with costs to arrive at a B/C ratio and net present value for a project.

NET_BC version 5

Program Documentation
&
User's Manual

April, 2007

INTRODUCTION

The current version of NET_BC (Network Benefit-Cost analysis) was developed by Bernardin, Lochmueller & Associates, Inc. for the California Department of Transportation (CALTRANS). This version is customized to interface with the AMBAG Travel Demand Model.

NET_BC is designed to assist transportation planning practitioners in the complex process of economic evaluation of transportation projects. It is a stand alone tool which was written in Visual Basic computer language. NET_BC post-processes travel demand models built with TransCAD, TRANPLAN, and MINUTP. It evaluates the "classical" transportation system effects: *changes in travel time*, *safety* and *vehicle operation costs*.

This new version of NET_BC provides improved features such as: more user-friendly interface, significant improvements in the methodology for estimating crash costs, vehicle operating costs and mobility benefits, capability to analyze larger size networks, faster execution, etc.

This documentation discusses the underlying methodology, merits, and the disadvantages. The last part of the document is the NET_BC user's guide.

METHODOLOGY

NET_BC Theory and Principles

The economic evaluation of transportation projects includes;

1. the assessment of the costs for transportation system performance improvements, and
2. the assessment of benefits that users will enjoy after project completion.

This economic evaluation is known in terms of transportation Network Benefit-Cost analysis. User benefits for individual or groups of transportation projects (e.g., a proposed long range transportation plan) are calculated by NET_BC. The "classical" benefits traditionally associated with user benefit/cost analysis are: travel time (or "mobility" benefits), safety benefits, and vehicle operating benefits. Costs include: construction-related costs and operation and maintenance (O & M) costs. No attempt is made to incorporate other "societal" costs such as air quality related costs, since there is little agreement on how to value these kinds of costs.

All the components of *Benefits and Cost*s considered by NET_BC will be discussed in the following paragraphs.

User Benefits

Transportation system investments are expected to result in cost savings for users of the transportation system. Benefits are in the form of travel time savings, reduction in number of accidents, and sometimes, vehicle operating cost savings. NET_BC estimates and reports benefits in each category for four trip types:

i. Business Trips:
   1. Truck trips[1]
   2. Auto trips for business purposes (also called "on the clock" auto trips or "business auto" trips)

ii. Non-Business Trips:
   1. Commute trips made by auto
   2. Auto trips for other non-business purposes.

This classification is motivated by: a) the fact that the value of travel time depends on the trip purpose, and b) this breakdown of trips provides input data for subsequent regional economic impact analysis (if done).

The first two trips types are categorized as "business" trips. Reductions in travel time, safety-related costs, or vehicle operating costs for trucks or automobiles (used for business purposes) decrease business operating costs. These cost savings increase business productivity

[1] *This version of NET_BC assumes that trucks are an identifiable mode assigned to the network. Other version of NET_BC exist that estimate truck volumes as a function of facility type and total volume.*

and competitiveness, which often leads to economic expansion. The remaining two trip types are non-business, or personal, trips. User benefits associated with non-business trips do not directly impact the cost or productivity of doing business (and therefore would be excluded from a regional economic impact analysis). However, because non-business trips provide a societal benefit, the benefits of these trips are included in the benefit-cost ratio.

a. **Travel Time Savings.** Reductions in travel times for motorists and commercial vehicles are the largest source of benefits of potential transportation project. Travel time savings (sometimes referred to as "mobility benefits") is the result of time savings provided by the transportation improvements. These savings are achieved directly by faster speeds on improved facilities and reduced distances provided by new facilities. Savings are also provided indirectly by the diversion of traffic away from congested roads to new or improved roads, which allows faster speeds on otherwise unimproved roads. Indirect travel time savings are also provided by the ability to travel a greater distance within a relatively constant travel time budget. This latter component of travel time savings is referred to by the economic term, "*consumer surplus*". In the context of user benefit cost analysis, consumer surplus refers to the time savings benefits that accrue to the traveling public by virtue of the fact that a highway improvement may permit the ability to drive a longer distance without increasing travel time, thus opening up an array of new destination choices for many types of trips. It is well documented that vehicle-miles of travel (VMT) do increase in relation to increases in highway system mileage and capacity. From a user benefit standpoint, this is a two-edged sword. On the one hand, the increased VMT may drive up total vehicle operating costs and, since there is more traffic, it at least has the potential to dampen the positive safety effects of a project as well as the travel time benefits. On the other hand, "highway-induced travel demand" would not occur at all, if travelers did not freely elect to travel more in response to the highway improvements. This travel time related benefit makes the process of valuing "travel time savings" more complex than simply applying a monetary value to the system-wide reduction in vehicle-hours of traffic (VHT), since consumer surplus associated with induced demand may eliminate any reduction in total VHT. The method used for calculating this travel time savings benefits includes the following features: (1) matrix based calculations using "congested skim times" (specifically, average daily speeds) and trip tables (i.e., origin-destination matrices); (2) computation of travel times for base year build and no-build conditions and forecast year build and no-build conditions; (3) linear interpolation of intermediate-year values; (4) vehicle type-specific calculations for autos, single-unit trucks, and combination trucks; (5) application of varying unit values of time by type of vehicle and for work-related vs. non-work-related trips; and (6) valuation of consumer surplus (i.e., longer trips in the build condition vs. no-build condition are valued at one-half the standard values of time). Since people value their time based on the purpose of the trip, the automobile vehicle-hours of travel (VHT) are divided among three auto trip types: work trips, commute trips, and non-work trips. The vehicle-hours of travel in each of these categories are then converted into person-hours of travel (PHT) using average auto occupancy rates for each of the trip types. Table 1 shows the automobile VHT share and vehicle occupancy assumed for each of the trip types.

Table 1. Automobile Trips

	Auto Work Trips	Auto Commute Trips	Other Non-Business Auto Trips
% of Auto VHT	6.1%	26.9%	67.0%
Vehicle Occupancy (passengers/vehicle)	1.86	1.20	2.22

Source: Developed from values and methods reported by Highway Economic Requirements System (HERS), 1991, and Transportation Research Circular 477 (Transportation Research Board, 1997).

Similarly, truck VHT is divided between single-unit trucks and heavy-duty combination trucks. The values for trucks are show in Table 2.

Table 2. Truck Trips

	Single Unit Trucks	Combination Trucks
% of Truck VHT	25%	75%

Source: Highway Economic Requirements System (HERS), 2000.

The value of time for a truck depends on the value of its cargo as well as the value of the driver's time, and since the average vehicle occupancy for trucks is close to 1 , the value of time for trucks is given for vehicle hours rather than person-hours.

Note. Although the NET_BC methodology permits the use of different values of time for autos by trip purpose and trucks by size, this version of NET_BC considers only the time values for autos and trucks in general. This was done for the reason of compatibility with CAL-B/C, the other tool widely used by CALTRANS.

Table 3. Values of Time (in year 2000 dollars)

	Passenger Cars	Trucks
Value of Time	$10.46/hour	$27.83/hour

Source: CAL-B/C Parameters Spreadsheet

Should the user prefer using disaggregated values of time by trip purpose, he/she needs to contact Bernardin Lochmueller and Associates, Inc since these values are hard coded in the NET_BC source code

b. **Vehicle Operating Costs.** The costs of operating a vehicle are influenced by a host of driving conditions as well as the type of vehicle, itself. Individual operating cost values are computed and reported by vehicle type and by type of cost. The types of cost include:

- Fuel consumption
- Oil consumption
- Tire wear
- Vehicle maintenance
- Depreciation

These are computed for the following vehicle types:

- Small autos
- Medium/large autos
- 4-tire trucks
- 6-tire trucks
- 3+ axle, single unit trucks
- 3-4 axle combination trucks
- 5+axle combination trucks

NET_BC estimates the split between the small and medium/large autos as well as the percentage of each truck type.

The method used for computing vehicle operating costs incorporates the following features: (1) constant speed operating cost equations from the *Highway Economic Requirements System* (source: *HERS Technical Report* v 3.54, September 2003); (2) excess fuel consumption adjustment curves for acceleration/deceleration cycles based on link flow density; (3) excess operating cost curves due to speed variability (source: *HERS Technical Report* v 3.26, December 2000); (4) computations for both base year build and no-build conditions and forecast year build and no-build conditions, and (5) the composition of truck volumes.

In order to ensure that all costs are valued as of the same point in time, the costs for the five components and the excess costs are adjusted to current year dollars (or the year of the analysis) based on consumer and producer price indices specific to each cost component. Consumer price indices are used for all auto costs, as well as single-unit trucks' fuel and maintenance for both classes of trucks. Producer price indices are used for all the remaining truck cost components.

An important feature of this analysis is the excess fuel consumption adjustment curves for driving cycles based on link flow density (a.k.a. congestion). Ordinarily, benefit cost analysis bases vehicle operating costs on the simplifying assumption that traffic operates at a

constant average speed (i.e., without speed fluctuations) associated with each link in the network. In this analysis, excess fuel consumption resulting from frequent accelerations and decelerations associated with the level of traffic congestion on each link has been incorporated. These curves were developed by Bernardin, Lochmueller & Associates, Inc. (BLA) and incorporated into the latest version of NET_BC. They are based on EPA fuel consumption rates for highway and city driving.

The new method of estimating the vehicle operating costs due to speed variability associated with congestion implemented in this analysis used flow densities from the travel model as the basis for estimating these costs. Traffic flow density was selected as the independent variable based on the inference that the component of speed variability, not associated with traffic control devices is a function of the stability (or variability) of the traffic flow and that the stability of flows is closely related to their density. A relationship between flow density and light vehicle fuel consumption was developed using available data, and the relative sensitivity of the other vehicle types and operating cost components were based on the HERS "excess cost" equations. These equations were used to pivot costs for other vehicle types and cost components off of the light vehicle fuel consumption. Fuel consumption for light vehicles on urban and rural facilities is calculated using the applicable HERS average speed equations using the speeds from the model and the model's VMT adjusted by functional class to agree with Highway Performance Monitoring System (HPMS) estimate.

The average urban, rural, and overall consumption rates predicted by the HERS equations were then compared to U.S. Environmental Protection Agency official average fuel consumption rates for light vehicles on urban and rural roadways and the difference was related to the average urban and rural flow densities. A curve was fit to these data and then applied to travel demand model in a link-by-link calculation. A remaining additional increment of fuel consumption not accounted for by flow density is presumably due to speed variability associated with turning movements.

In addition to the excess costs associated with traffic congestion, traffic signals represent another factor that influences total vehicle operating costs[2]. If a vehicle makes a partial or complete stop at a traffic signal, the "stop-and-go" process will lead to higher operating costs than the costs that are incurred in a constant-speed driving condition without any interruptions by traffic signals. This analysis takes into consideration this impact by adding a sixth cost item in addition to the five mileage-based costs. This additional cost due to traffic control devices is referred to as "excess cost." To estimate excess cost due to signalization, the probability that a vehicle stops at a traffic signal was calculated by using a binomial distribution. Then, excess costs for each of the three vehicle types were estimated, taking into account both the deceleration-acceleration cycle based on the vehicle's initial approach speed as well as the idling time.

Another feature of the analysis is the incorporation of topographical impacts on vehicle operating costs. Operating costs vary depending on the vertical grade of the road with the impact being more severe for trucks. The incorporation of estimated grades on a system-wide basis represents a significant advance over earlier analyses that lacked them.

[2] *Traffic signals are explicitly coded in the network as link end point attributes.*

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c. **Accident Cost Savings.** User benefits associated with expected crash reductions attributable to the project(s) being evaluated are estimated by computing the probable number and type of crashes that would occur if the project(s) were implemented versus the number and type of crashes assuming the status quo. The crash rates used by this version of NET_BC are taken from *2004 Collision Data on California State Highways.* Individual crash percentages are applied for each of the three major classifications of accidents: fatalities, injuries, and property damage only (PDO). The number and type of crashes are computed based on group rates given for mainline highways, ramps and intersection control types as follows.

1) *Mainline Highway.* Each group rate is defined by:
   - FHWA Functional Class
   - Area Type
   - Number of Lanes
   - Divided/Undivided
   - Terrain
   - Design Speed
   - VMT

2) *Ramps.* Each group rate is defined by:
   - Ramp Type
   - Ramp Area
   - ON or OFF ramp
   - Area Type
   - VMT

3) *Intersections.* Each group rate is defined by:
   - Area Type
   - Control Type
   - Intersection Type
   - VMT

Average cost factors associated with each type of accident are then applied to the "build" versus "no-build" conditions. Table 4 gives the costs by crash type. The difference between the total accident costs with and without the planned improvements represents the safety benefits of the project(s).

Table 4: Crash Costs (year 2000 $/crash)

	Fatal Crash	Injury Crash	PDO
Cost	$3,262,459/crash	$85,716/crash	$7,198/crash

Source: CAL-B/C Parameters Spreadsheet

Transportation Project Costs

a. **Project Capital Costs:** For any project, its capital costs are assumed to be spent in roughly equal annual increments. All financial data - costs and benefits - are expressed in un-inflated, constant dollars. Any user benefits derived from the operation of segments of an alternative that might be opened prior to its final completion is not included in the analysis. Conversely, any temporary increase in user costs resulting from motorist inconvenience or traffic detours during construction is excluded from the analysis.

b. **Operation and Maintenance Costs:** In addition to capital costs, projects generally require increases in the ongoing operation and maintenance (O&M) cost budgets of state and local highway departments, as well as state and local police forces. The O&M cost consists of annual maintenance cost and annual public safety cost. The annual maintenance cost increases with the marginal increase in lane mileage, and annual public safety cost increases with additional centerline miles attributed to the project(s) being analyzed.

c. **Residual Values:** At the end of the economic analysis period, the highway will clearly have some remaining useful life. This *residual value* must be estimated by the user. Its discounted value is then netted out of the cumulative discounted cost stream in NET_BC. Estimation of the project's residual value is based on typical highway life cycle costs for the major components of highway construction.

d. **Discount Rates:** In benefit-cost analysis, all benefits and costs are discounted back to a base year in which construction is assumed to begin. This discounting is necessary, because if capital costs incurred in the construction period were financed and invested in the beginning year of construction, the amount of the funds raised (and subsequently invested) would be less than the total amount needed. Benefits are discounted because of the "opportunity cost" associated with giving up benefits that might have been derived from other competing public investments. Traditionally, the benefit and cost streams are discounted at the same rate. Standard practice calls for the selection of a discount rate approximately equal to the "cost of capital" for a public investment *without* any allowance for inflation. Inflation is not included, since both benefits and costs are computed in *constant* dollars. The problem is to select a discount rate that represents the cost of capital. The choice of a discount rate has a major impact on the outcome of the analysis, because of the timing of the benefits versus the timing of the costs. While the same discount rate is applied to both, the bulk of the costs are incurred early in the analysis period. On the other hand, the project's benefits accumulate over the entire economic life of the project; therefore, a substantial portion of the benefits is discounted more deeply than the costs. The higher the discount rate is, the more the benefits are penalized as compared to the costs[3].

[3] *The most recent update of Appendix C of OMB Circular A-94 published in February 2004 recommends a real discount rate of 3.5% for a 30 year cost-effectiveness analysis.*

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NET_BC Outputs

Net Present Value (NPV). The net present value of the project(s) is simply the difference between the discounted present value of benefits and the discounted present value of costs. A positive NPV indicates that benefits exceed costs, and is the most reliable benefit-cost measure.

Benefit-Cost Ratio. The benefit-cost ratio was calculated by dividing the total discounted benefits by total discounted costs. Essentially, a benefit-cost ratio of 2.0 means that for every dollar invested (the cost), two dollars are generated (the benefit). A benefit-cost ratio above 1.0 indicates that benefits exceed costs.

Other outputs are provided that document each of the three user benefits in detail. Data are also provided on discounted costs and residual value.

Caution Against Uncritical Applications

NET_BC is based on recent methodological and theoretical findings. With a friendly user interface, NET_BC is a very helpful tool in the hands of transportation planning practitioners. The main drawback of NET_BC is that the user is not fully in control of conventional naming and parameter inputs; this version of NET_BC was developed for the AMBAG model, and it is not entirely free of hard-coding. Other variables such as trip purpose composition, vehicle fleet composition etc., are based on California Demand characteristics.

Non-AMBAG model users are cautioned against uncritical application of NET_BC or any other benefit-cost post processor. The developer recommends that non-AMBAG users seriously consider limited customization of NET_BC that reflects the vehicle composition and link attributes of the demand model that will be used.

Additional Assumptions

Time frame. Except for the No Build Scenario, all scenarios assumed that construction would begin in 2010 and would be completed by 2013. Benefits and costs were calculated through 2035.

Discount rate. The discount rate was set at 5% corresponding to the discount rate currently used in Cal-B/C calculations.

Residual value. Residual values were assumed to be zero, which is consistent with the Cal-B/C method.

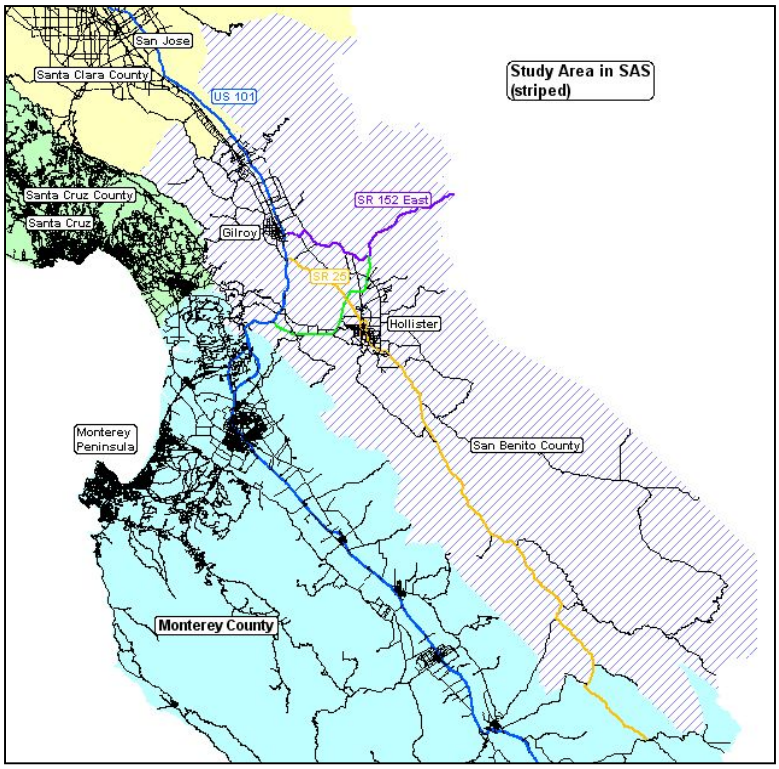
Constant dollars. Monetary costs were reported in constant 2006 dollars.

Vehicle operating costs. Gasoline and oil costs were based on the California Energy Commission estimates for the year 2006. Other vehicle operating costs are documented in a NET_BC input spreadsheet, which is available upon request.

In addition, elevation data available from Caltrans District 5 were incorporated into the NET_BC vehicle operating cost information.

Other assumptions. Vehicle operating cost equations and other assumptions are available upon request from Caltrans District 5.

Study area. User benefits were estimated for trips with origins or destinations in the study area shown in the map to the right. However, safety benefits from trips starting or ending outside the study area but that used roadways within the study area were included in the safety benefit calculation.



C3: Comparison of NET_BC with Cal-B/C

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Phone: (415) 395-7000 Fax: (415) 397-1000

July 27, 2007

To: Judy Lang – Caltrans D5

From: Chris Williges

Subject: **System Analysis Study of Routes 101, 156, and 152 – Comparison of Cal-B/C to NET_BC (revised)**

Caltrans District 5 in association with Districts 4 and 10, as well as other local and regional public agency partners are developing Phase II of the System Analysis Study of Routes 101, 152, and 156. The focus routes form what is commonly known as the Southern Gateway Corridor, which provides major east-west service for the interregional movement of goods and people. These routes connect the Central Valley, I-5, and State Route 99 (SR-99) to Monterey, Santa Cruz, and Santa Clara Counties. The routes already operate at capacity during a portion of the day, and traffic is expected to increase due to continued growth in population, jobs, and housing in the study area.

In an earlier technical memorandum, we recommended using NET_BC to estimate project benefits, compare alternatives, and select the right project phasing. At an April 20, 2007 study meeting, some participants raised concerns about the potential for differences when estimating benefit-cost ratios using NET_BC compared to the Caltrans Headquarters model, Cal-B/C. Such a comparison is worth considering since the California Transportation Commission recently adopted the Cal-B/C model to assess projects for the Corridor Mobility Improvement Account (CMIA). Cal-B/C is also likely to be used in future Caltrans programming analyses.

In this memorandum, we compare NET_BC and Cal-B/C using results for three study alternatives. The memorandum is a revision to a June 4, 2007 memorandum that

recommended changes to NET_BC to make the results more comparable to Cal-B/C. The changes have been made and this memorandum details the results.

We had difficulty making the comparison, since NET_BC evaluates nearly 2000 roadway links in the study area, while Cal-B/C can analyze only a single corridor or use aggregate results for the entire area. In general, we find that the modifications to NET_BC (e.g., adopting California economic values, using California safety data, applying the Cal-B/C discount rate, and using a twenty-year analysis period) make the model analogous to Cal-B/C.

However, we note a few differences for Caltrans and study stakeholders to remember when comparing NET_BC and Cal-B/C results. As expected, NET_BC is able to include multiple roadway links and assesses project benefits for the study area more comprehensively. For example, a project that adds capacity on one state highway may improve travel times on nearby roadways as vehicles divert to the new, faster route. NET_BC captures this effect while Cal-B/C focuses on the benefits from the state highway project alone. The net effect is that NET_BC produces slightly higher benefit-cost ratios than Cal-B/C.

In the June 4, 2007 review, NET_BC used a different discounting method (i.e., end of period) than did Cal-B/C (i.e., beginning of period). It also included residual values, while Cal-B/C did not. As a result of the earlier review, the project team decided to adjust the discounting method and exclude the analysis of residual values to be consistent with Cal-B/C. Other adopted recommendations include: using the Cal-B/C values of time in 2003 dollars and changing the fuel cost assumption to $2.55 per gallon. We continue to use the existing NET_BC method for calculating the value of induced demand.

The rest of this memorandum provides more detail about our comparison and is organized as follows:

- Basis for the Analysis
- Findings
- Conclusions.

Basis for the Analysis

With the help of Bernardin, Lochmueller & Associates (BLA), District staff have been preparing NET_BC simulations for different project alternatives within the study area. The alternatives are evolving, so the evaluations are not yet final. To compare results using Cal-B/C and NET_BC, we selected three study alternatives and used NET_BC runs

available as of July 10, 2007. All three alternatives widen US 101 between SR-156 and Cochrane Road and but otherwise differ as follows:

- *Scenario 1: SR-25, SR-152 and Partial SR-156 Widening* – widen State Route 152, Bloomfield and Bolsa Avenues, State Route 25, and State Route 156 (between The Alameda and the Hollister turn off at San Juan Highway/4th Street) to four lanes each.

- *Scenario 4: New East-West Route with New US 101 Connection (Mid Connection) and partial SR-25 widening* – construct a new east-west route (Option A) as a four-lane freeway connecting State Routes 25 and 156 and widen SR-25 between the new east-west route and San Felipe Road in Hollister.

- *Scenario 6: New East-West Route Option C and SR-25 widening* – construct a new east-west, four-lane freeway (Option C) just north of Shore Road and widen SR-25 between US 101 and San Felipe Road in Hollister.

Rather than extract information from the regional planning model, we relied on the output of NET_BC to supply the necessary information. This allows us to make an "apple-to-apples comparison," but it also means that the analysis is limited to the summary data available in NET_BC.

The first section of NET_BC output provides a summary of roadway conditions by functional class. An example of this output is shown in Exhibit 1. NET_BC provides a separate summary table for four traffic assignments: base year existing plus committed (E+C) network, forecast year E+C network, base year build network, and forecast year build network.

Exhibit 1: NET_BC Functional Class Summary

Functional Class	Number of Links	Road Miles (mi)	Free-Flow Speed (mph)	Free-Flow VHT (veh-hr)	Congested Speed (mph)	Congested VHT (veh-hr)	VMT (veh-mi)	V/C
Rural Interstates	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rural Principal Arterials	115	77.97	57.10	25,905.66	50.72	31,462.39	1,448,100.66	0.46
Rural Minor Arterials	116	92.47	46.87	7,296.60	45.80	7,547.35	314,640.63	0.21
Rural Major Collectors	195	186.87	31.99	7,949.73	29.85	8,849.22	241,268.97	0.15
Rural Minor Collectors	131	186.15	47.48	3,139.28	44.56	3,692.94	143,977.26	0.08
Rural Local Roads	153	46.77	30.19	1,045.41	28.95	1,127.87	31,313.94	0.08
Urban Interstates	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Urban Freeways & Expressways	145	60.44	70.02	33,613.77	51.29	36,756.15	2,353,090.37	0.95
Urban Principal Arterials	140	26.31	38.06	7,790.40	36.74	8,068.95	257,910.46	0.32
Urban Minor Arterials	236	50.37	25.78	7,630.09	24.89	7,895.65	191,101.38	0.23
Urban Collectors	294	64.17	28.01	8,354.48	27.32	8,609.33	219,186.00	0.21
Urban Local Roads	301	37.84	18.59	1,329.27	18.25	1,355.45	24,388.30	0.06
Other Roads	129	24.92	36.50	2,839.70	34.49	2,903.32	100,361.10	0.23
	1,955			106,894.38		118,268.63	5,325,339.09	

The second section provides a list of input parameter assumptions. This includes a synopsis of traffic assignment years, project costs, and construction years as well as the discount rate.

The third section describes the impacts of the four traffic assignments on truck vehicle-miles traveled (VMT) and truck vehicle-hours traveled (VHT). An example of this section is shown in Exhibit 2.

Exhibit 2: Truck Impact Summary

********** Truck VMT & VHT **********

Truck VMT

Base Year Build Network	502,751.20
Forecast Year Build Network	1,221,644.90
Base Year E+C Network	499,507.33
Forecast Year E+C Network	1,235,730.91
Changes in Truck VMT (Base Year)	3,243.87
Changes in Truck VMT (Forecast Year)	-14,086.01

Truck VHT

Base Year Build Network	10,312.38
Forecast Year Build Network	27,195.24
Base Year E+C Network	11,417.32
Forecast Year E+C Network	31,001.64
Changes in Truck VHT (Base Year)	-1,104.94
Changes in Truck VHT (Forecast Year)	-3,806.40

Other sections describe the mobility, vehicle operating, and safety benefits. They also provide annual user benefits and costs and summarize the user benefit-cost analysis. Exhibit 3 shows an example of the benefit and cost summary.

Exhibit 3: Annual User Benefit and Cost Summary

********** ANNUAL USER BENEFITS and COSTS **********

Year	Discounted User Benefits	Discounted Maint Cost
2013	$125,231,785	$2,028,784
2014	$121,189,425	$1,932,176
2015	$117,248,080	$1,840,167
2016	$113,407,295	$1,752,540
2017	$109,666,430	$1,669,086
2018	$106,024,679	$1,589,606
2019	$102,481,084	$1,513,910
2020	$99,034,556	$1,441,819
2021	$95,683,885	$1,373,161
2022	$92,427,758	$1,307,772
2023	$89,264,768	$1,245,498
2024	$86,193,428	$1,186,188
2025	$83,212,182	$1,129,703
2026	$80,319,415	$1,075,908
2027	$77,513,459	$1,024,674
2028	$74,792,607	$975,880
2029	$72,155,116	$929,409
2030	$69,599,218	$885,152
2031	$67,123,121	$843,002
2032	$64,725,021	$802,859
2033	$62,403,105	$764,627
2034	$60,155,556	$728,217
2035	$57,980,555	$693,540

Year	Discounted Const Costs
2010	$465,033,333
2011	$442,888,889
2012	$421,798,942

After reviewing the information available in the NET_BC output, we decided to try comparing the models using two set of data:

- *Examining benefits by functional class.* NET_BC outputs VMT and VHT by roadway functional class at the beginning of its summary report. There are 13 separate functional classifications listed. However, the rural and urban interstate classifications are not applicable to the system analysis study area, leaving 11 classifications with user benefits. Cal-B/C can handle seven classifications, so we focused on the seven classifications with the most VMT and VHT. This excludes rural minor collectors, rural local roads, urban local roads, and other roads, which comprise less than ten percent of the study area in terms of VMT or VHT.

- *Examining truck and automobile benefits separately.* We took aggregate VMT and VHT from functional class report and subtracted the truck figures listed later in the report. We assumed that the remaining VMT and VHT were automobiles. This approach allowed us to take into account the different values of time and vehicle operating costs associated with automobiles and trucks. However, it does not reflect the different conditions on roadways in the study area, which is very extensive geographically.

After conducting an initial analysis for only Alternative 1, we decided that examining benefits by function class was more comprehensive and used that approach for all three alternatives in the analysis.

Findings

We found that NET_BC provides a more detailed and comprehensive evaluation than Cal-B/C. Our June 4, 2007 comparison revealed two methodological differences that lead to higher benefit-cost ratios in NET_BC than in Cal-B/C:

- End-of-year discounting
- Residual value.

The discounting has been changed to be in-line with Cal-B/C and the District has decided not to use residual value for the System Analysis Study. We highlight these and other differences in this section.

End-of-Year Discounting. As of the June 4, 2007 review, NET_BC discounted benefits at the end of the year, while Cal-B/C discounted benefits at the beginning of the year. The end-of-year approach takes into account the opportunity cost of funding spent rather than invested. However, the approach also has the effect of discounting costs for an additional year. For example, Cal-B/C does not discount costs for a project constructed in one year. NET_BC discounted these costs for the full year and used a lower cost in the benefit-cost calculation than estimated for the project. Since our initial review, NET_BC has been modified to discount using the same method as Cal-B/C.

Residual Value. NET_BC allows users to take into account the residual value of a project remaining after the lifecycle. The residual value is subtracted from the project costs, which has the affect of raising the benefit-cost ratio. This approach makes sense from an investment analysis standpoint. For example, the Department needs to acquire right-of-way for new roadway construction and the right-of-way has value even after the project is built. If the Department does not planning to privatize facilities or sell right-of-way, these are sunk costs and an investment analysis framework does not make sense.

Cal-B/C uses a different, and equally valid, analysis framework. Rather than conducting an investment analysis, Cal-B/C examines project benefits from a user benefit standpoint. Projects represent agency outlays that generate user benefits. It is assumed that the Department will never sell the facilities and that operating and maintenance costs are adequate to preserve facilities throughout their lifecycle. As a result, Cal-B/C does not consider residual values.

The inclusion of residual value has the potential to discourage maintenance activities. Roadways are depreciating assets, so maintenance and operating costs are likely to have negative returns. That is, the maintenance and operating costs will increase residual value by less than their cost at the end of the period. As a result of the June 4, 2007 review, the Department has decided not to include residual value as part of its analysis.

Travel Time Benefits. In the June 4, 2007 review, NET_BC used the following values of time: $10.46 for a passenger car and $27.83. This was the result of mistakenly entering Cal-B/C values of time in 2000 dollars rather than 2003 dollars. These have since been corrected, so NET_BC is consistent with Cal-B/C. NET_BC updates the value of time to 2006 dollars using the consumer price index (CPI).

Travel time is a function of the average vehicle occupancy (AVO). Cal-B/C lists AVOs of 1.48 in the non-peak period and 1.38 in the peak period as well as higher AVOs for high occupancy vehicles. The CTC used a lower AVO of 1.15 in the recent CMIA analysis. NET_BC uses higher AVOs based on local travel surveys, which contributes to higher travel time benefits in the NET_BC analysis.

Exhibit 4 summarizes travel time benefits reported by NET_BC for the three alternatives in the comparison using the model outputs received on July 10, 2007. We also calculated travel time benefits using the functional class method in Cal-B/C with an AVO of 1.15 and the higher (1.38 and 1.48) AVOs. To make the results comparable, we examined only the opening year and the project end year. Cal-B/C typically conducts an analysis over only a 20-year lifecycle, but the Department is using a longer analysis period (i.e., 23 years) for the System Analysis Study. We extrapolated the project end year benefits to take into account the longer period in Cal-B/C. Although Exhibit 4 shows that NET_BC produces consistently higher values for the mobility benefits, most of the difference can be attributed to the AVO estimated from the local travel surveys.

Exhibit 4: Mobility Benefits in NET_BC versus Cal-B/C

Alternative	NET_BC	Cal-B/C with AVO = 1.15	Cal-B/C with higher AVOs
Alternative 1			
– Opening Year	$87.1 million	$68.9 million	$81.3 million
– Project End Year	$123.6 million	$114.1 million	$132.6 million
Alternative 4			
– Opening Year	$82.4 million	$50.4 million	$62.8 million
– Project End Year	$106.6 million	$77.0 million	$94.6 million
Alternative 6			
– Opening Year	$83.6 million	$63.6 million	$75.2 million
– Project End Year	$119.3 million	$101.5 million	$117.5 million

Note: These values are not discounted.

Induced Demand. Both Cal-B/C and NET_BC estimate induced demand using consumer surplus theory and calculate induced demand using the same values. In a network framework, estimating induced demand is extremely difficult. The project team has held a number of discussions about the most appropriate way to capture this demand. The process for estimated induced demand is complicated by the ability of the Association of Monterey Bay Area Governments (AMBAG) to adjust origin-destination demand for the various scenarios.

One method for estimating induced demand is to examine the overall change in VHT and VMT. The assumption in this method is that the induced demand occurs evenly across origin-destination pairs, even though the induced demand may be concentrated in particular corridors. Cal-B/C uses this method if aggregate data are entered.

Another method for estimating induced demand would be to examine the change in demand for individual origin-destination pairs. The assumption in this method is that the consumer surplus benefit is roughly equal to the change in travel times for the limited number of trips that change origin-destination pairs. In most cases, this results in a conservative estimate (underestimation) of the overall travel time benefits.

This issue of estimating induced demand in a network model is currently unresolved in the theoretical research. Finding the "perfect solution" is beyond the scope of this project.

Vehicle Operating Benefits. These benefits are more difficult to compare between Cal-B/C and NET_BC. Mobility benefits are additive and can be calculated simply by examining aggregate changes in VHT. Vehicle operating benefits are a function of speed and vary for every grouping of vehicles (e.g., by classification, highway functional class, highway segment, etc.). For Alternative 1, NET_BC estimates a positive (non-discounted) benefit of $35.7 million in the forecast year. Cal-B/C estimates negative overall benefits – reductions in vehicle operating costs on rural principal arterials are more than offset by increases on urban freeways and expressways.

These seemingly disparate results are due primarily to the vehicle groupings rather than differences in vehicle operating cost assumptions. NET_BC allows vehicle operating costs to be estimated by highway links, which is more accurate than the vehicle groupings.

NET_BC estimates vehicle operating costs using equations from the federal Highway Economic Requirements System (HERS). The equations account for a number of factors, such as mileage, speed, and speed cycling factors. To compare the vehicle operating costs in HERS to those in Cal-B/C, we estimated the vehicle operating cost per mile using aggregate vehicle operating cost and VMT statistics for the four scenarios in Alternative 1 (using the revised July 10, 2007 model runs). As Exhibit 5 shows, the costs are fairly consistent across the scenarios and much higher for trucks than for automobiles.

Exhibit 5: Vehicle Operating Costs Estimated in NET_BC for Alternative 1 (in $ per mile)

Scenario	Cost per Mile		
	Average	Truck	Auto
Base Build	$0.45	$2.46	$0.24
Forecast Build	$0.57	$2.47	$0.24

Base E+C	$0.46	$2.61	$0.24
Forecast E+C	$0.62	$2.65	$0.25

In Cal-B/C, fuel-related vehicle operating costs vary by speed, while the other costs are a function of mileage. The lowest vehicle operating costs occur at 45 miles per hour (mph). Exhibit 6 shows vehicle operating costs for only non-fuel costs plus the fuel costs at three different speeds. As the exhibit illustrates, the majority of costs are due to changes in VMT.

Exhibit 6: Vehicle Operating Costs in Cal-B/C (in $ per mile)

Cost	Truck	Auto
Non-Fuel Only	$0.30	$0.17
+ Fuel @ 30 mph	$0.70	$0.30
+ Fuel @ 45 mph	$0.69	$0.28
+ Fuel @ 60 mph	$0.69	$0.29

While the costs for automobile appear to be higher in Cal-B/C, most of this difference is due to the assumed cost of gasoline. The NET_BC assumption is $1.03 per gallon in 2000 dollars. After updating the fuel cost to 2006 dollars using the CPI [i.e., (219.9/128.6)*$1.03], the fuel cost is $1.76. The current Cal-B/C assumption is $2.55 per gallon in 2003 dollars. If the Cal-B/C assumption is changed to $1.76 in 2006 dollars, the total automobile costs range from $0.24 to $0.26, which is in the same range as the NET_BC values.

Truck operating costs are much higher in NET_BC (roughly three times as high). This does not greatly impact the results, since trucks comprise only about nine percent of traffic statewide. The scenario estimates for Alternative 1 show truck VMT as a percentage of total VMT ranging from 9.5 percent in the base scenarios to about 16 percent in the forecast scenarios. As Exhibit 5 shows, the net impact of the truck operating costs still puts the overall vehicle operating costs (listed as "average") in the range of Cal-B/C estimates for automobile and truck operating costs.

NET_BC includes one category of vehicle operating costs, excess costs, not explicitly included in Cal-B/C. Excess costs refer to the increased vehicle costs caused by vehicle acceleration and deceleration. Cal-B/C estimates one set of vehicle operating costs regardless of terrain or signalization. Theoretically, the contribution of excess costs relative to Cal-B/C should net to zero, since Cal-B/C's vehicle operating costs are for

average conditions that include acceleration and deceleration. The similar cost ranges in Exhibits 5 and 6 support this conclusion.

Safety Benefits. Cal-B/C and NET_BC use the same methodology for estimating safety benefits. The models compare the number of collisions predicted by accident rates and VMT. Accident rates are assumed to be the statewide "rate group," or average for similar facilities. In the case of Cal-B/C, users can change accident rates for corridors to actual historic accident rates for the corridor. This approach was deemed too onerous for the System Analysis Study, given the total number of roadways included in the network.

Cal-B/C and NET_BC use the same values for fatality, injury and property damage only (PDO) accidents, so the estimated safety benefits should be equal. NET_BC reports monetary versus non-monetary costs. Monetary costs flow through the economy (such as loss of income or property damage), while non-monetary costs do not impact the economy (e.g., the grief of relatives, etc.). This distinction is not applicable to the System Analysis Study and should be ignored.

NET_BC can easily calculate the safety benefits for the entire study area, since the model includes every roadway segment in the network. Such a comprehensive calculation would be prohibitive in Cal-B/C. The estimation would need to be simplified for a smaller network, such as the four primary state routes. In this case, the Cal-B/C estimation would be less accurate.

The implication of our findings is that NET_BC will product higher benefit-cost ratios than Cal-B/C, but capture the benefits in the study area more accurately.

Conclusions

As a result of our June 4, 2007 review, we suggested making a few changes to make the results more similar:

- Changing discounting from end-of-period to beginning-of-period
- Excluding residual value from the analysis
- Making sure to use the Cal-B/C values of time in 2003 dollars
- Continuing using the existing method for calculating induced demand
- Changing the fuel cost assumption to $2.55 per gallon.

We also recommended that the District continue using the existing method for calculating induced demand and include monetary and non-monetary costs in the safety

benefits. Our review using the revised model results confirm that these recommendations were adopted.

The NET_BC and Cal-B/C models appear to produce similar results, but NET_BC provides a better estimate of the network benefits. A few of the differences between the models lead to NET_BC producing higher benefit-cost ratios. This will not affect the comparison of alternatives in the System Analysis Study, but should be kept in mind when comparing results with Cal-B/C.

Please feel free to call me or any of my colleagues if you have questions about this technical memorandum.

CRW

APPENDIX D: Technical Advisory Committee and Consultants

Technical Advisory Committee (TAC)

A technical Advisory Committee (TAC) guided the *System Analysis Study of Routes 101, 152, and 156* (SAS). The TAC consisted of representatives from:

Council of San Benito County Governments
Santa Clara Valley Transportation Authority
Association of Monterey Bay Area Governments
Merced County Association of Governments
Metropolitan Transportation Commission
Caltrans Headquarters and Districts 4, 5, and 10.

The TAC met periodically to develop scenarios and discuss interim results. Meetings were held on the following dates:

5/13/05, 1/13/06, 7/14/06, 11/6/06, 3/29/07, 4/20/07, 7/10/07, 3/26/08, and 4/18/08.

Management from the region's participating TAC agencies was invited to the TAC meetings on 4/20/07 and 7/10/07. In addition, Caltrans presented interim results to the Council of San Benito County Governments Board on 7/19/07 and presented results to Caltrans Headquarters Planning on 3/20/08, Caltrans District 4 management on 4/2/08, and to the Steering Committee on 5/8/08. Presentations are scheduled for 6/5/08 to the Council of San Benito County Governments Technical Advisory Committee and for 6/19/08 to the Council of San Benito County Governments Board. A presentation to Santa Clara Valley Transportation Authority's Public Advisory Board is planned but not yet scheduled as of this writing.

Consultants

Consultants providing support for the SAS were:

System Metrics Group, Inc.
Bernardin, Lochmueller & Associates, Inc.
Kimley-Horn and Associates, Inc.
WILTEC

APPENDIX E: SELECT LINK ANALYSIS and TRAVEL PATTERN COMPARISON

This appendix consists of two parts:

1. E1: Select Link Analysis Maps, and
2. E2: Travel Pattern Comparison.

Information from select link analyses was used to understand the travel patterns of each scenario as well as any travel path changes of each of the improvement scenarios in relation to the No Build case. The AMBAG model for the 2030 PM peak hour was used for the select link analyses. The PM peak hour was chosen because traffic in the study area is the heaviest during this hour for a typical weekday.

The following abbreviations are used in the discussion, maps, and charts below:

EB: Eastbound	NB: Northbound
WB: Westbound	SB: Southbound

Volumes are rounded to the nearest 25 while percentages are usually rounded to the nearest five. Note that volumes on SR 152 in the 2030 PM peak hour are lower than volumes currently projected by Santa Clara Valley Transportation Authority (VTA) by about 1,000 vehicles. This difference does not affect the conclusions of the SAS. However, when VTA analyzes possible SR 152 Bypass locations, VTA and Caltrans District 5 have agreed to conduct additional analyses and to come to an agreement about the growth patterns and future volumes on SR 152.

E1: Select Link Analysis

For each scenario, travel patterns were examined at six locations in the study area:

- SR 156 between San Juan Bautista and Hollister
- SR 25 north of Shore Road
- SR 152 east of Gilroy
- SR 152 east of the SR 152/156 interchange
- US 101 south of the SR 156 East/101 interchange
- US 101 north of the SR 152 East/101 interchange.

These locations are shown as stars in Figure 1 below.

By doing select link analyses at these locations, we can see how trips approach the location and to where they are headed. This will help to explain any changes in travel patterns due to the different scenario improvements.

Figure 1. Travel Pattern Locations

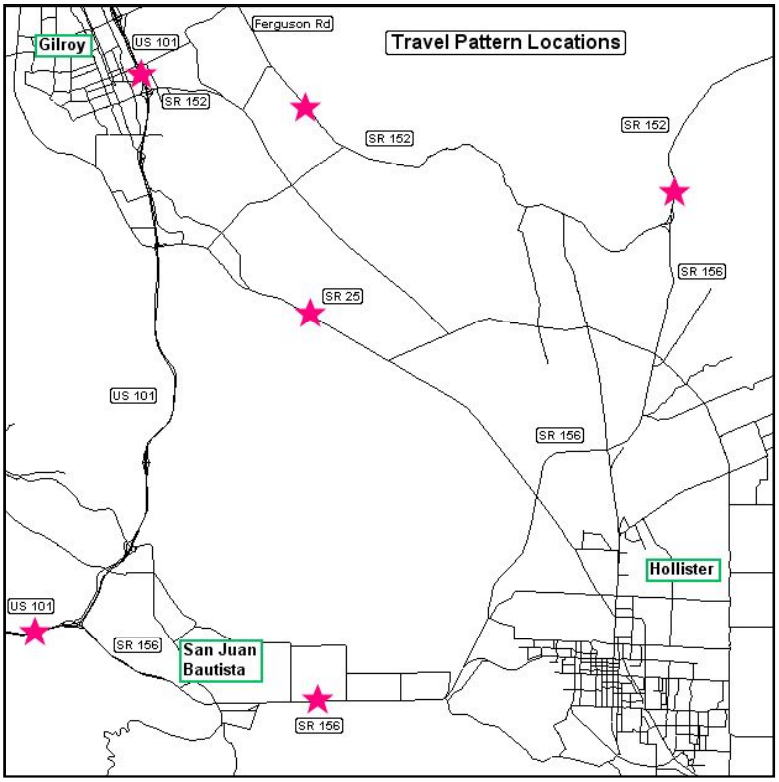
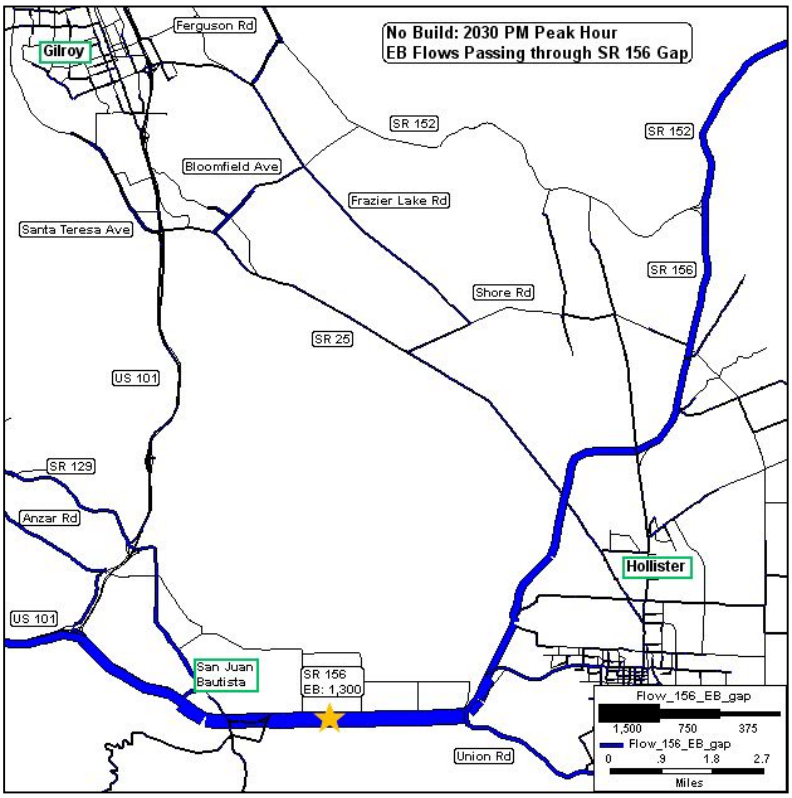


Figure 2. Isolating Travel Paths



Isolating travel paths. In Figure 2 above, the colored lines indicate eastbound traffic that passes through a point on SR 156 between San Juan Bautista and Hollister (the star shows the location). The thickness of the line indicates the volume of this traffic as it travels along roads from various origins to various destinations in the area. For example, the line is thickest at the selected point on SR 156 (the star) since that is our observation point. From the color and thickness of the lines, we see that most traffic passing through the point comes from the west and south (US 101, Anzar Road, and SR 129) and travels to Hollister and to SR 152 east of the SR 152/156 interchange.

In Appendix E1, the select link results are displayed by scenario and in map format.

E2: Travel Pattern Comparison

In Appendix E2, the results of the select link analyses are displayed by location and in bar chart format. An example is shown in Figure 3 below.

Figure 3. Select Link Results by Location

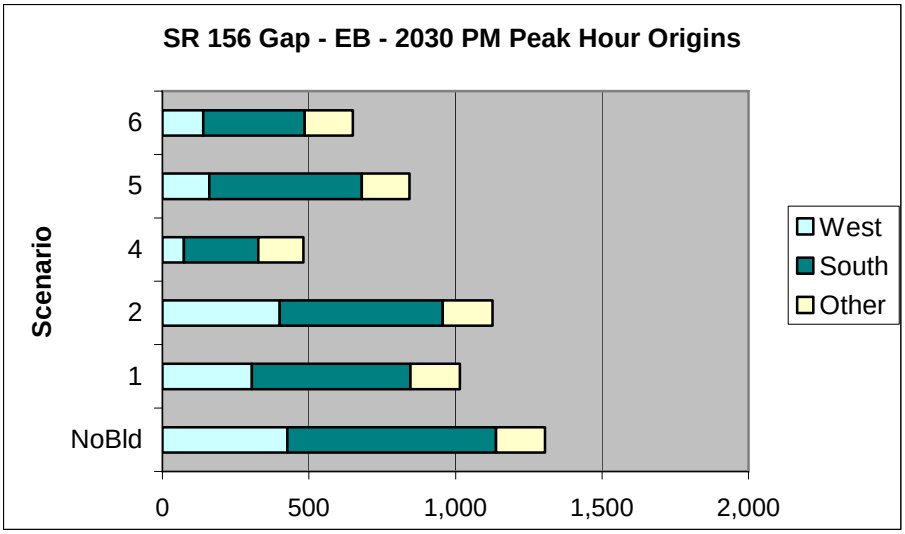
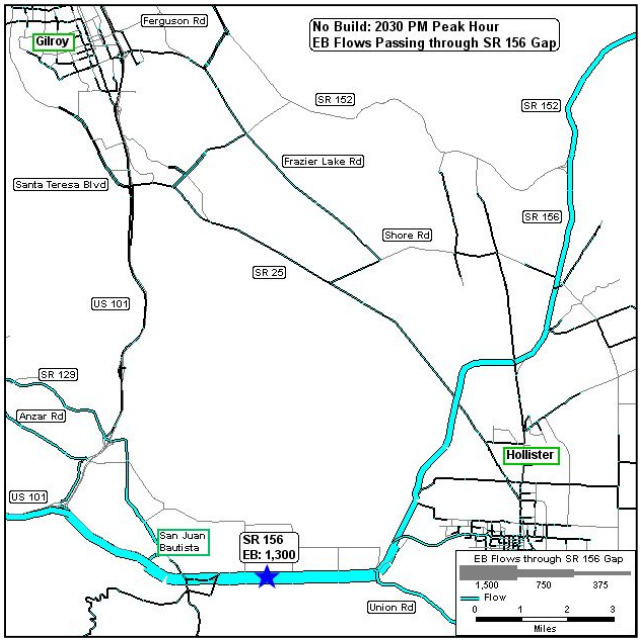
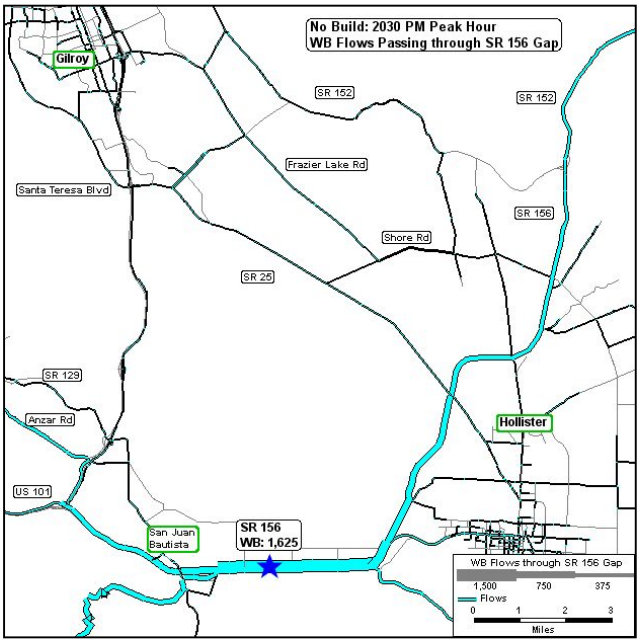


Figure 3 shows select link results for eastbound (EB) traffic passing through a point on SR 156 between San Juan Bautista and Hollister (see Figure 1 above). Each bar shows results for a given scenario, and the colors within a bar indicate the direction from which traffic arrived. For example, for the No Build Scenario, which is represented by the bar at the bottom of the chart, we see that about 425 trips came from the west, 700 came from the south, and 175 arrived from other locations. This gives us about 1,300 EB trips passing through SR 156 between San Juan Bautista and Hollister, and of all the scenarios, this is the greatest number of trips at this location. By comparing the different bars in the chart, we have an easy way to see the effects of each of the improvement scenarios compared to the No Build case.

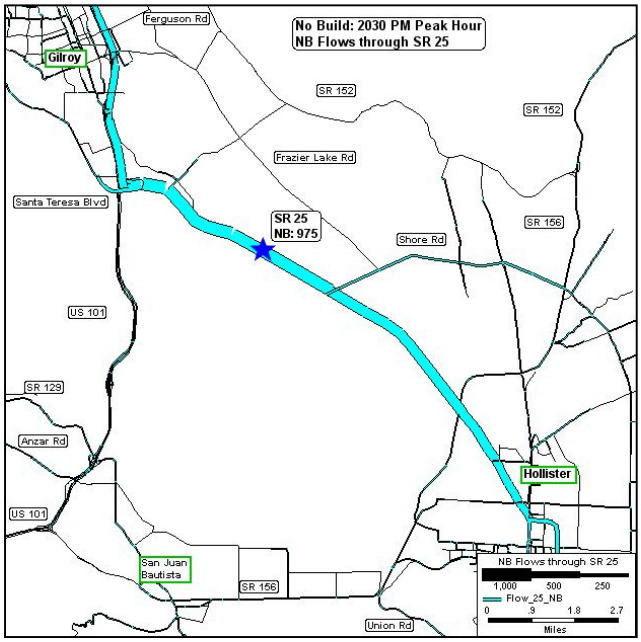
No Build Scenario

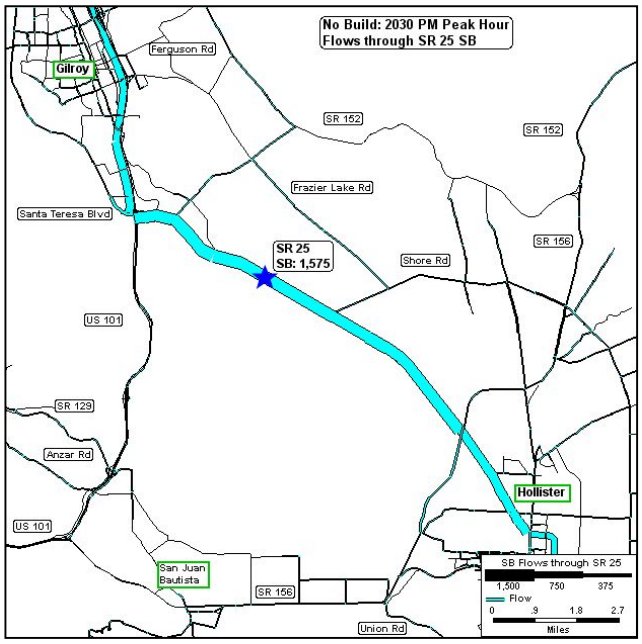
SR 156 between San Juan Bautista and Hollister





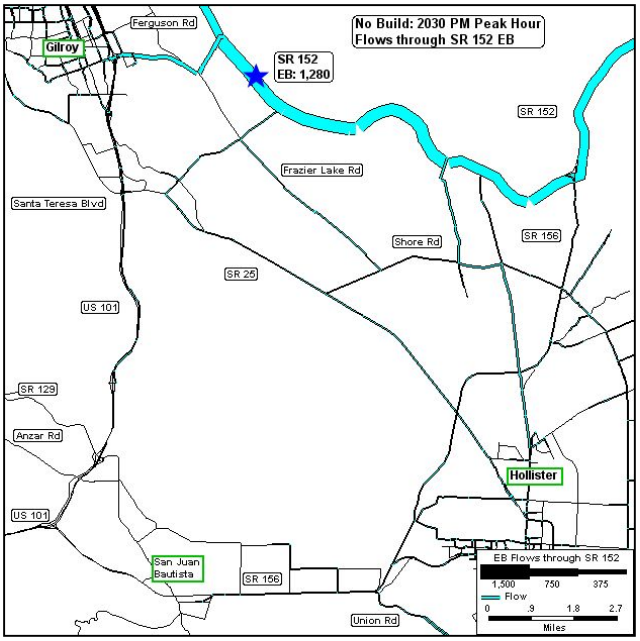
SR 25 North of Shore Road

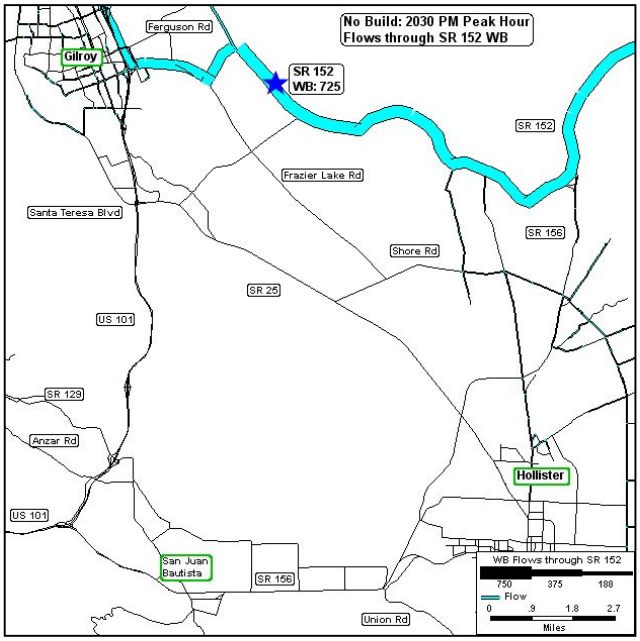




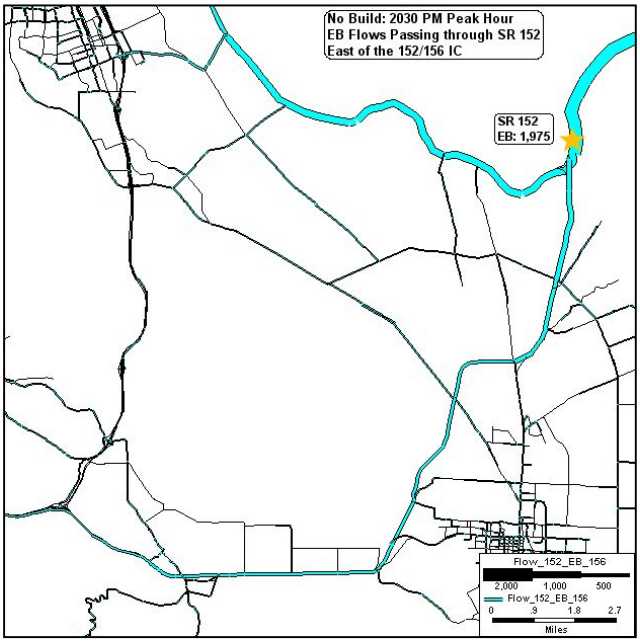
No Build Scenario

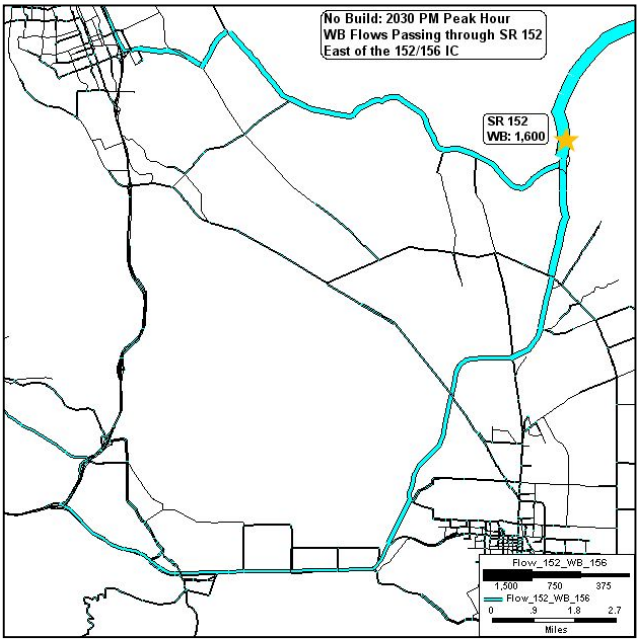
SR 152 East of Ferguson Road





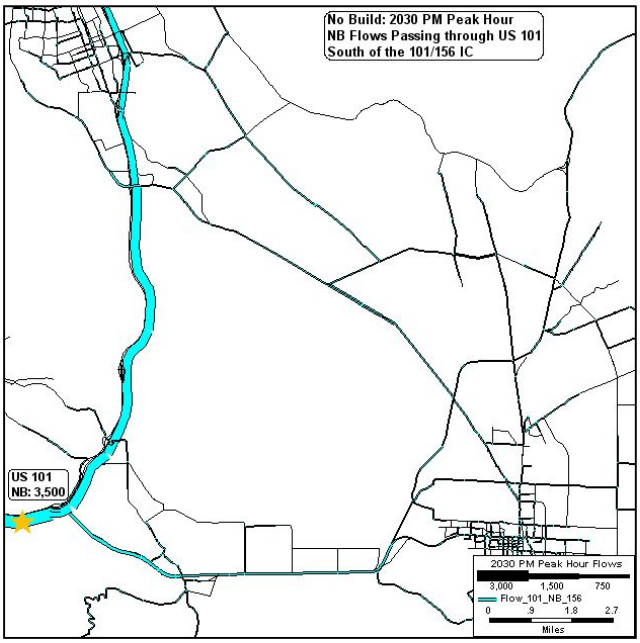
SR 152 East of SR 156

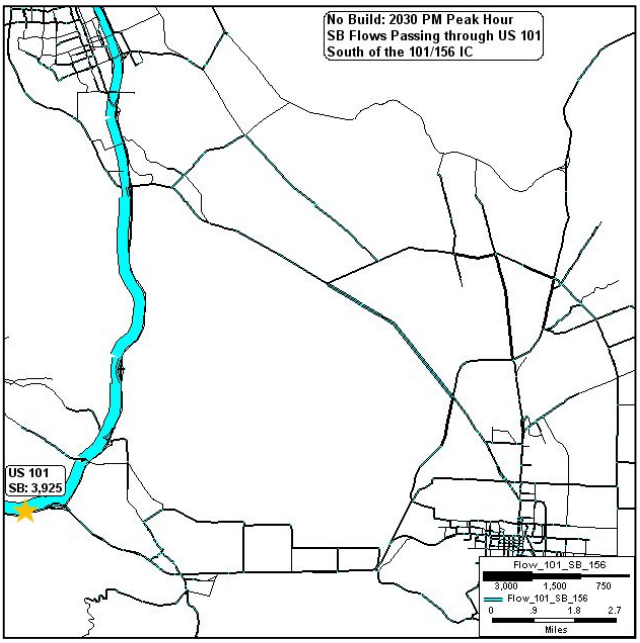




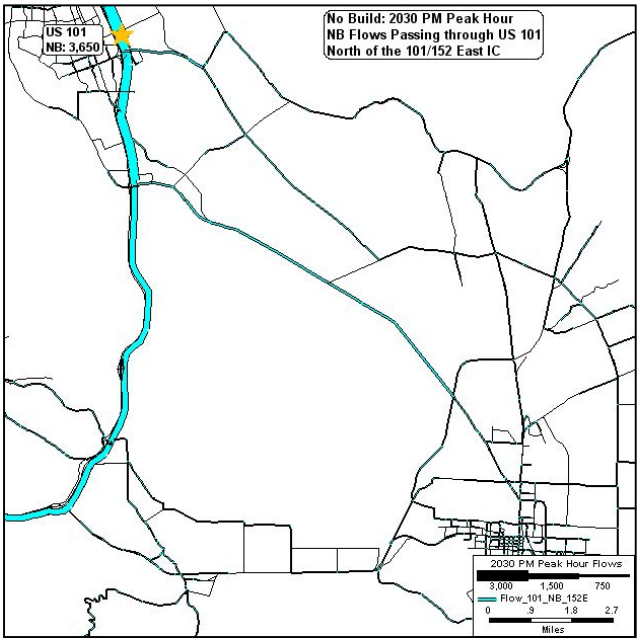
No Build Scenario

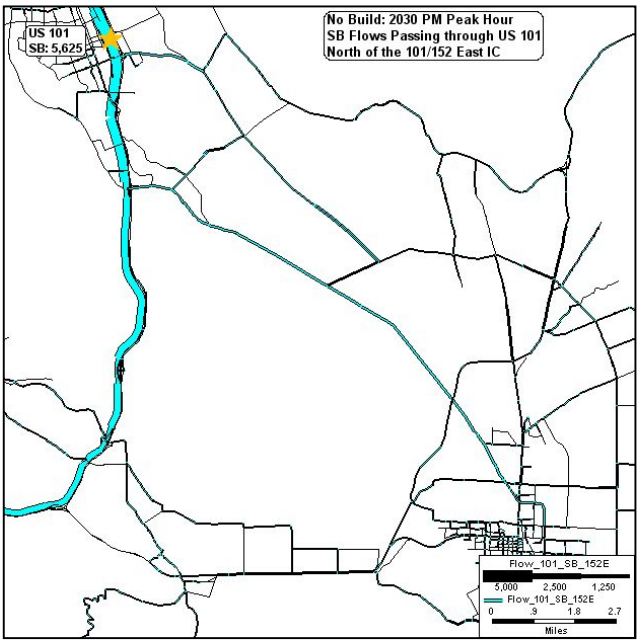
US 101 South of SR 156





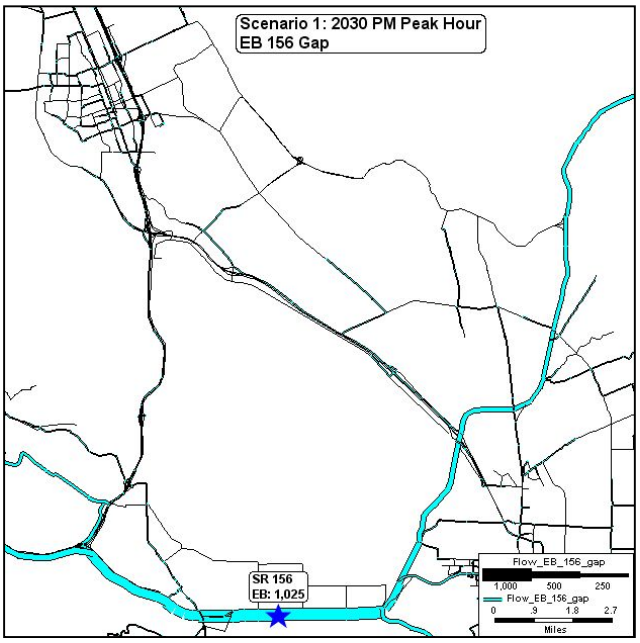
US 101 North of SR 152 East

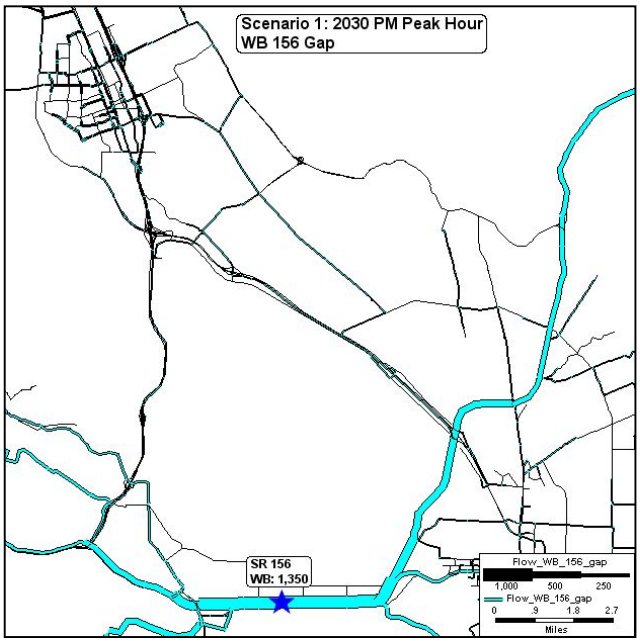




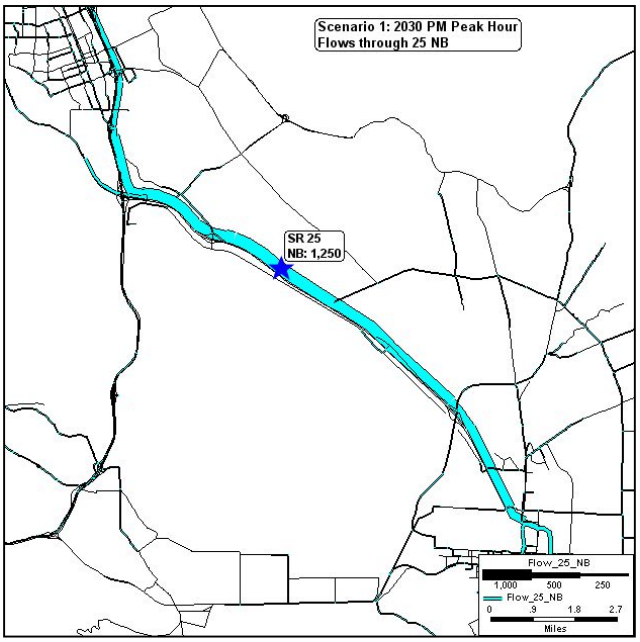
Scenario 1

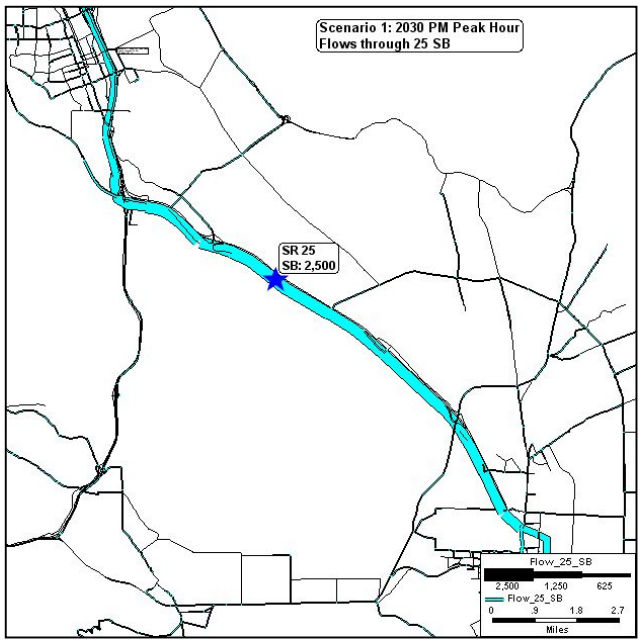
SR 156 between San Juan Bautista and Hollister





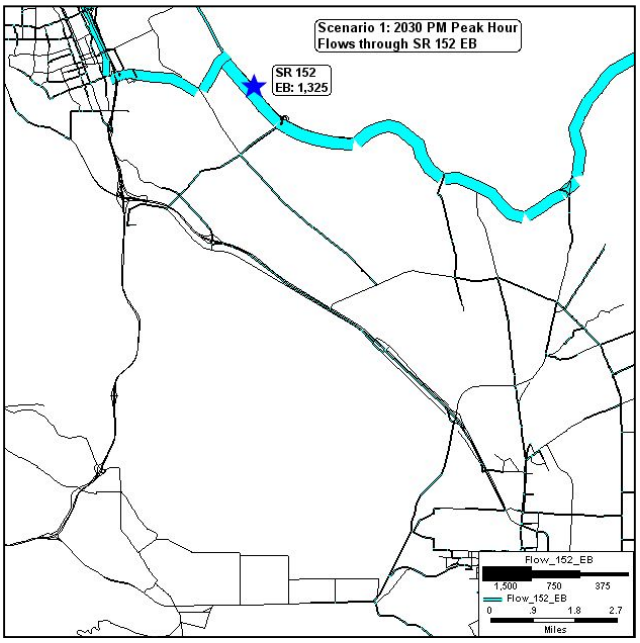
SR 25 North of Shore Road

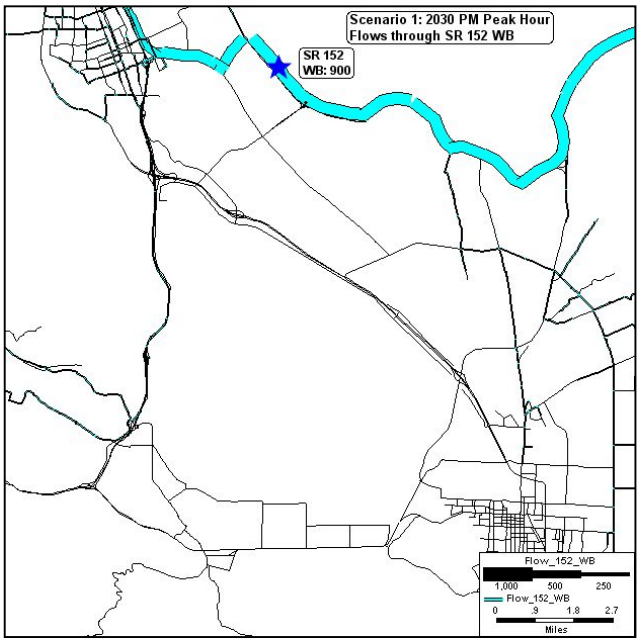




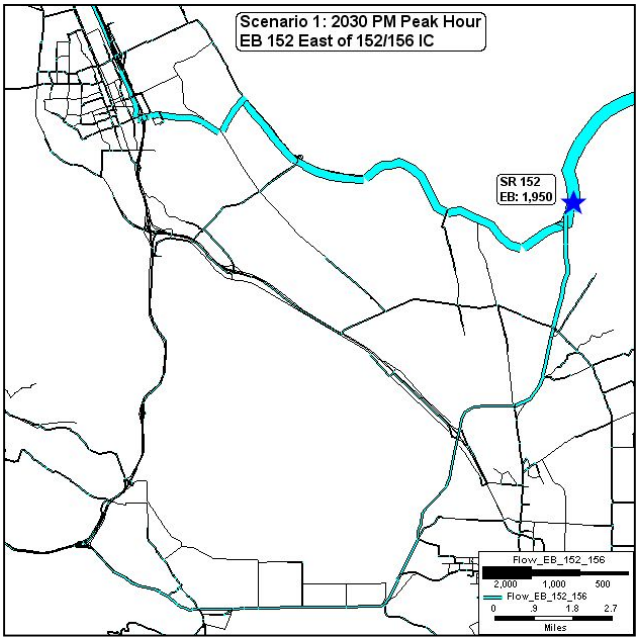
Scenario 1

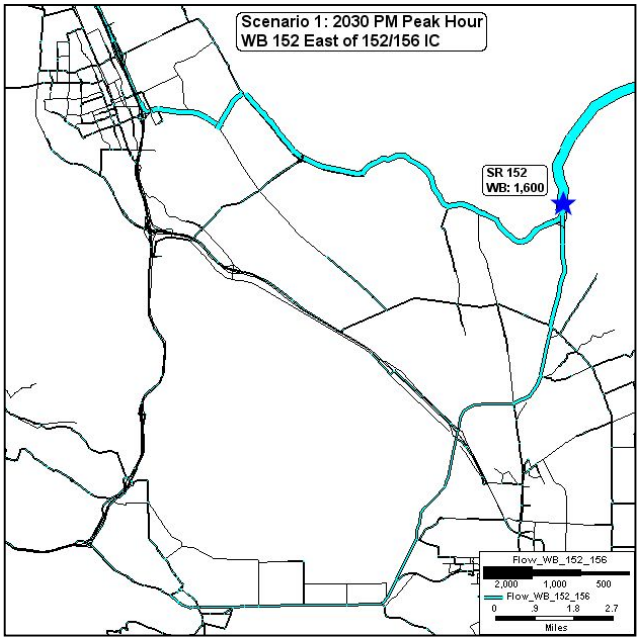
SR 152 East of Ferguson Road





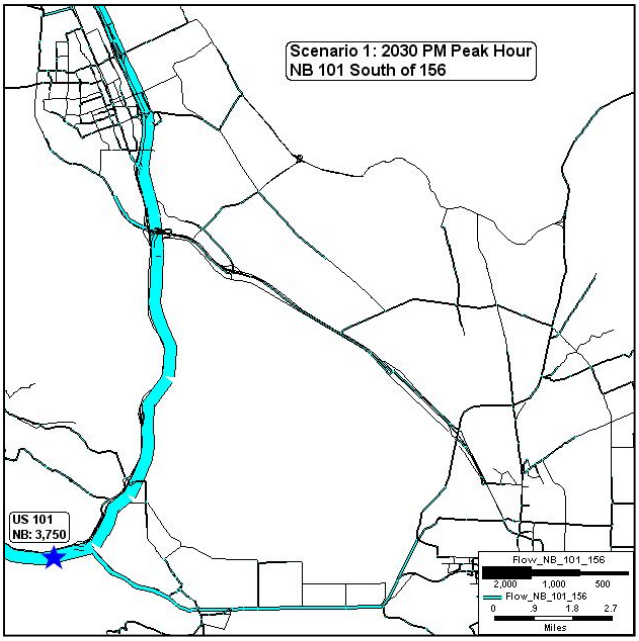
SR 152 East of SR 156

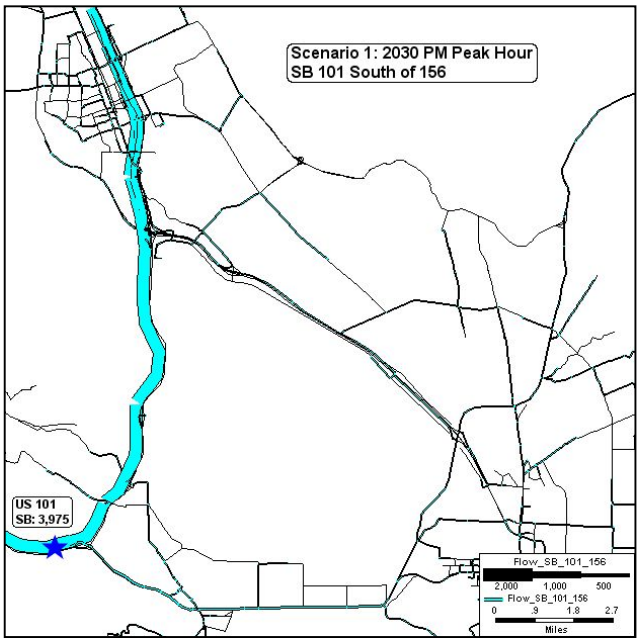




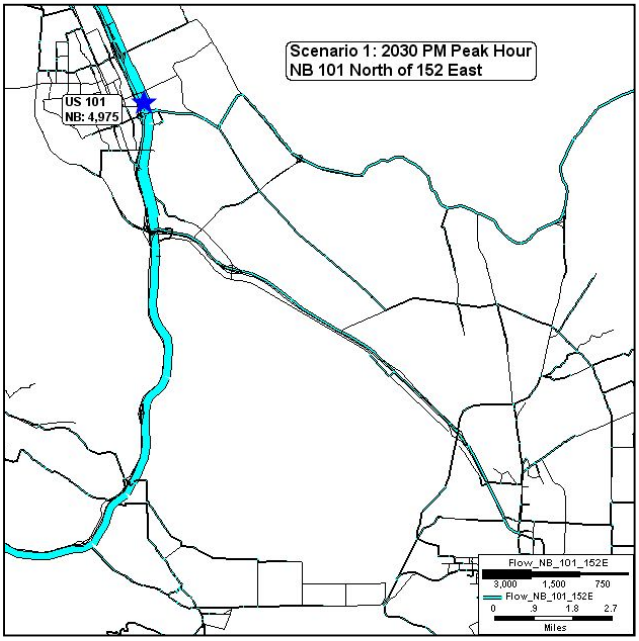
Scenario 1

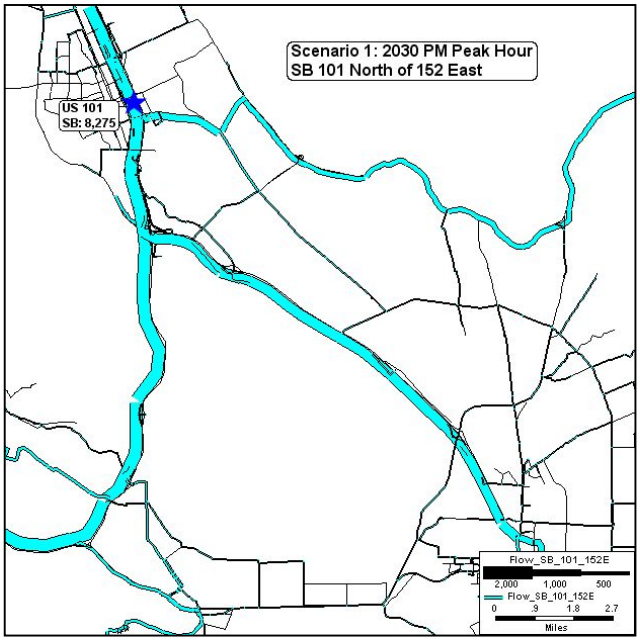
US 101 South of SR 156





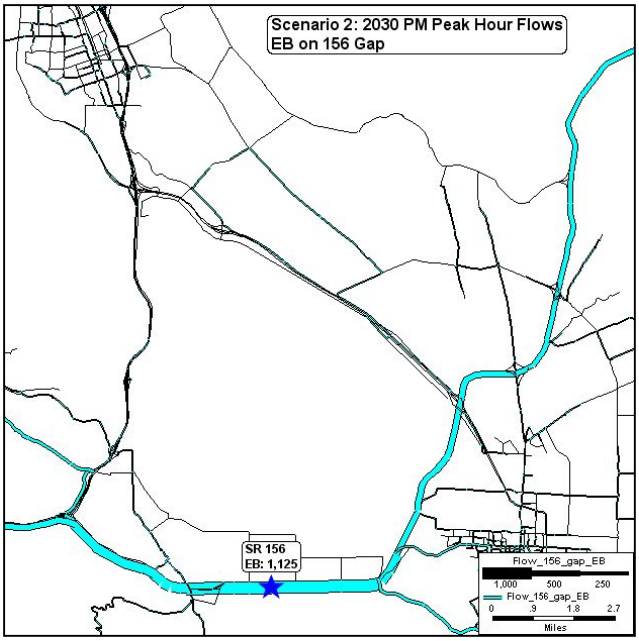
US 101 North of SR 152 East

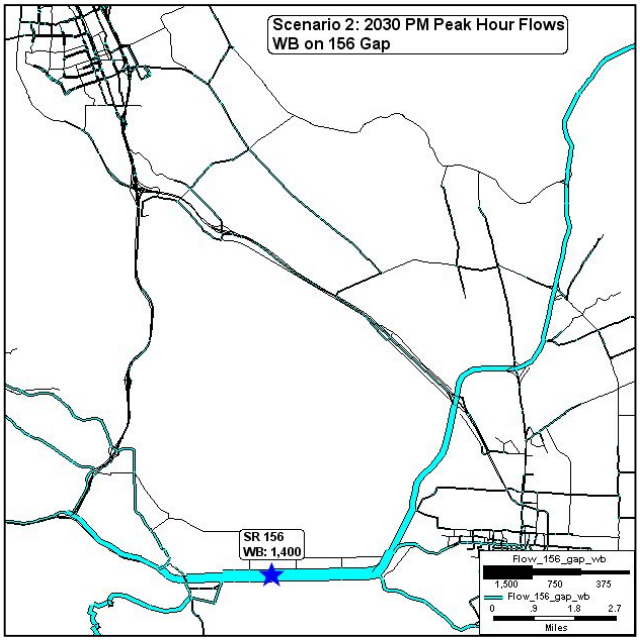




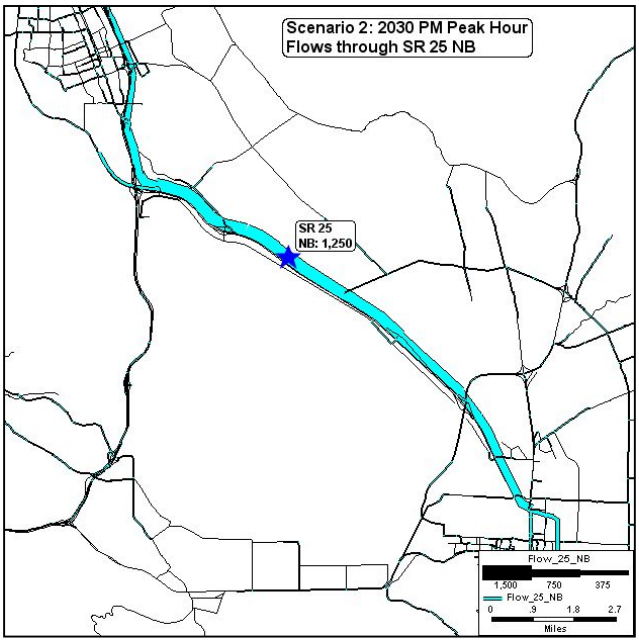
Scenario 2

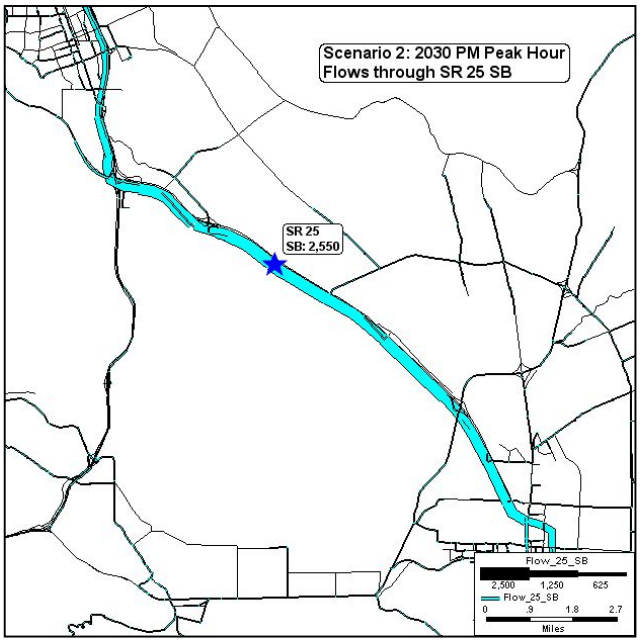
SR 156 between San Juan Bautista and Hollister





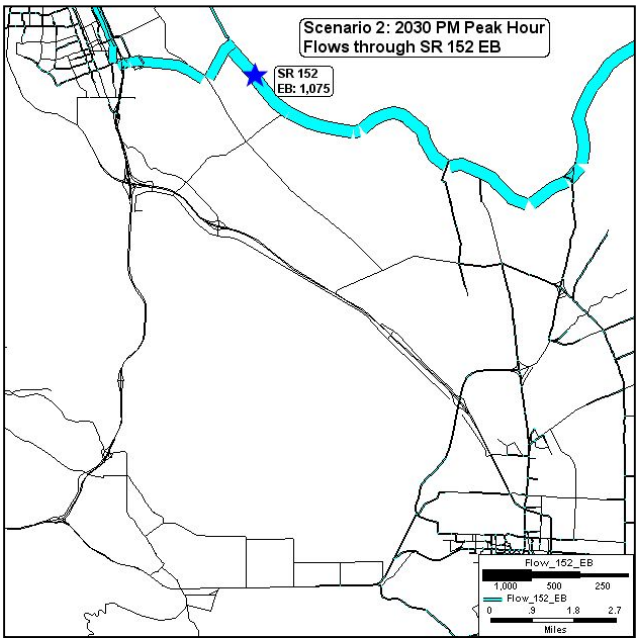
SR 25 North of Shore Road

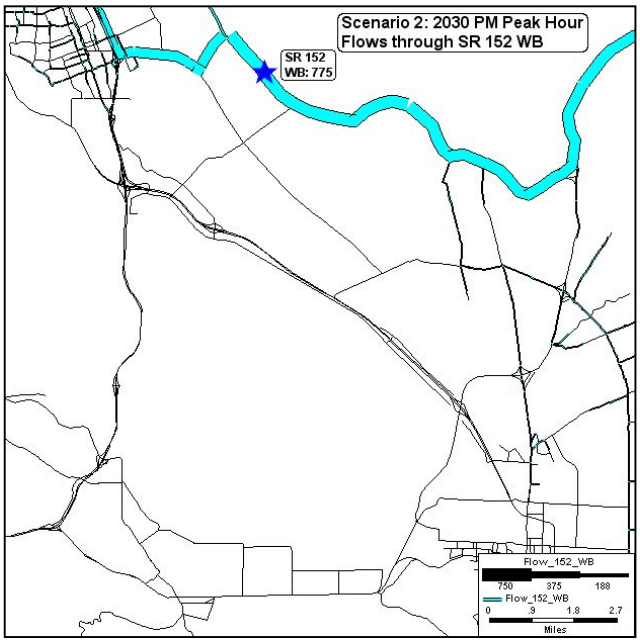




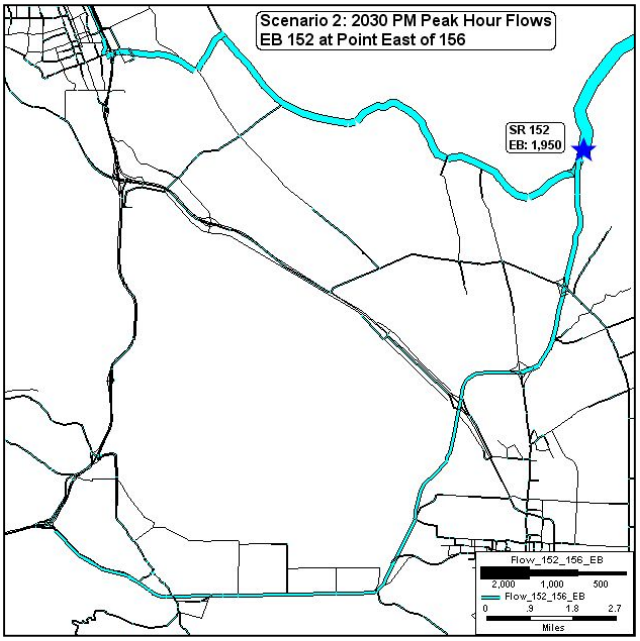
Scenario 2

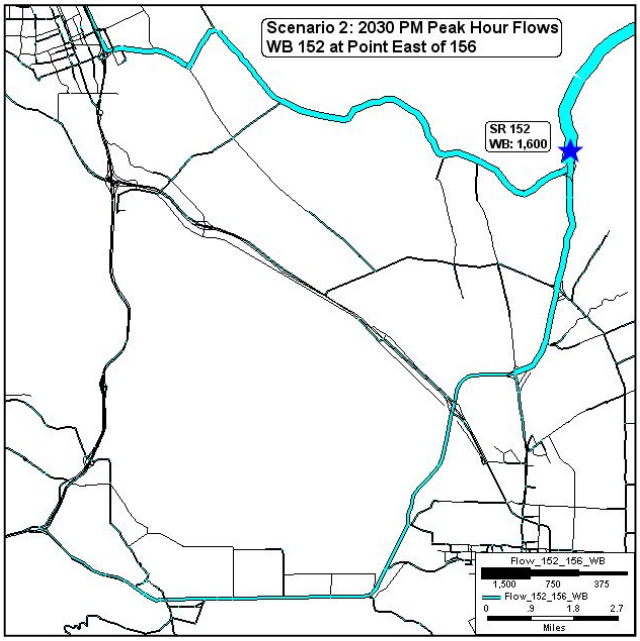
SR 152 East of Ferguson Road





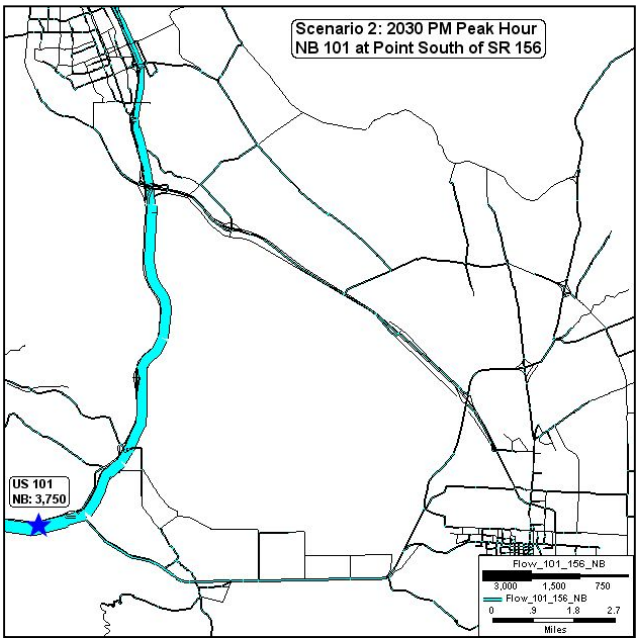
SR 152 East of SR 156

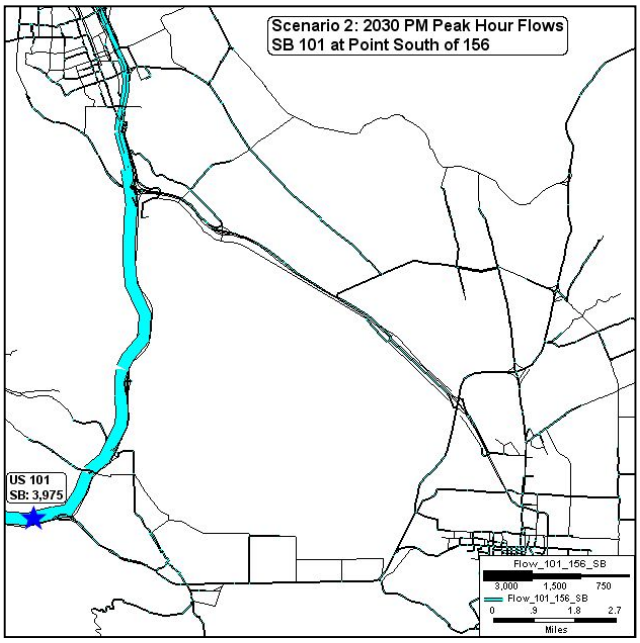




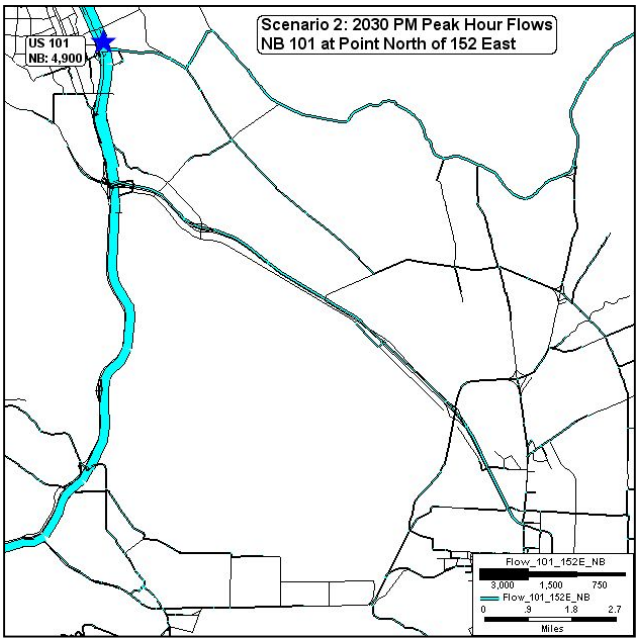
Scenario 2

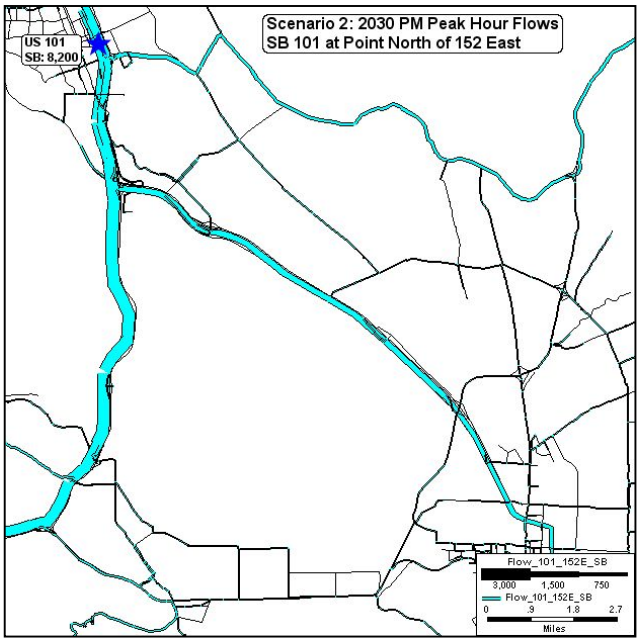
US 101 South of SR 156





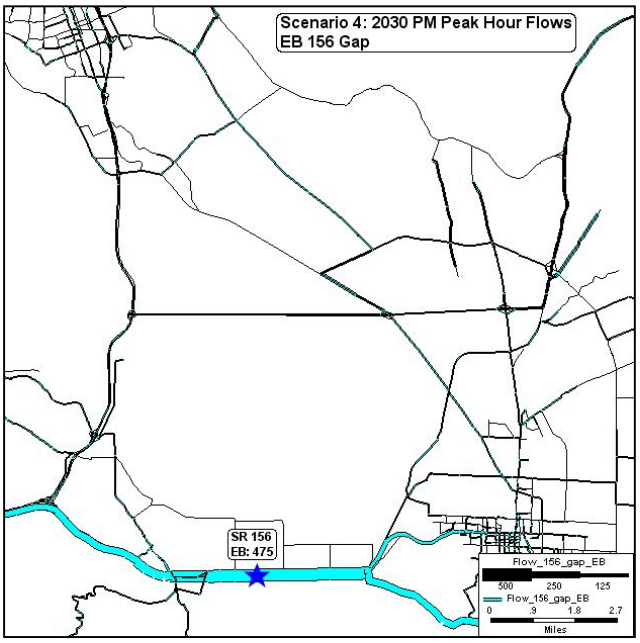
US 101 North of SR 152 East

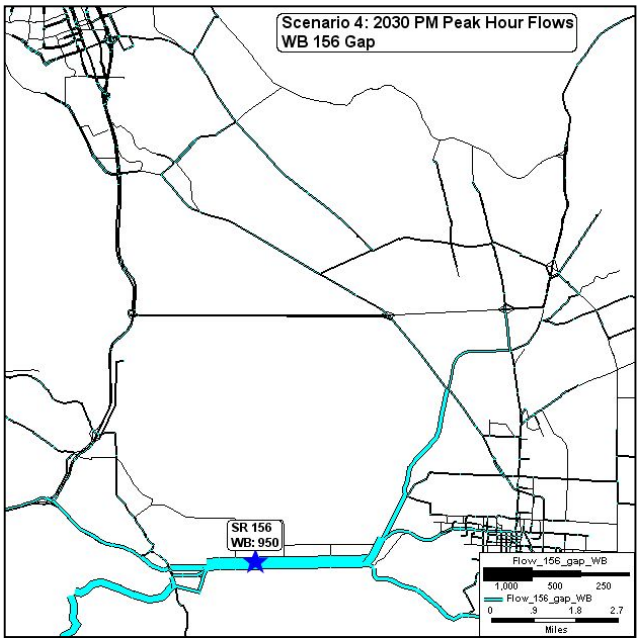




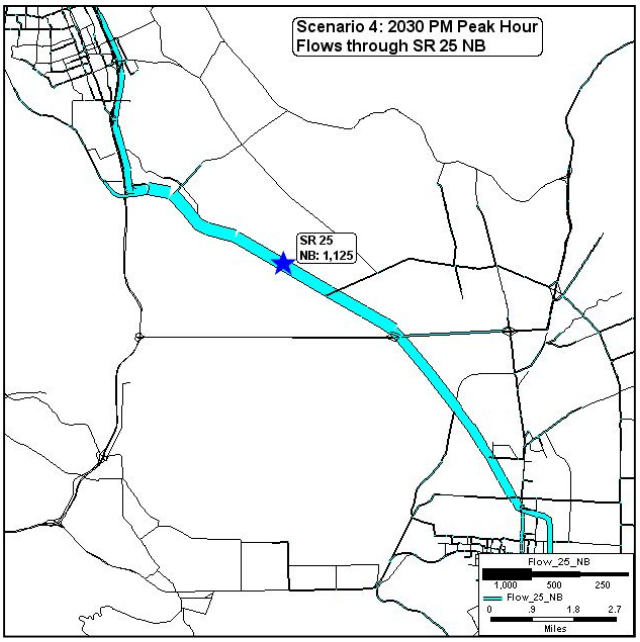
Scenario 4

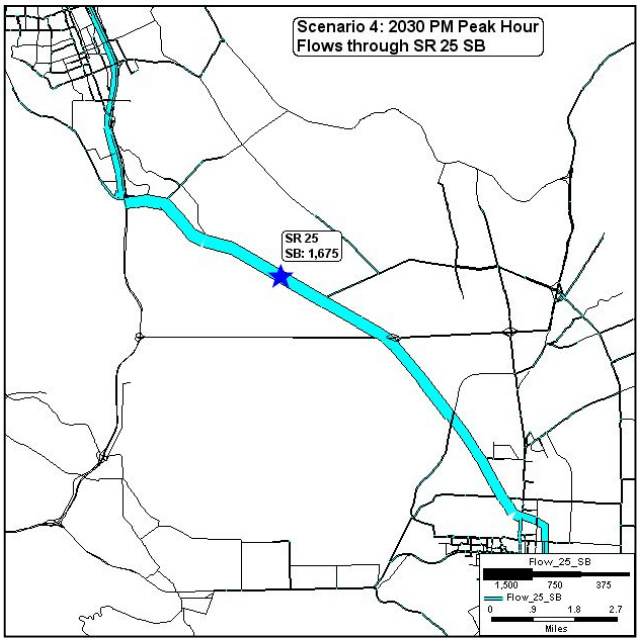
SR 156 between San Juan Bautista and Hollister





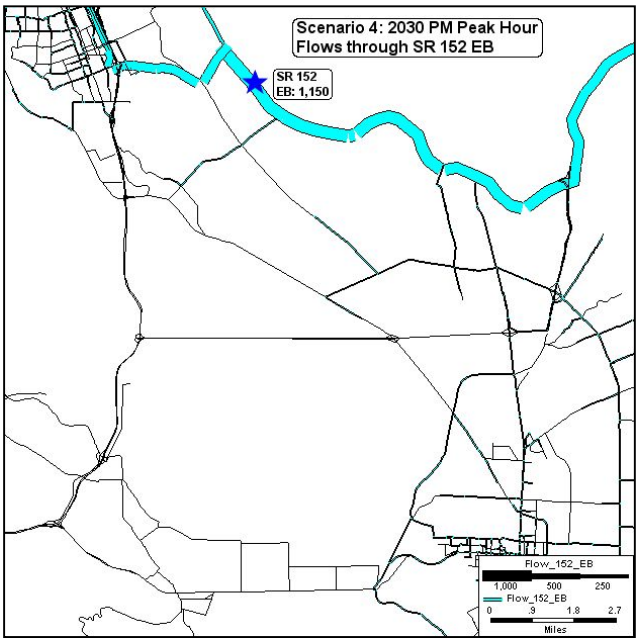
SR 25 North of Shore Road

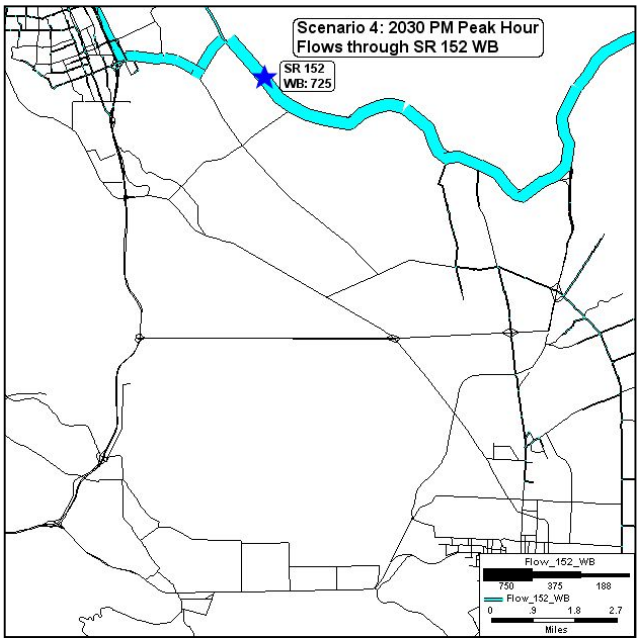




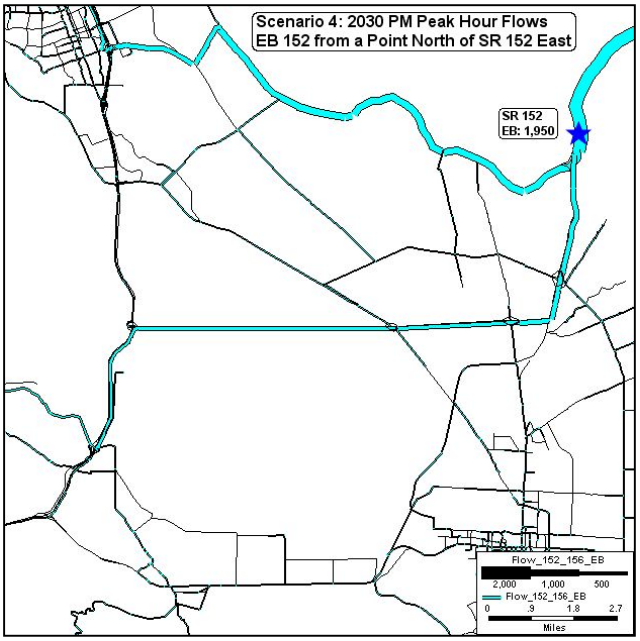
Scenario 4

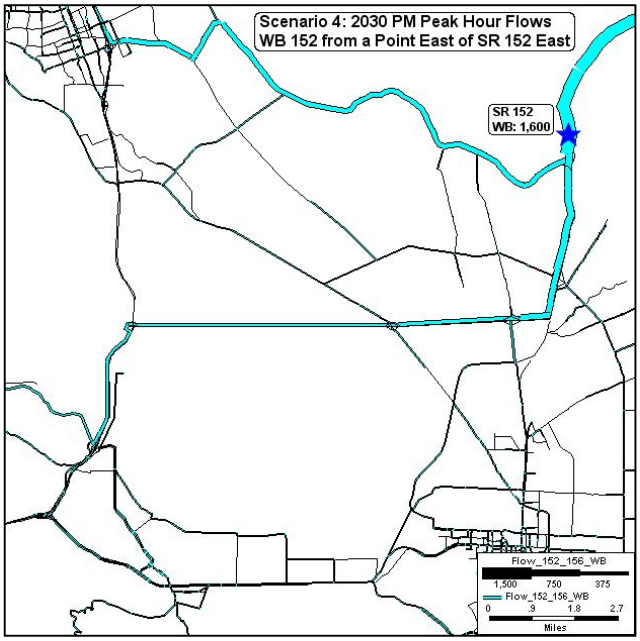
SR 152 East of Ferguson Road





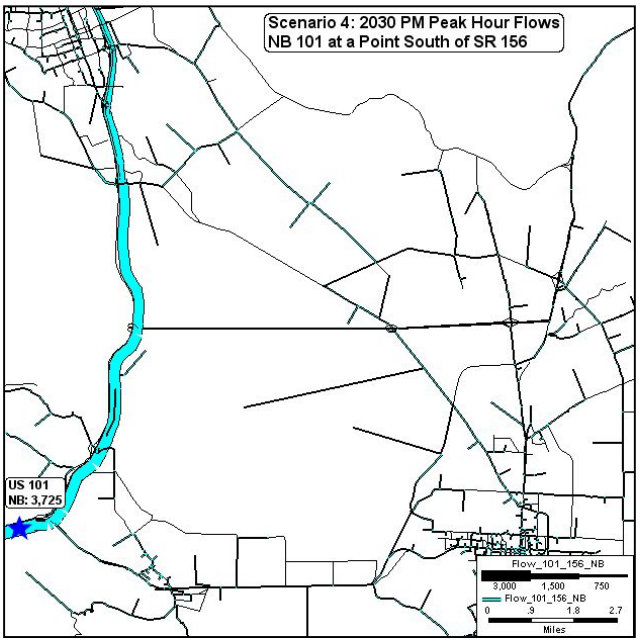
SR 152 East of SR 156

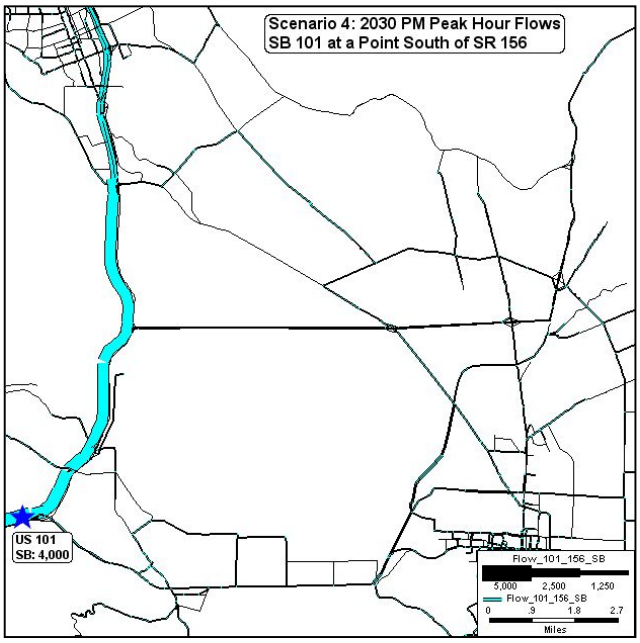




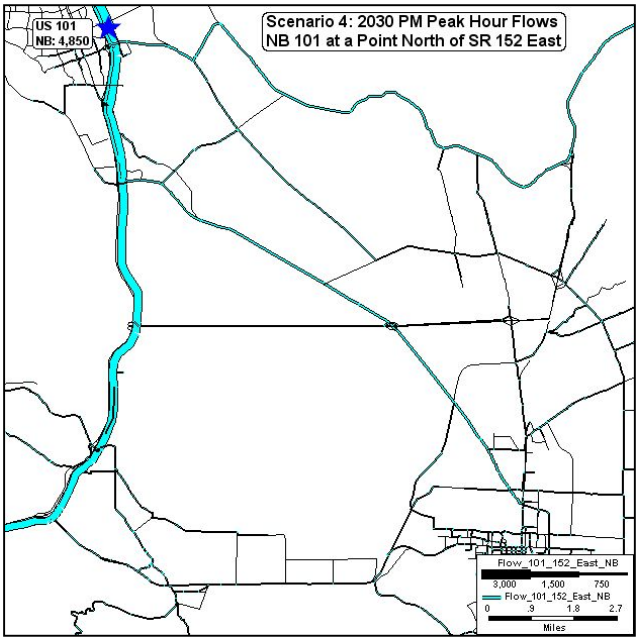
Scenario 4

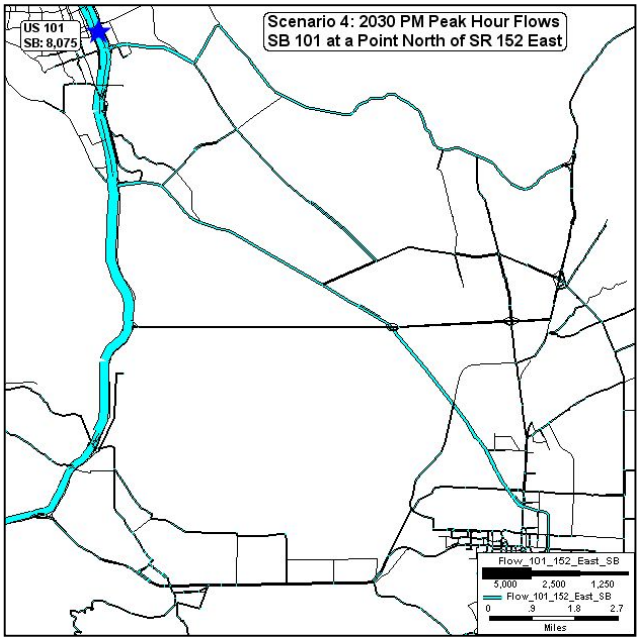
US 101 North of SR 156





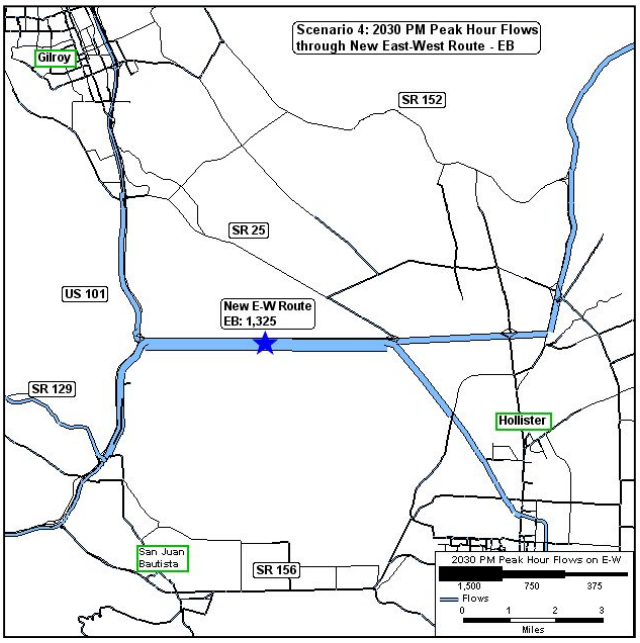
US 101 North of SR 152 East

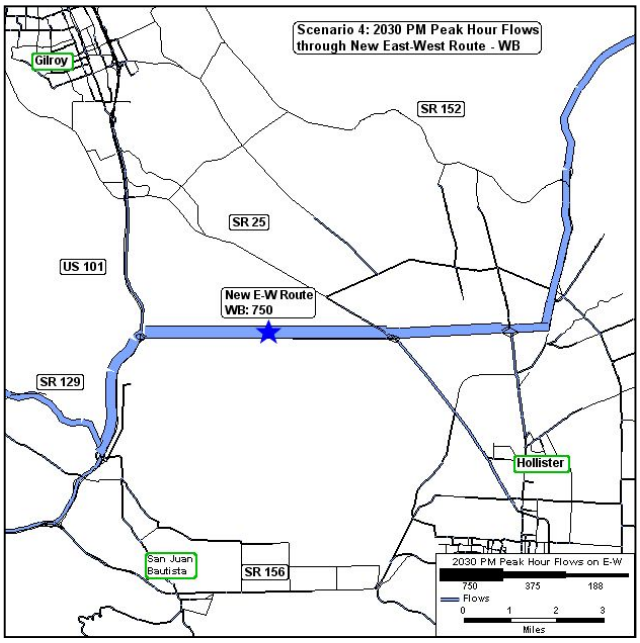




Scenario 4

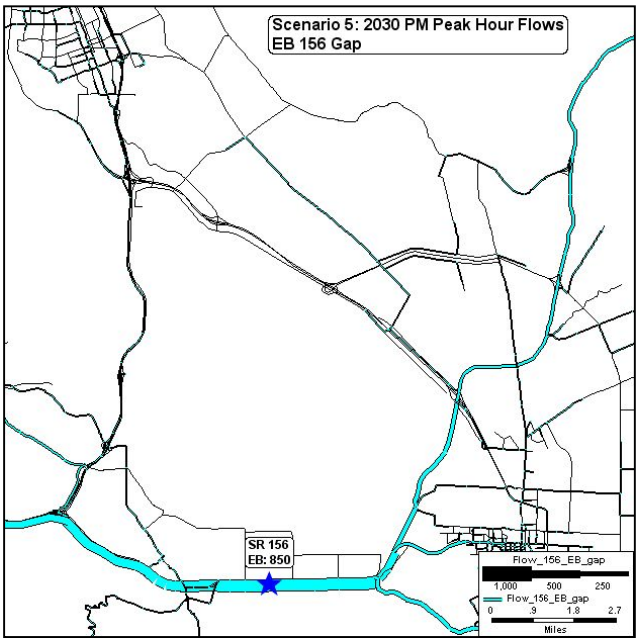
New East-West Route

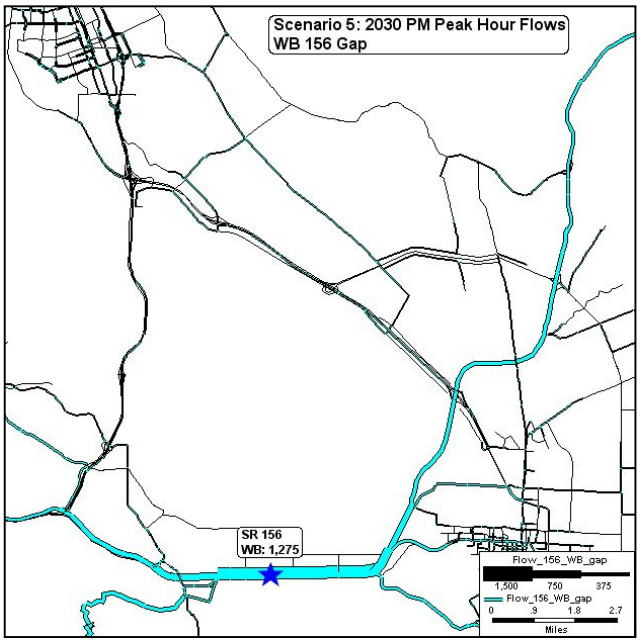




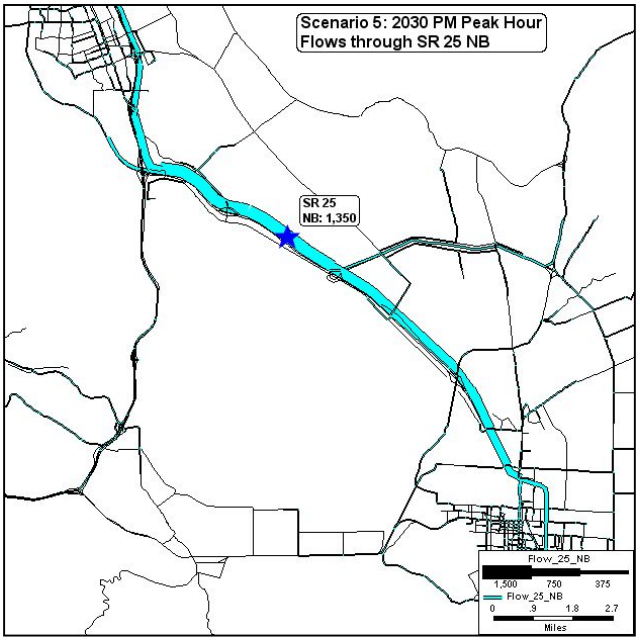
Scenario 5

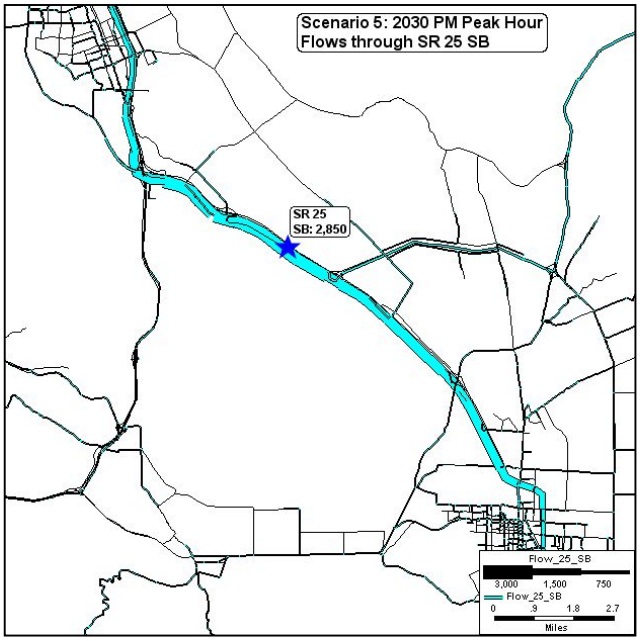
SR 156 between San Juan Bautista and Hollister





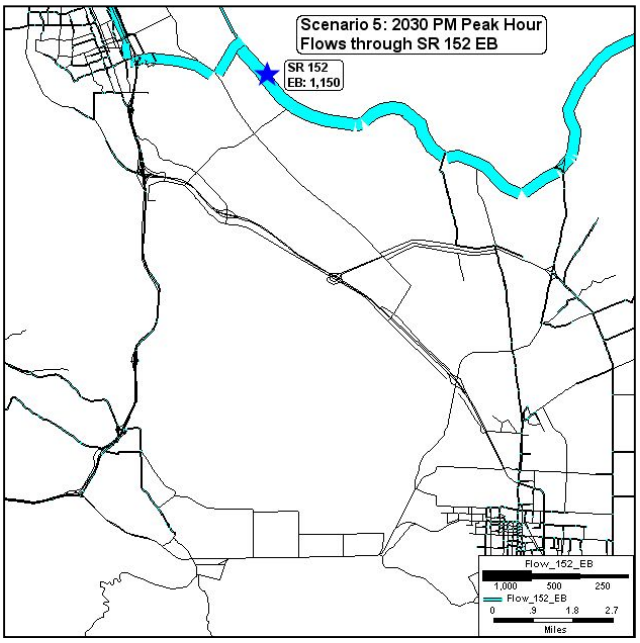
SR 25 North of Shore Road

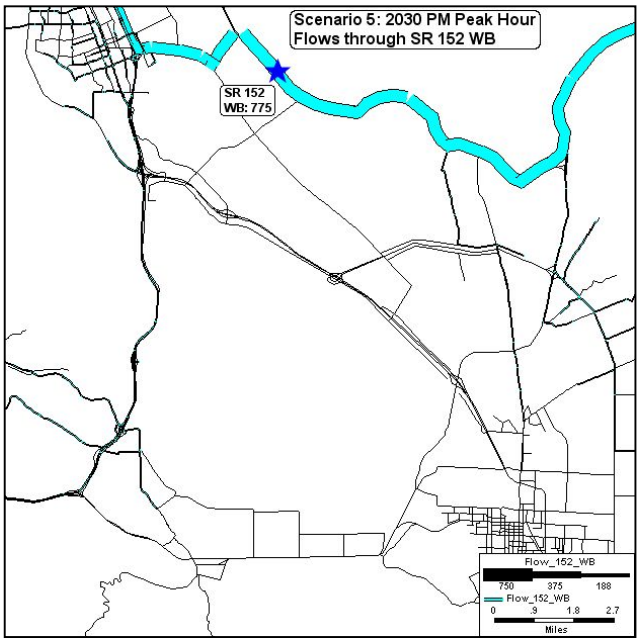




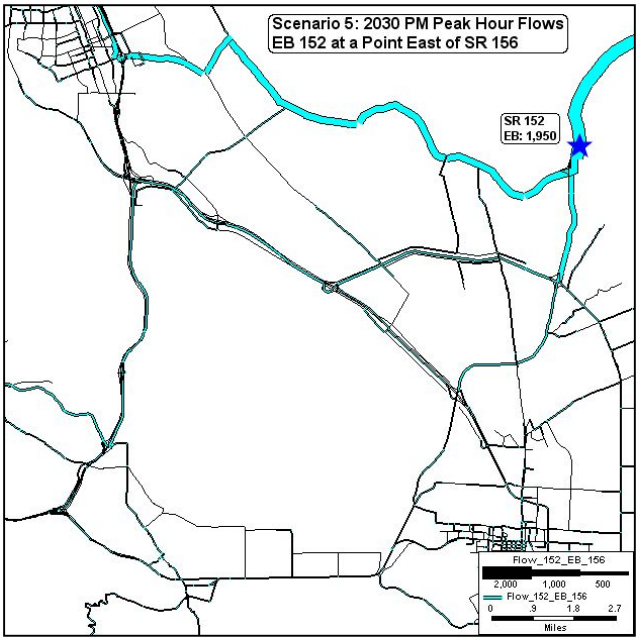
Scenario 5

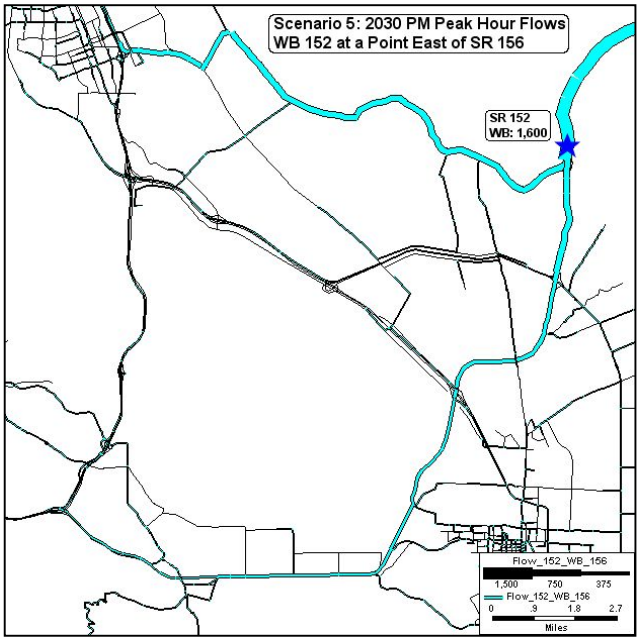
SR 152 East of Ferguson Road





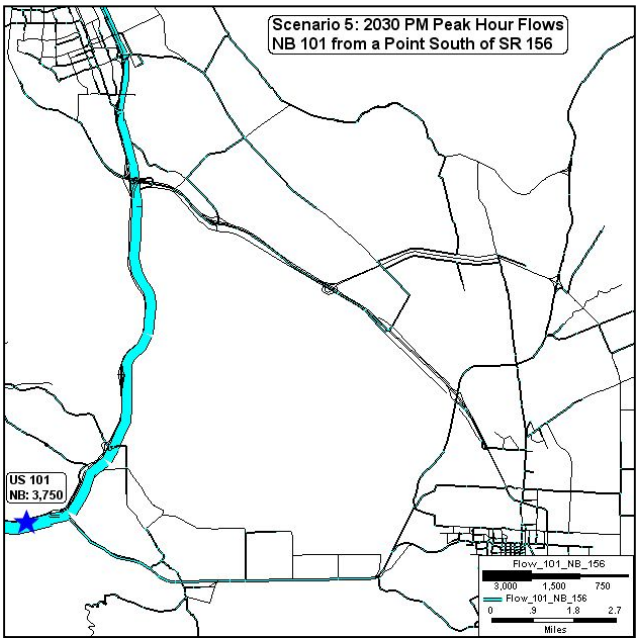
SR 152 East of SR 156

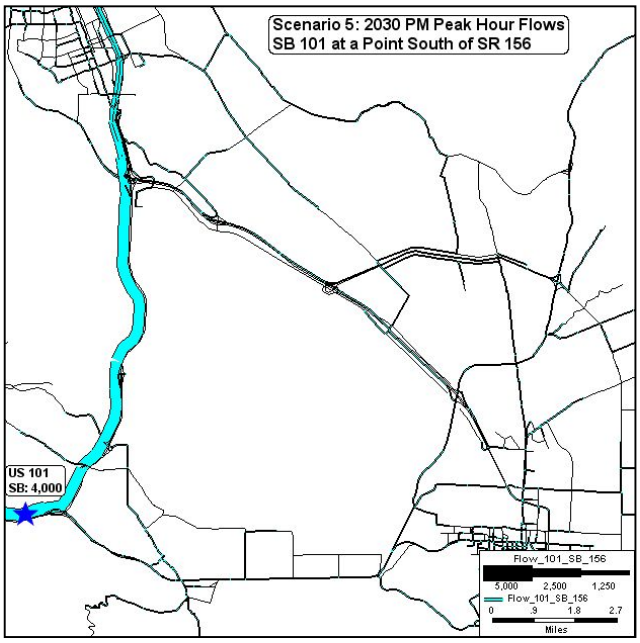




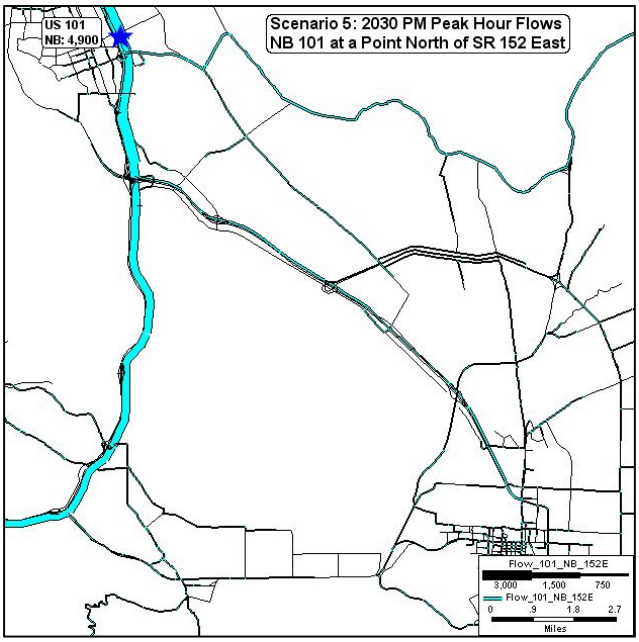
Scenario 5

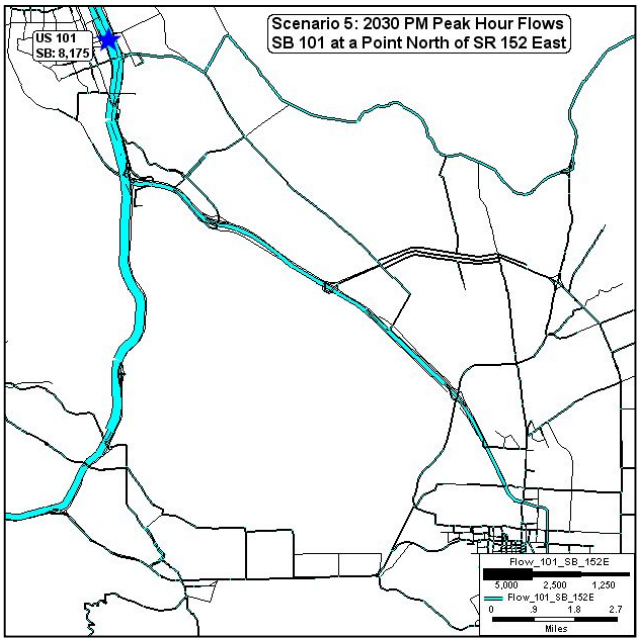
US 101 South of SR 156





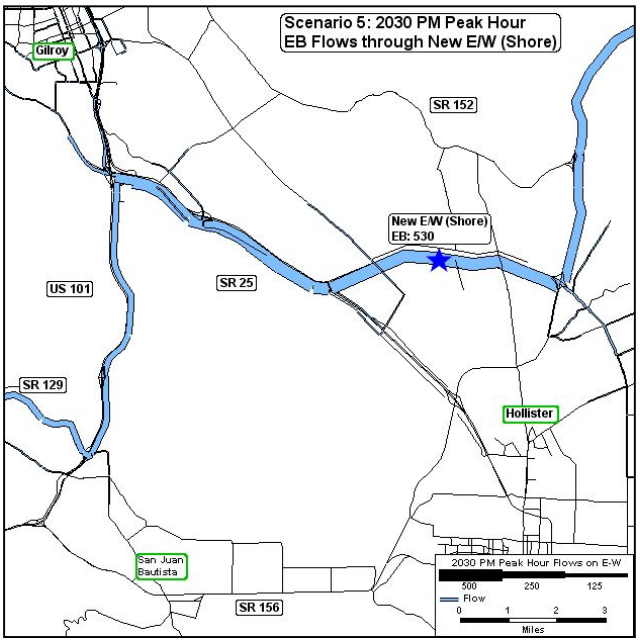
US 101 North of SR 152 East

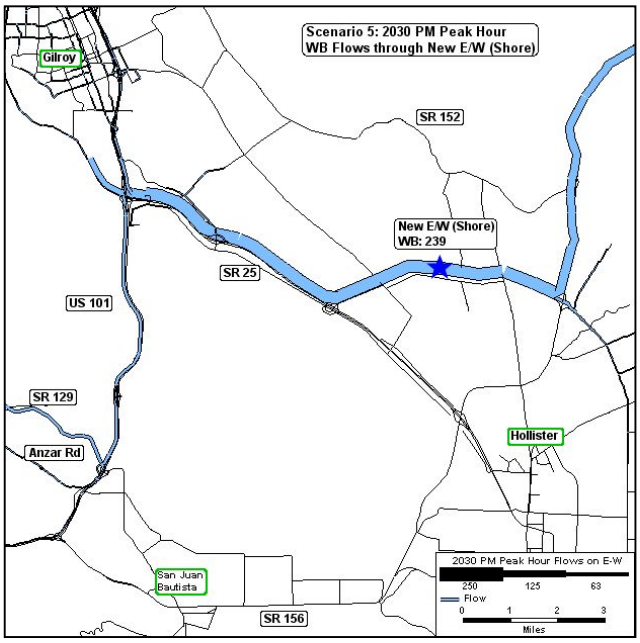




Scenario 5

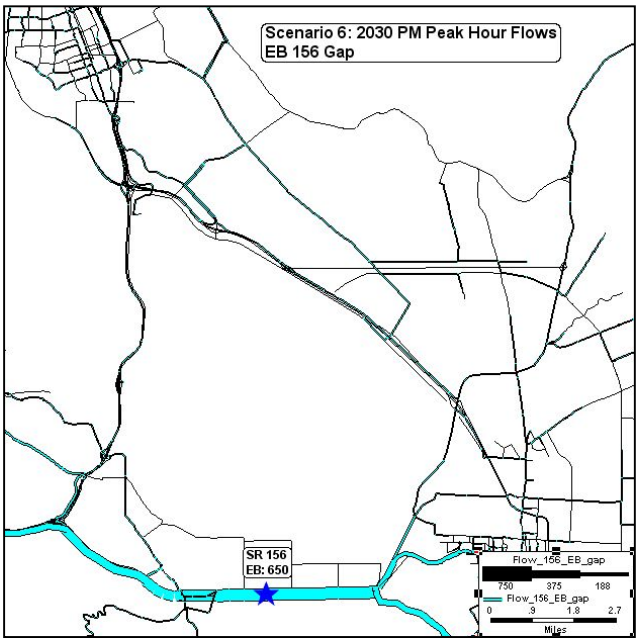
New East-West Route

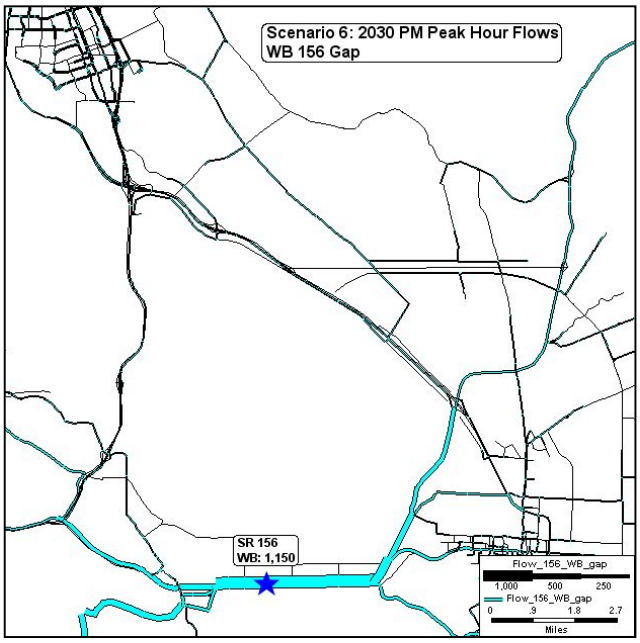




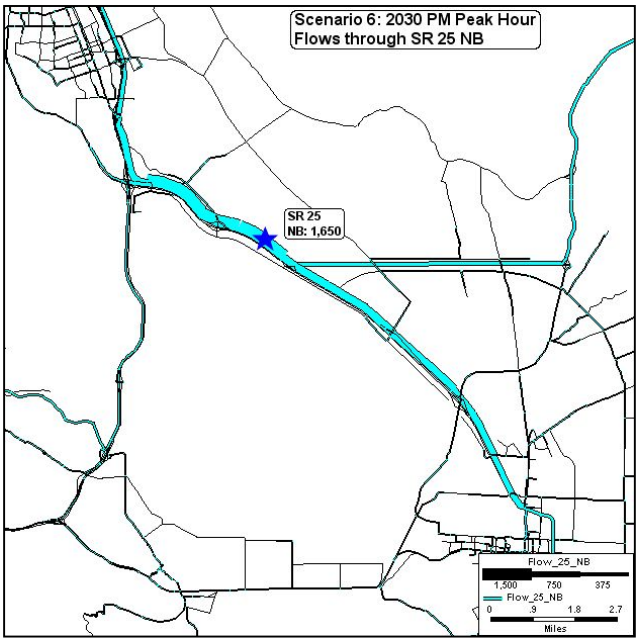
Scenario 6

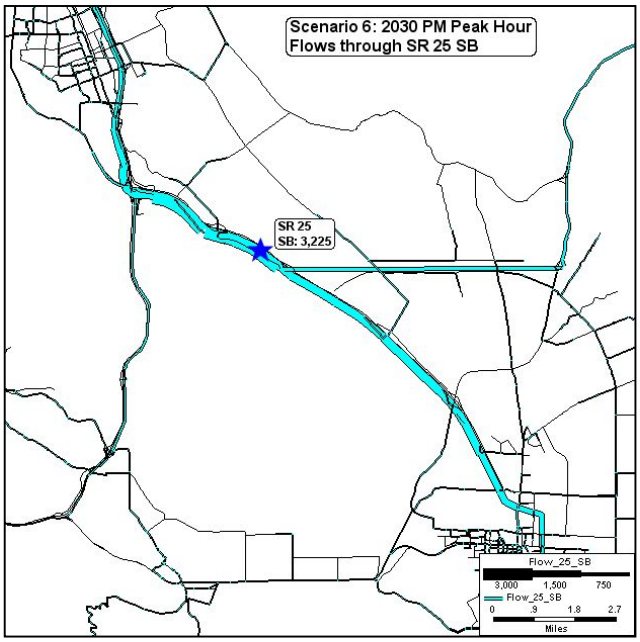
SR 156 between San Juan Bautista and Hollister





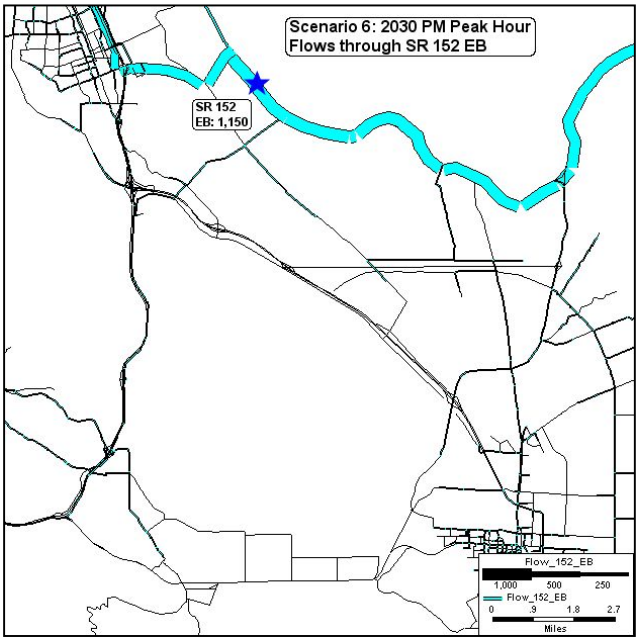
SR 25 North of Shore Road

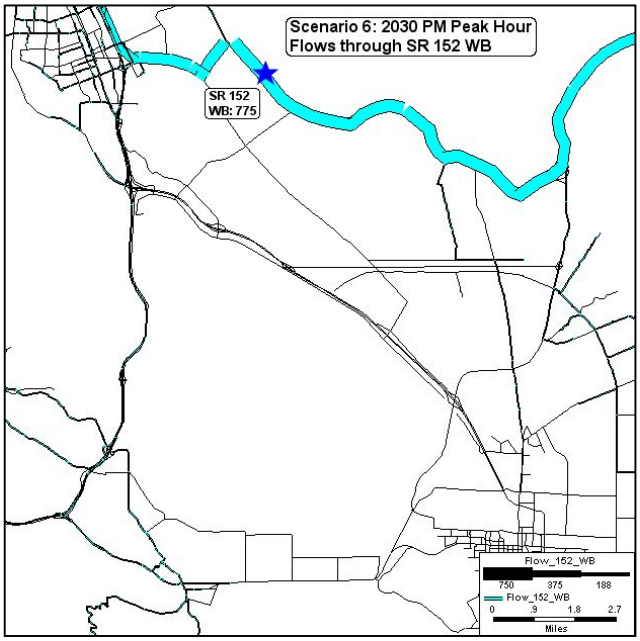




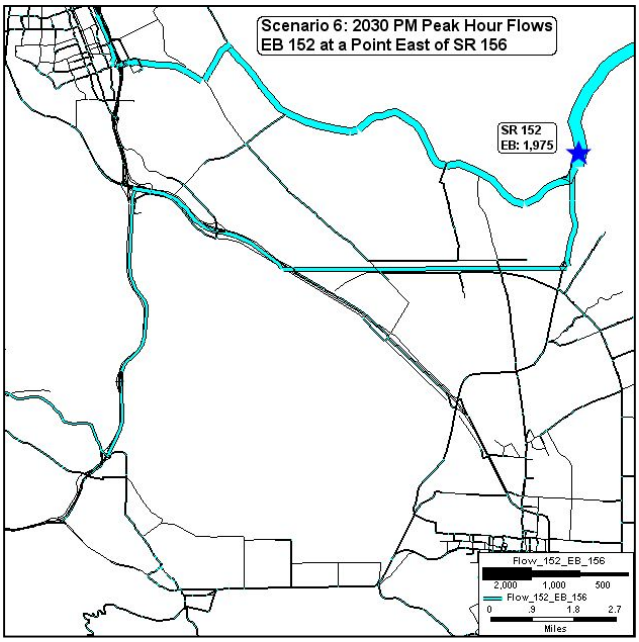
Scenario 6

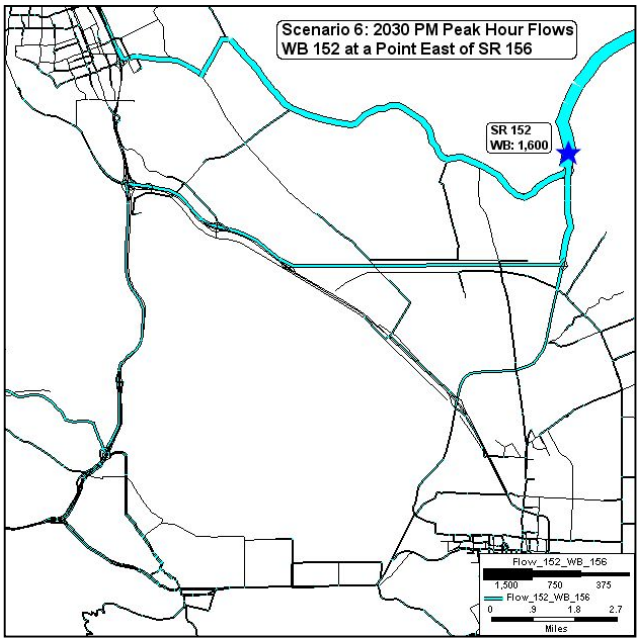
SR 152 East of Ferguson Road





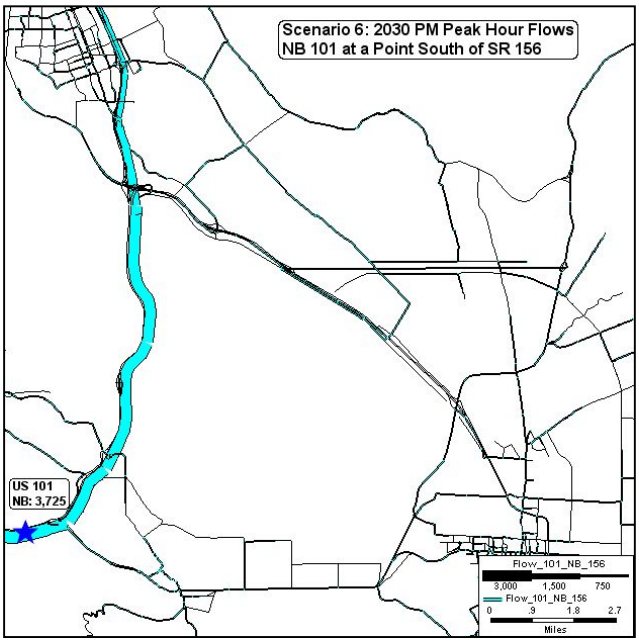
SR 152 East of SR 156

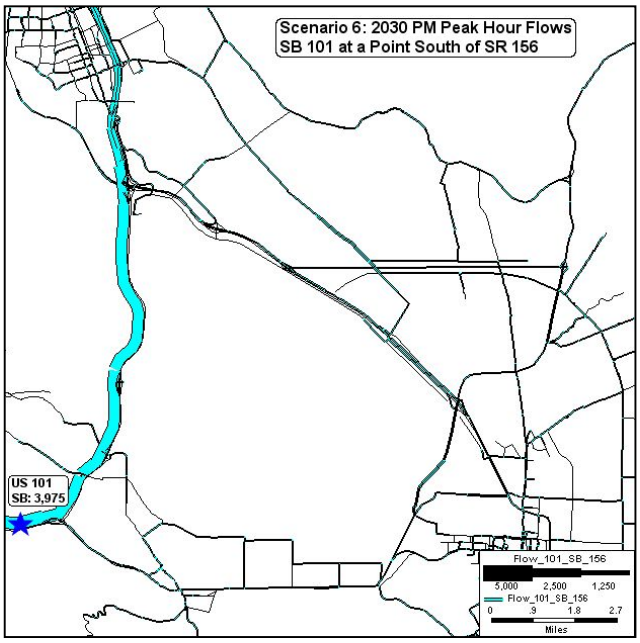




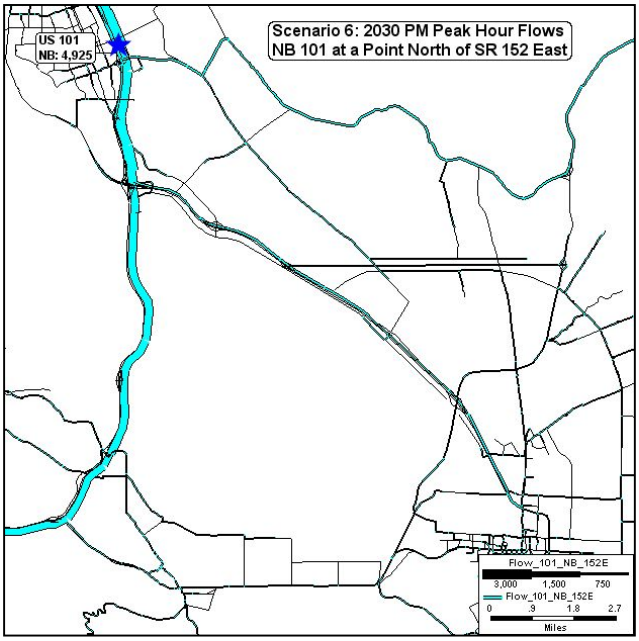
Scenario 6

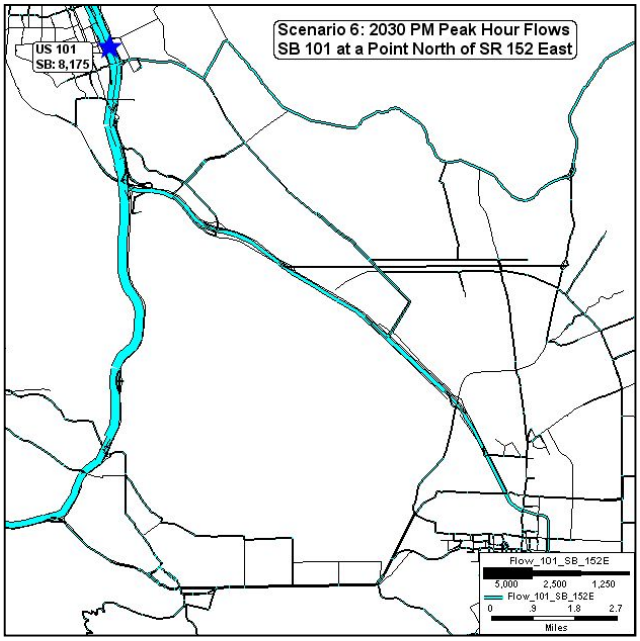
US 101 South of SR 156





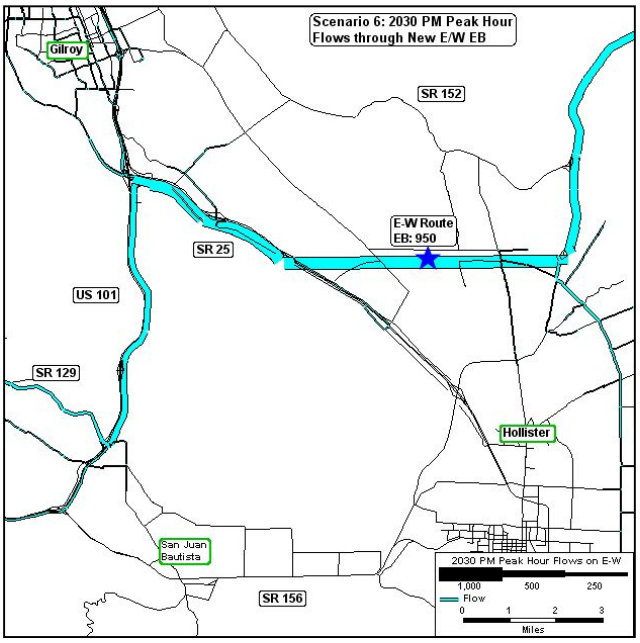
US 101 North of SR 152 East

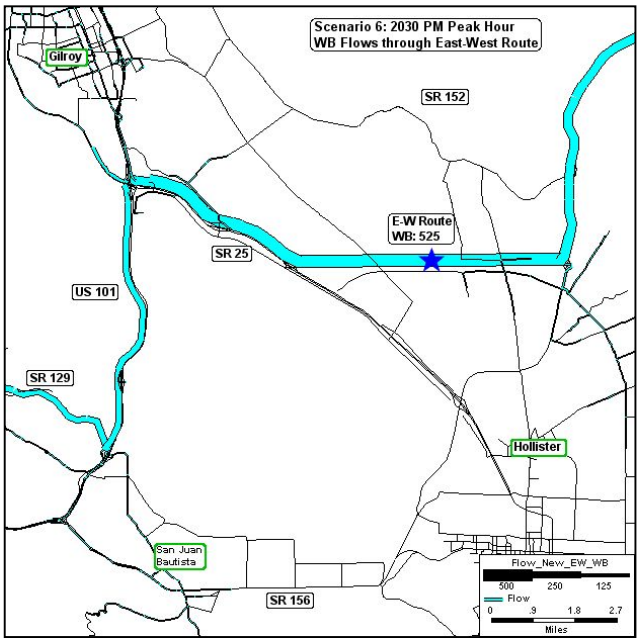




Scenario 6

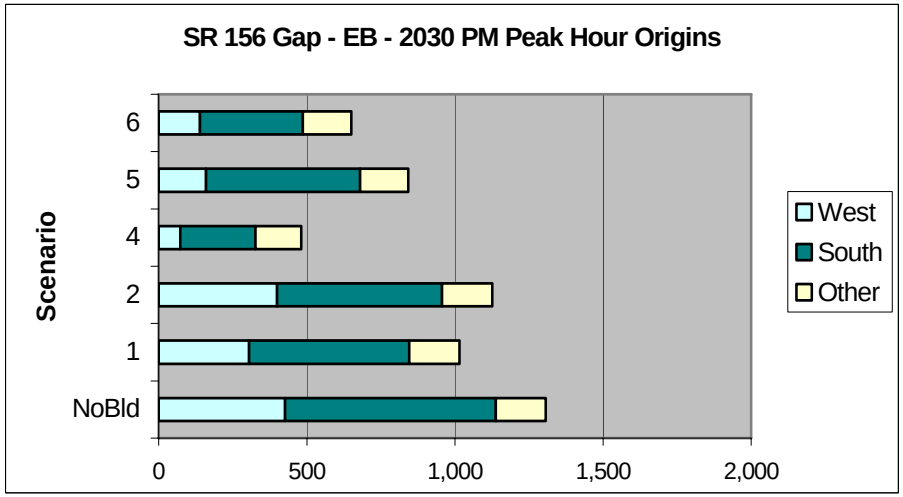
New East-West Route

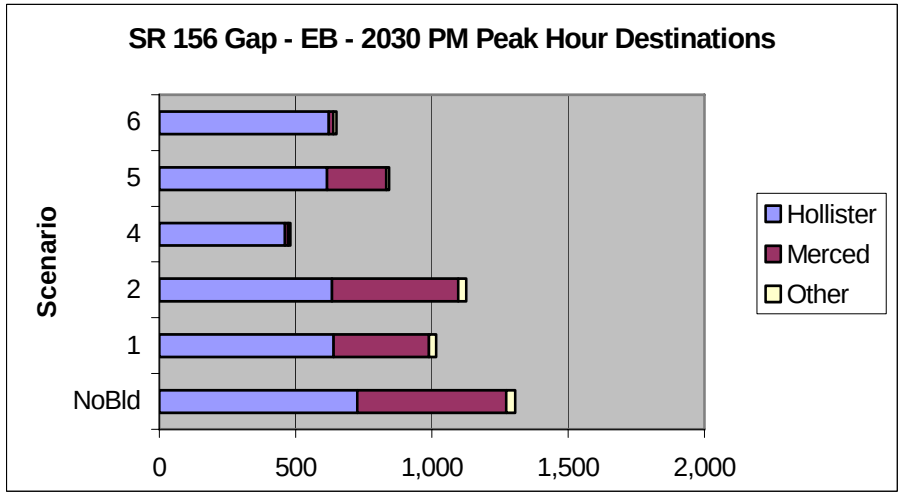




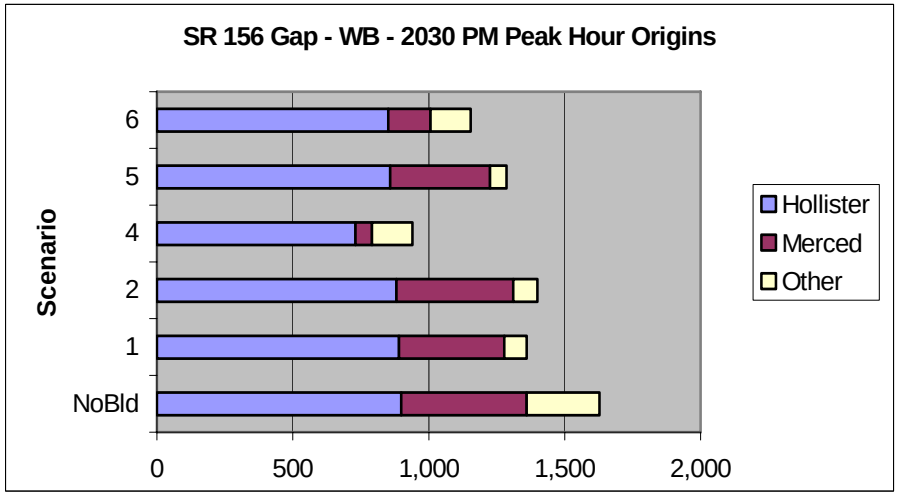
Appendix E2: Origin and Destination Comparison

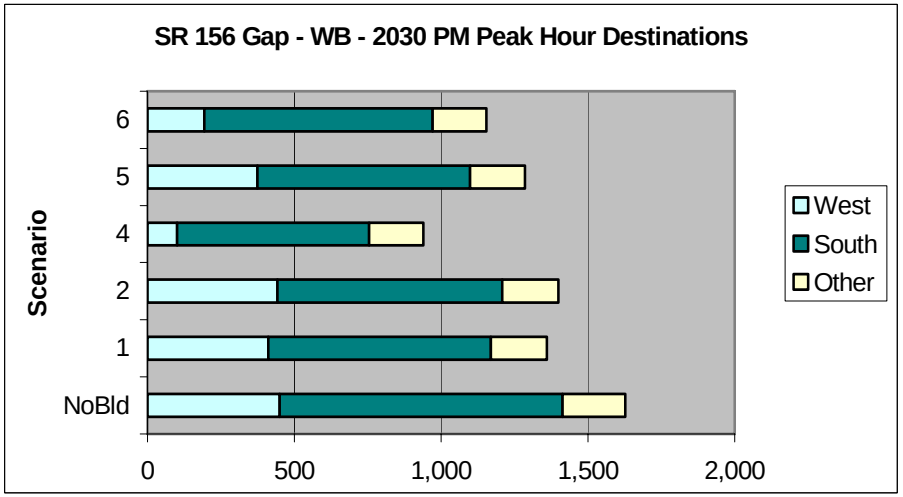
SR 156 between San Juan Bautista and Hollister – EB



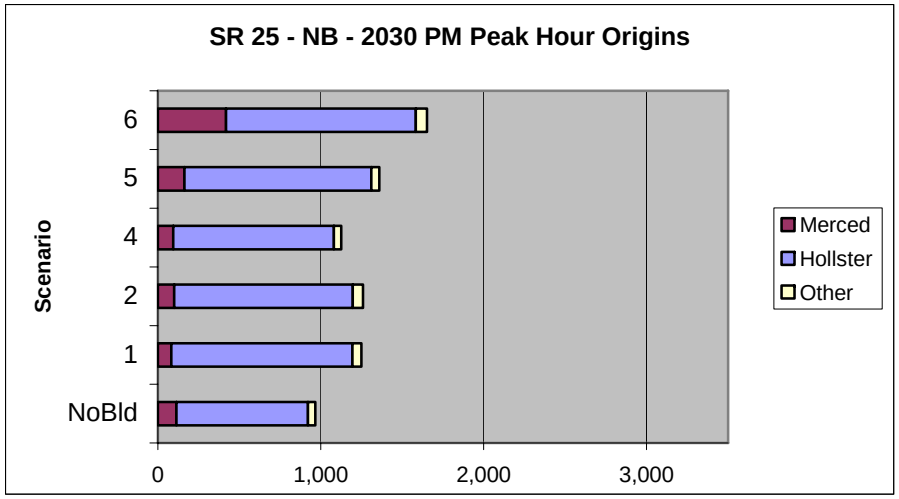


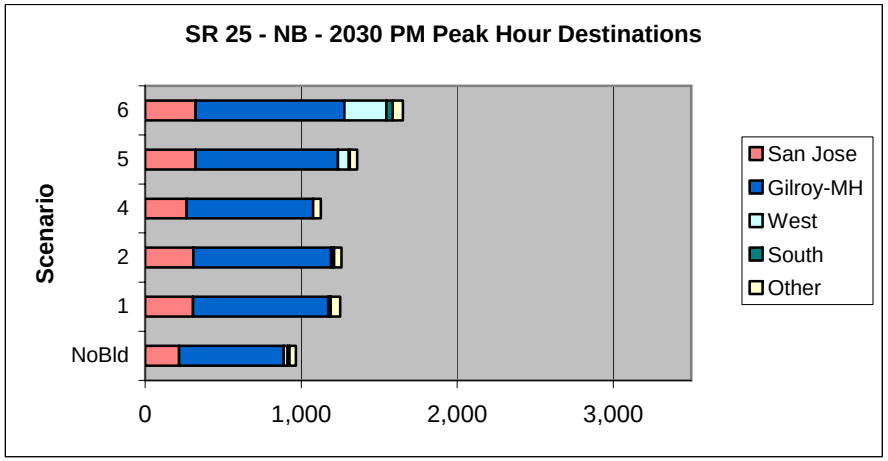
SR 156 between San Juan Bautista and Hollister – WB



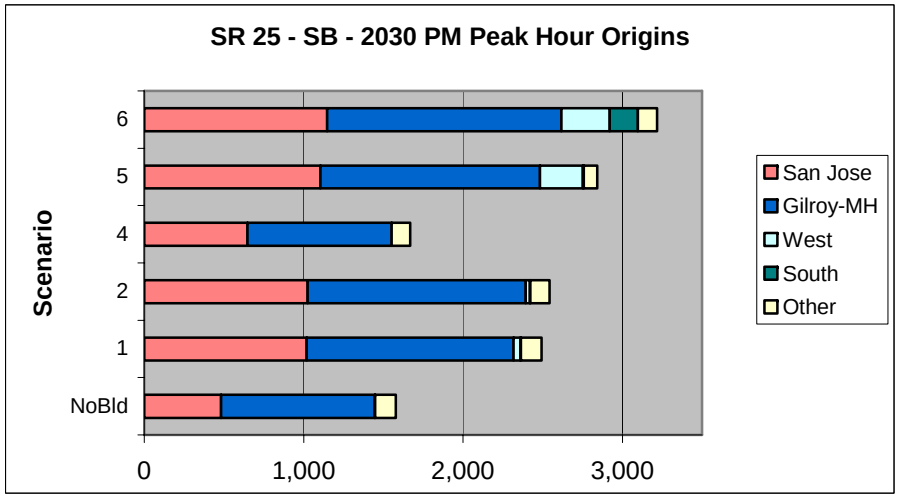


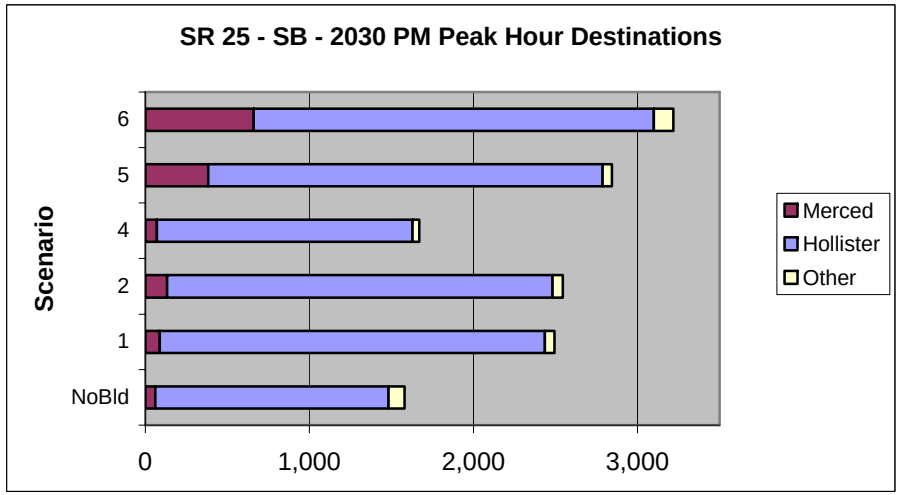
SR 25 North of Shore Road – NB



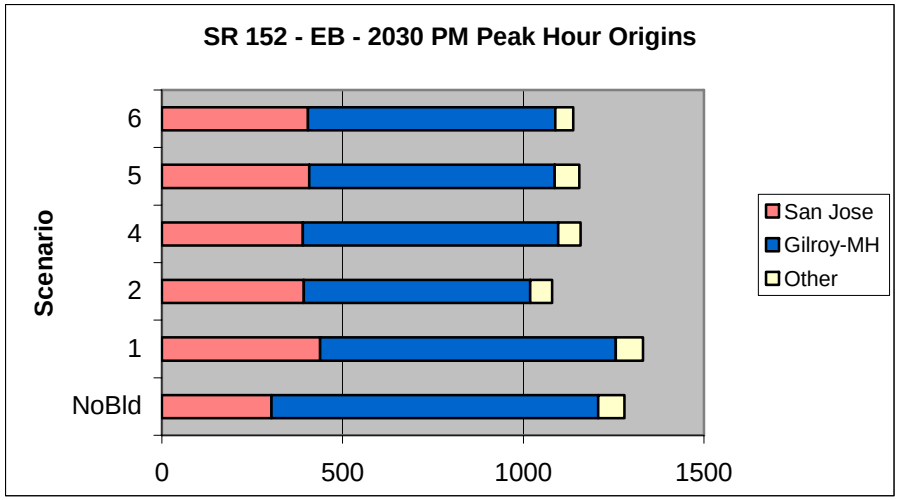


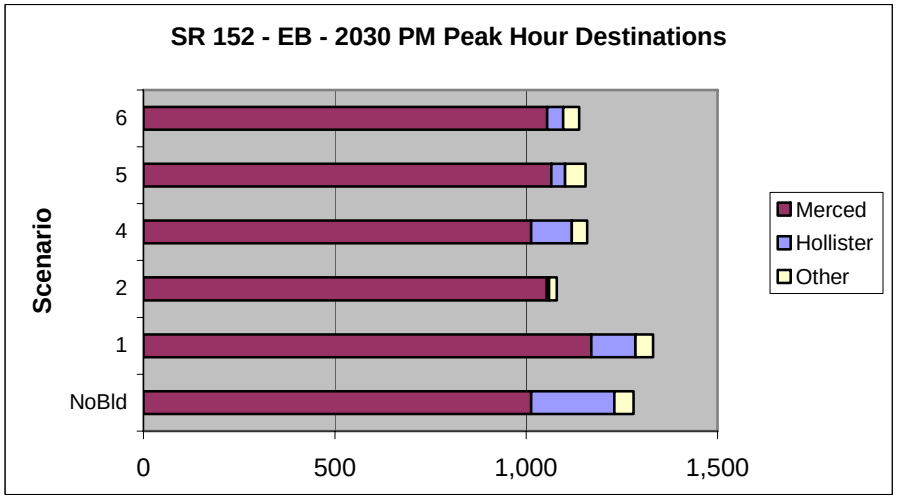
SR 25 North of Shore Road – SB



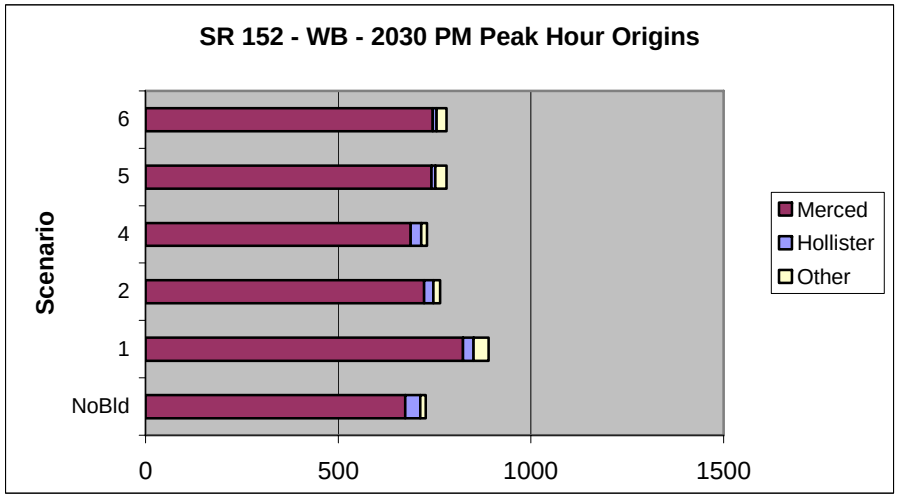


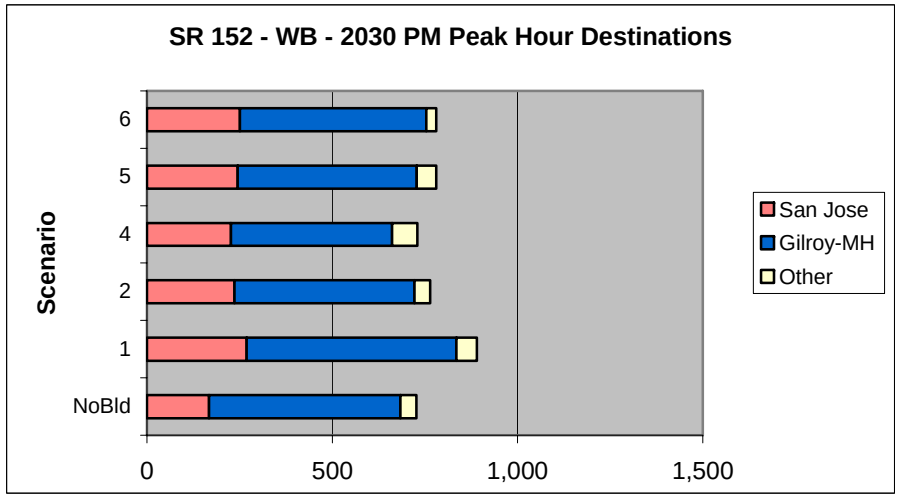
SR 152 East of Ferguson Road – EB



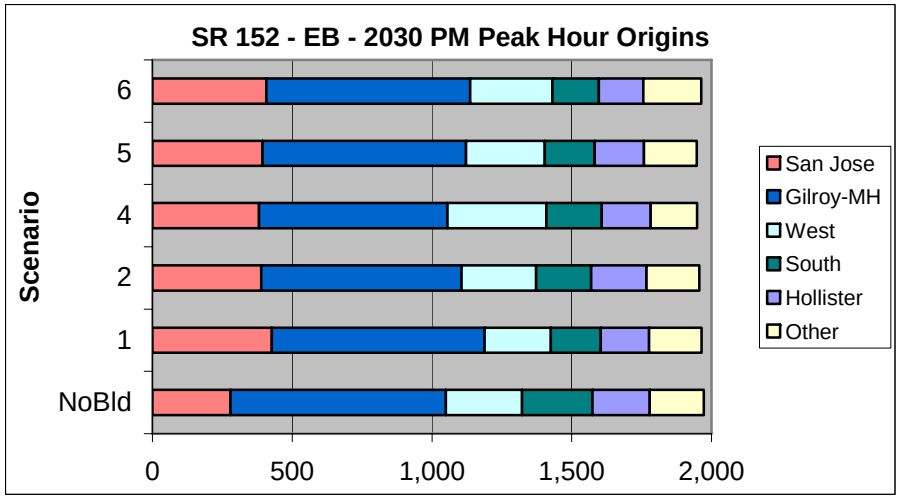


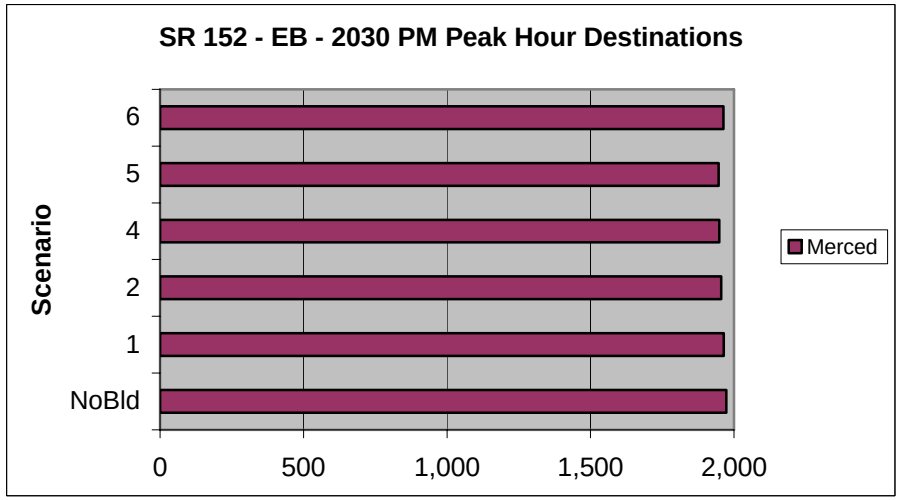
SR 152 East of Ferguson Road – WB



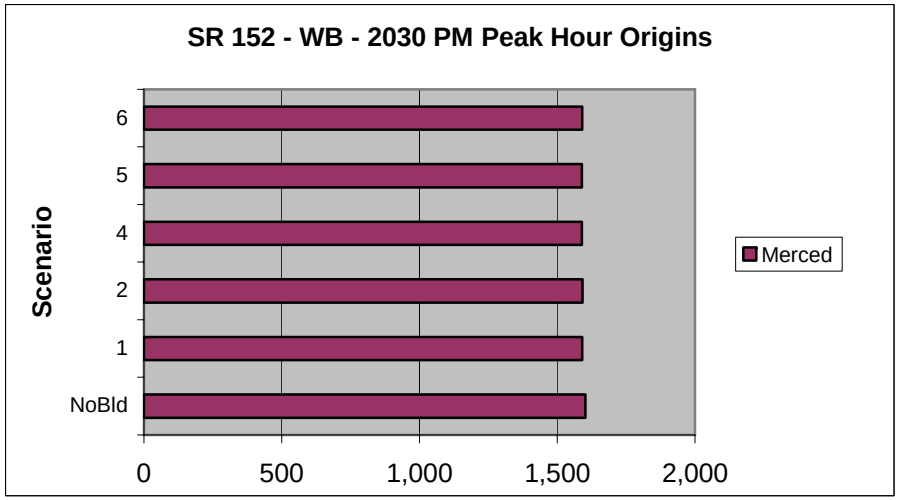


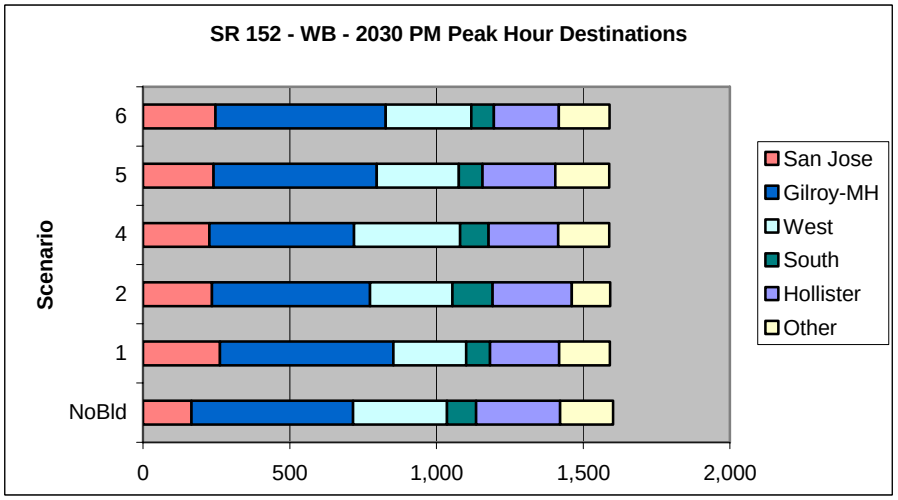
SR 152 East of SR 156 – EB



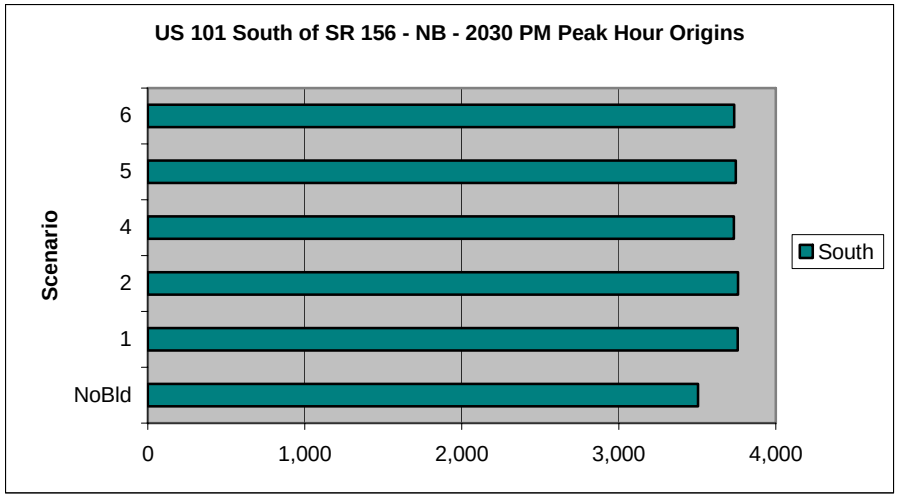


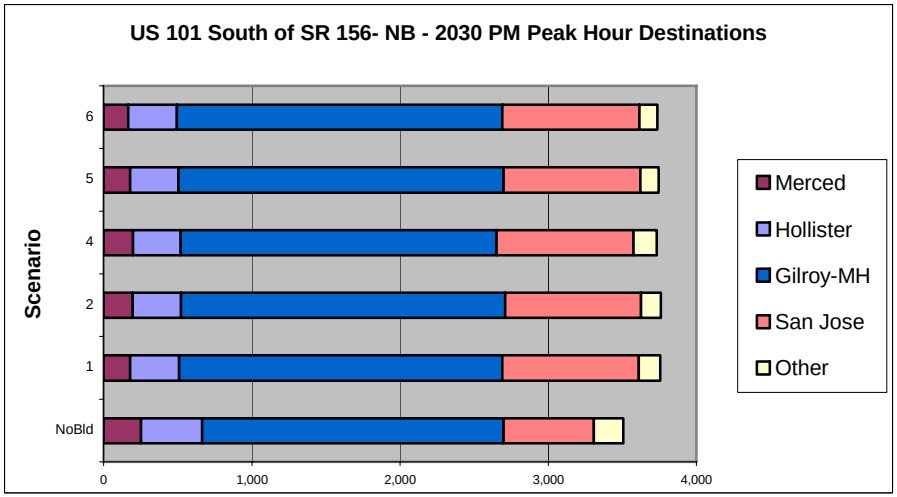
SR 152 East of SR 156 – WB



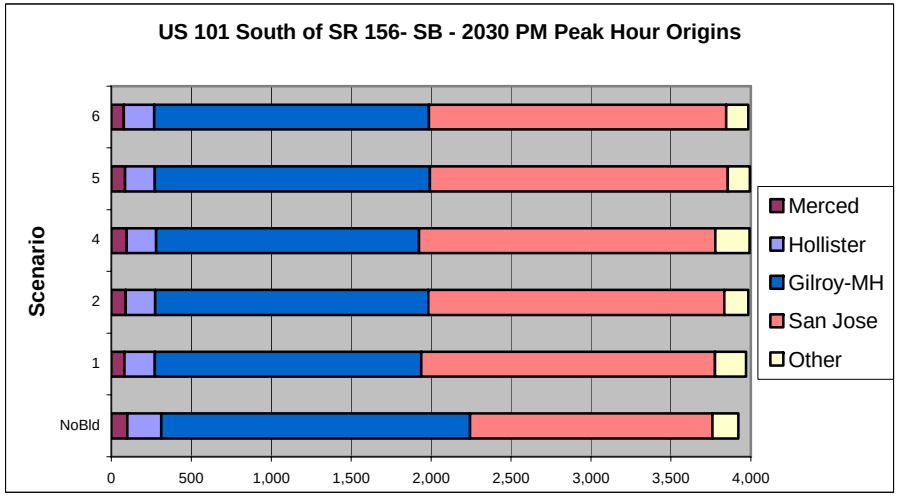


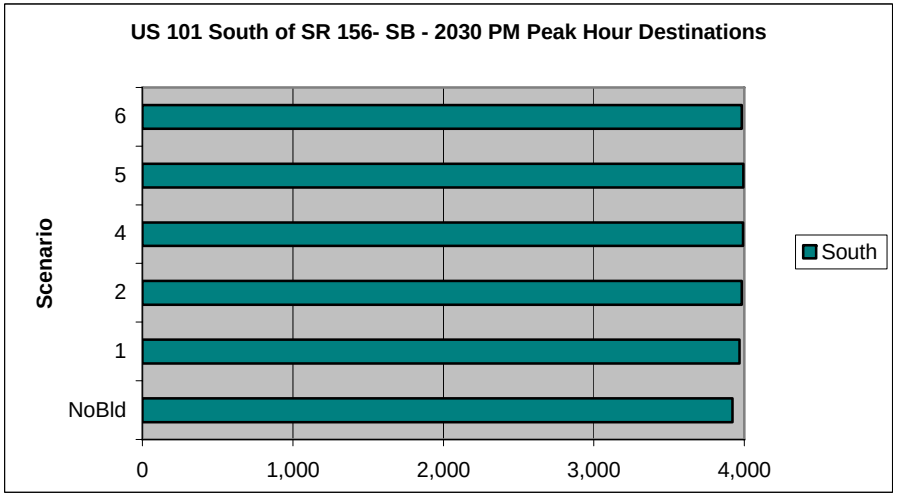
US 101 South of SR 156 – NB



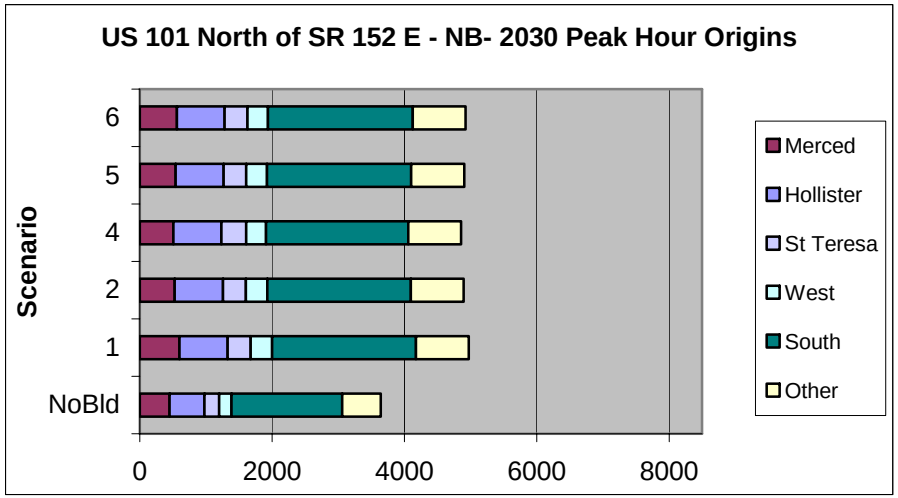


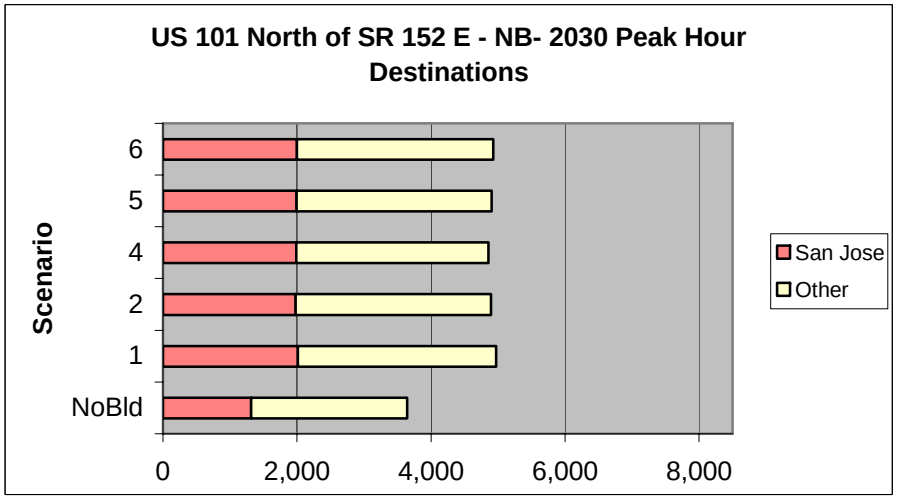
US 101 South of SR 156 – SB



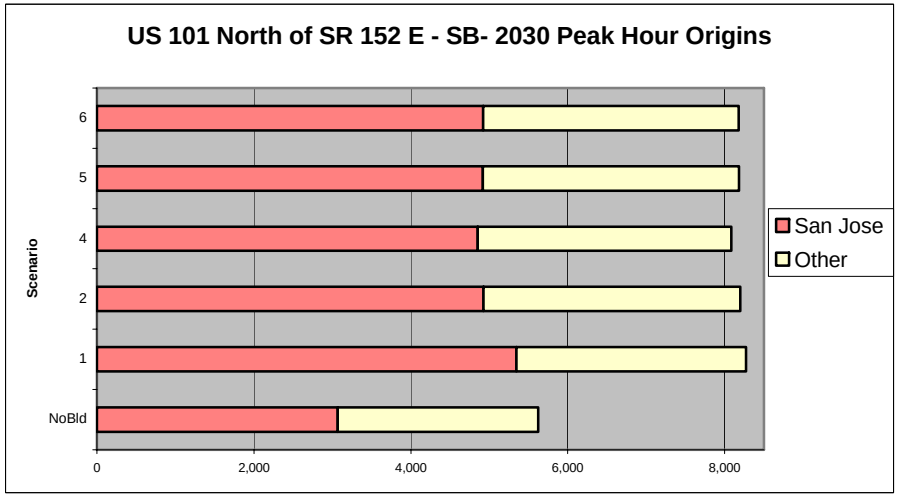


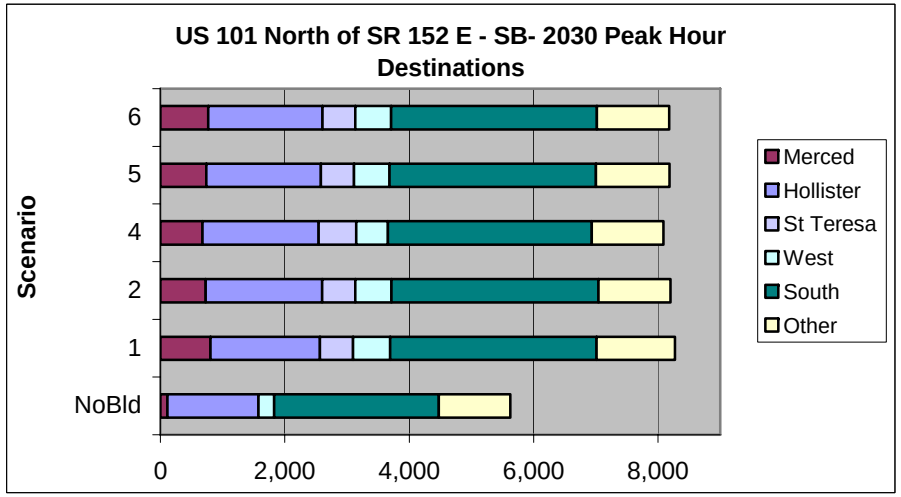
US 101 North of SR 152 East – NB



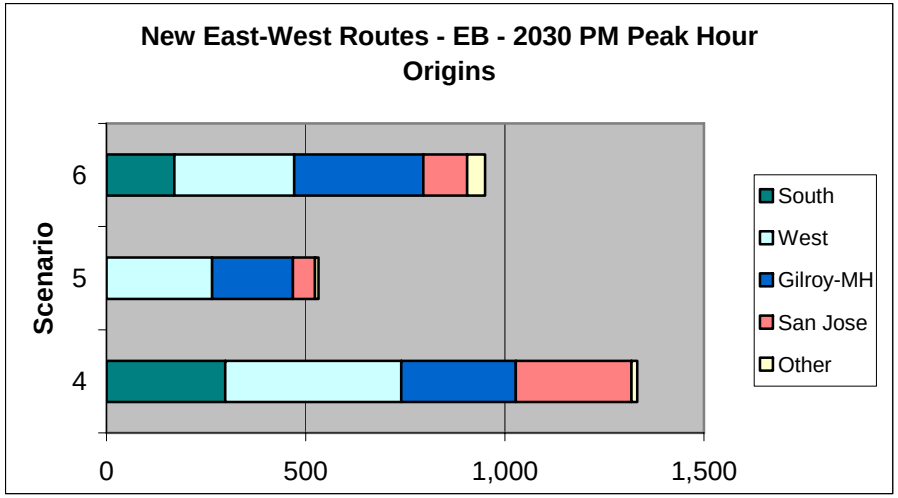


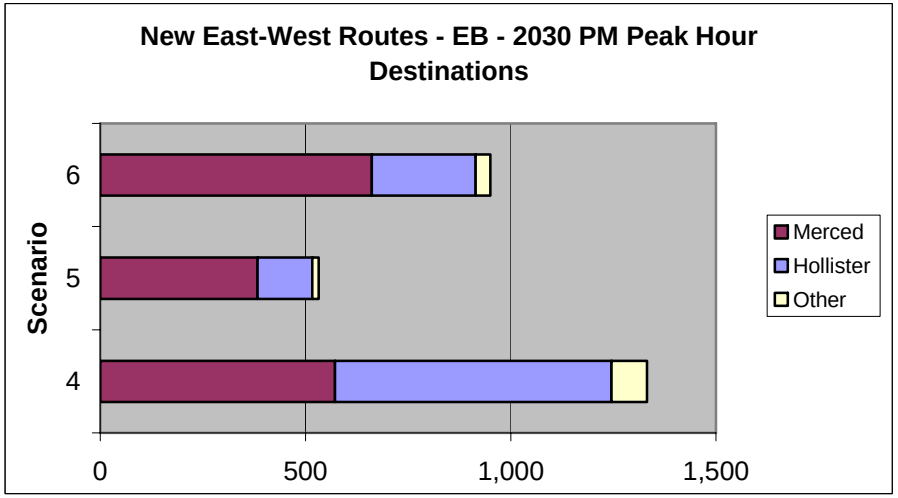
US 101 North of SR 152 East – SB



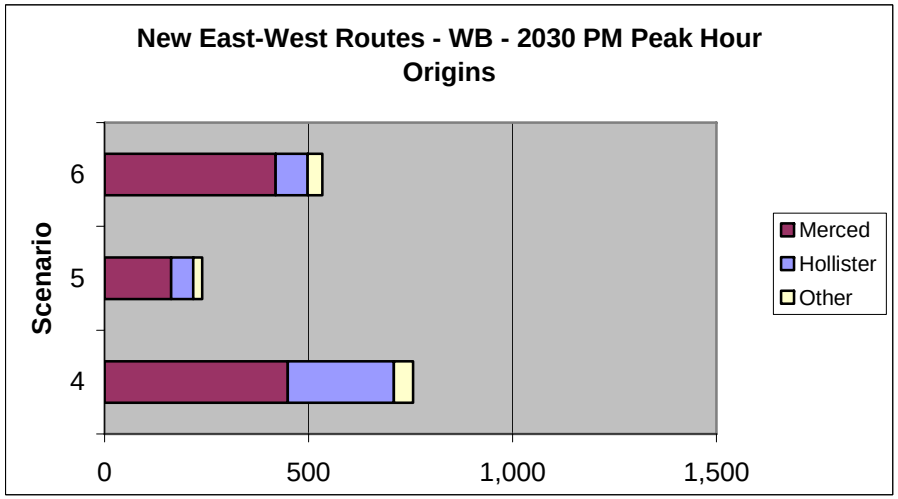


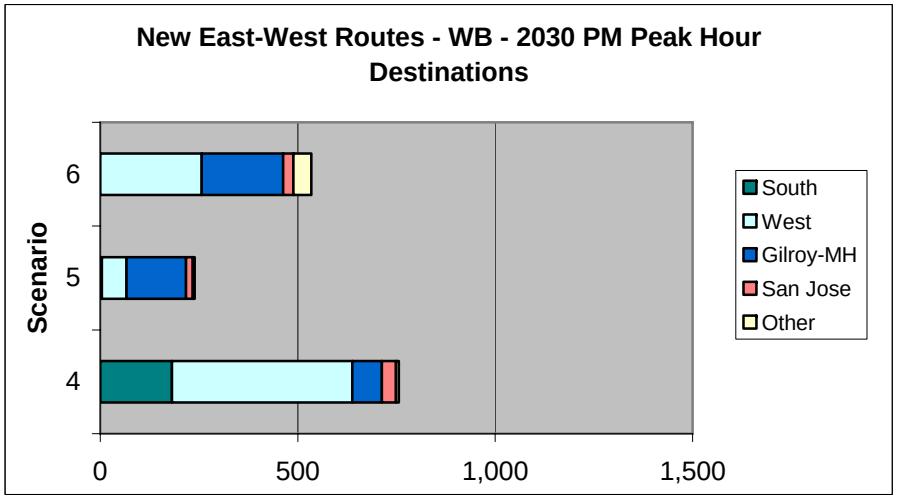
New East-West Routes – EB



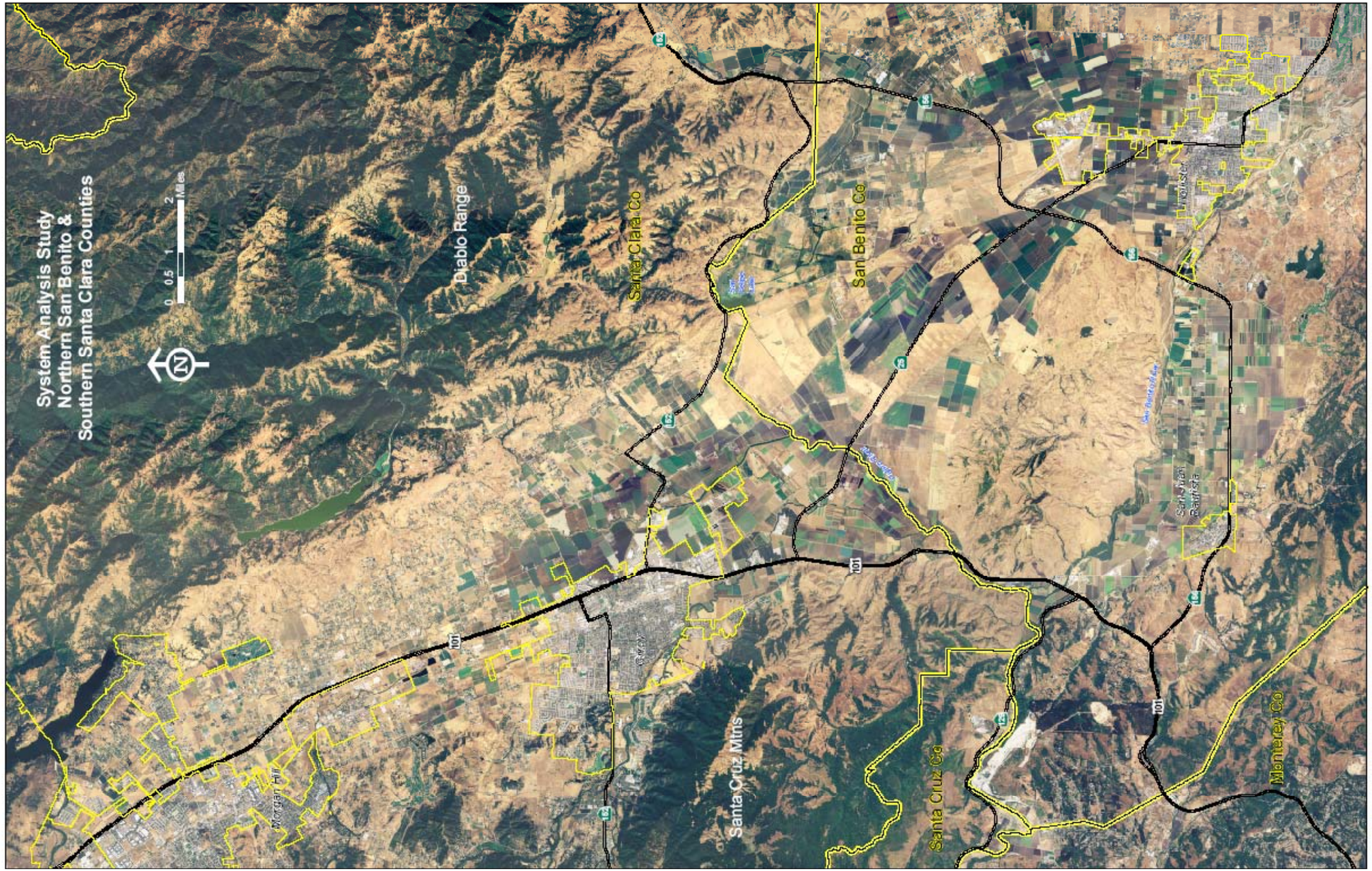


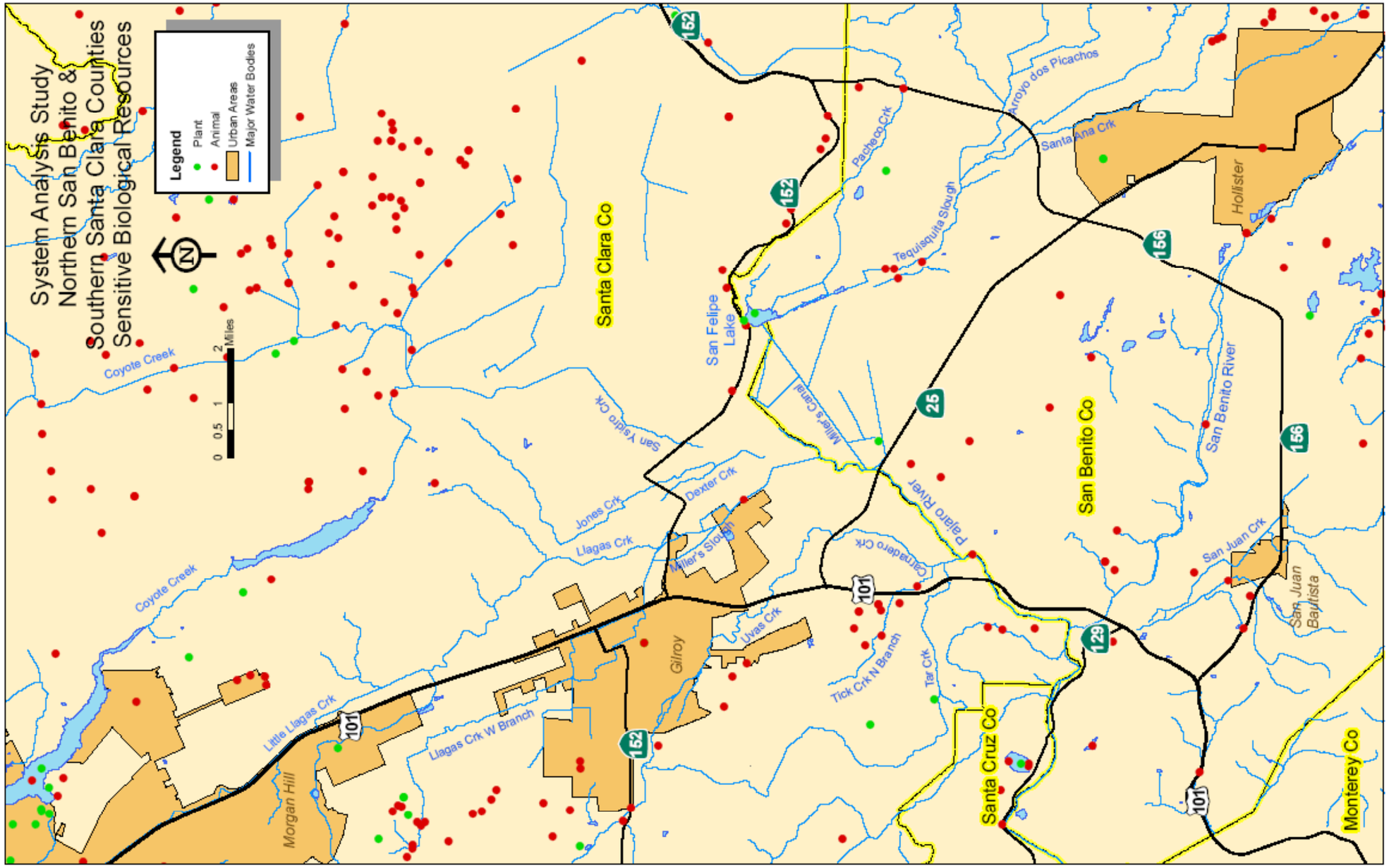
New East-West Routes – WB

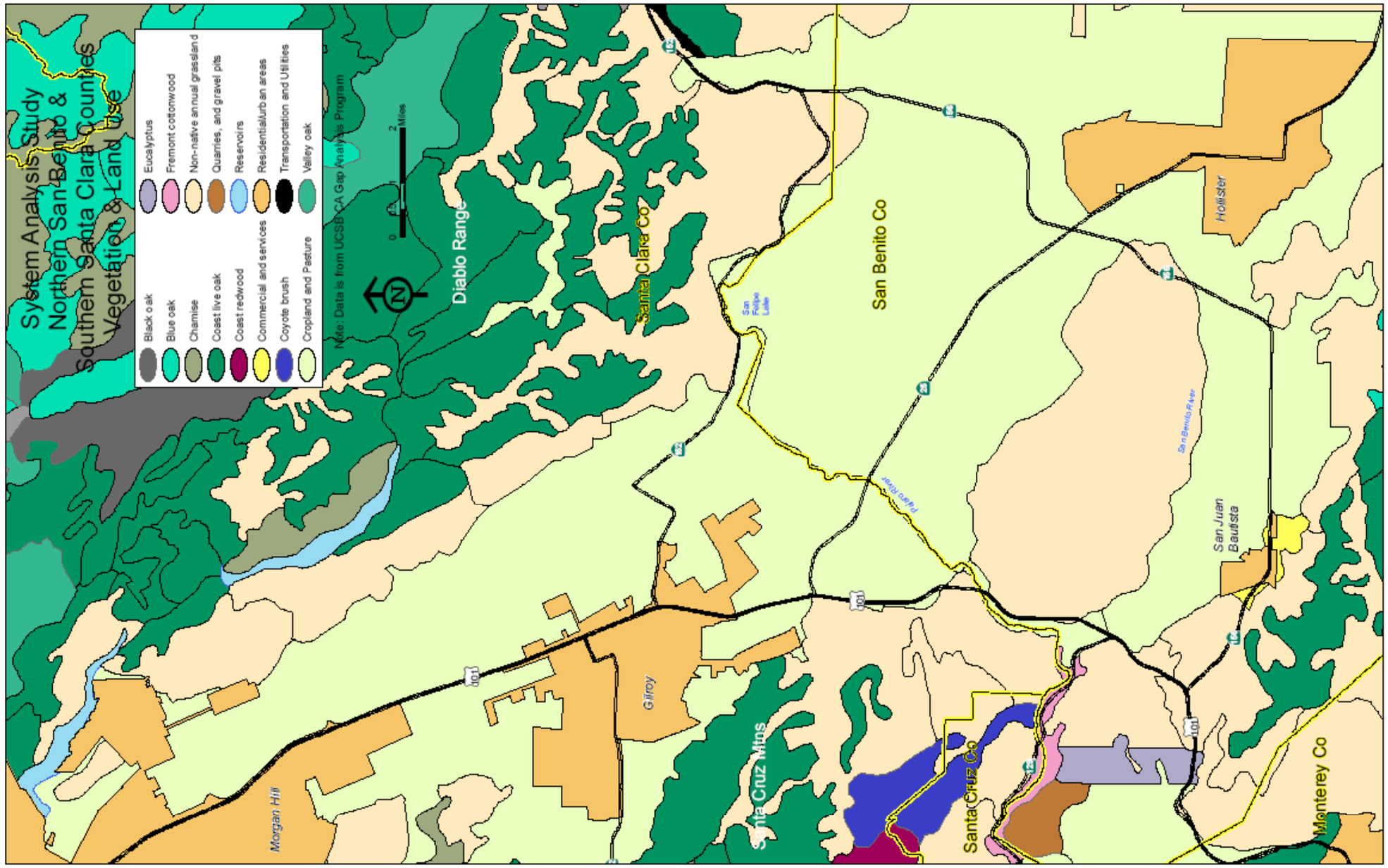


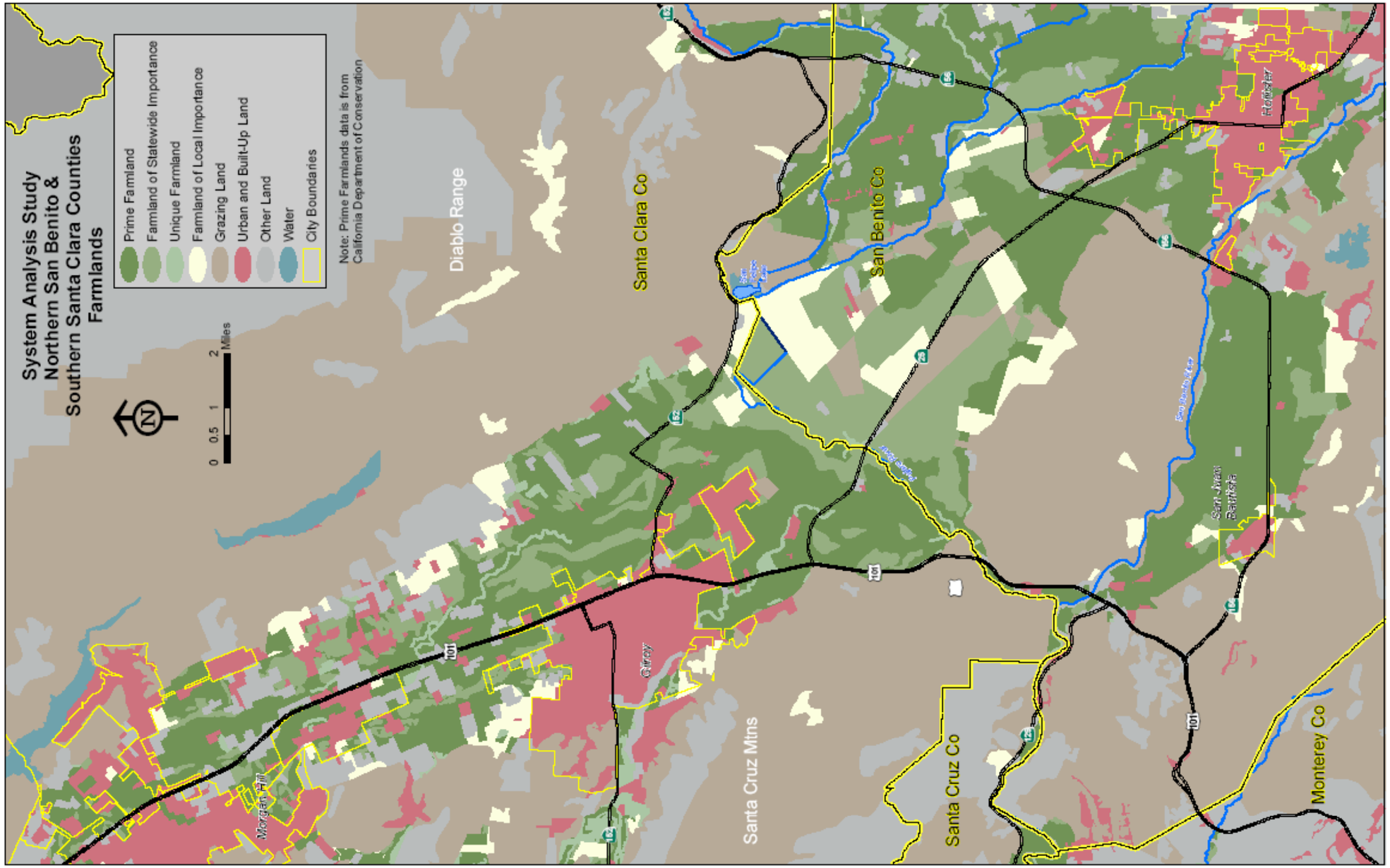


APPENDIX F. Environmental Resource Maps


System Analysis Study
Northern San Benito &
Southern Santa Clara Counties
0 0.5 1 2
Miles
N
Diablo Range
Santa Clara Co
San Benito Co
Hollister
San Juan Bautista
Gilroy
Morgan Hill
Santa Cruz Mtns
Santa Cruz Co
Monterey Co
101
152
156
25
129


System Analysis Study
Northern San Benito &
Southern Santa Clara Counties
Sensitive Biological Resources
Legend
Plant
Animal
Urban Areas
Major Water Bodies
N
0 0.5 1 2 Miles
Santa Clara Co
San Benito Co
Santa Cruz Co
Monterey Co
Coyote Creek
San Felipe Lake
Miller's Canal
Pacheco Crk
Tequisquite Slough
Arroyo dos Picachos
Santa Ana Crk
Hollister
San Benito River
San Juan Crk
San Juan Bautista
Pajaro River
Cienegadero Crk
Tick Crk N Branch
Tar Crk
Uvas Crk
Gilroy
Miller's Slough
Dexter Crk
Llagas Crk
Jones Crk
San Ysidro Crk
Little Llagas Crk
Llagas Crk W Branch
Morgan Hill
152
25
156
129
101


System Analysis Study
Northern San Benito &
Southern Santa Clara Counties
Vegetation & Land Use
Black oak
Blue oak
Chamise
Coast live oak
Coast redwood
Commercial and services
Coyote brush
Cropland and Pasture
Eucalyptus
Fremont cottonwood
Non-native annual grassland
Quarries, and gravel pits
Reservoirs
Residential/urban areas
Transportation and Utilities
Valley oak
Note: Data is from UCSB CA Gap Analysis Program
0 1 2 Miles
N
Diablo Range
Santa Clara Co
San Benito Co
Santa Cruz Mtns
Santa Cruz Co
Monterey Co
Morgan Hill
Gilroy
Hollister
San Juan Bautista
San Felipe Lake
Pacheco Creek
San Benito River
101
25
156
129

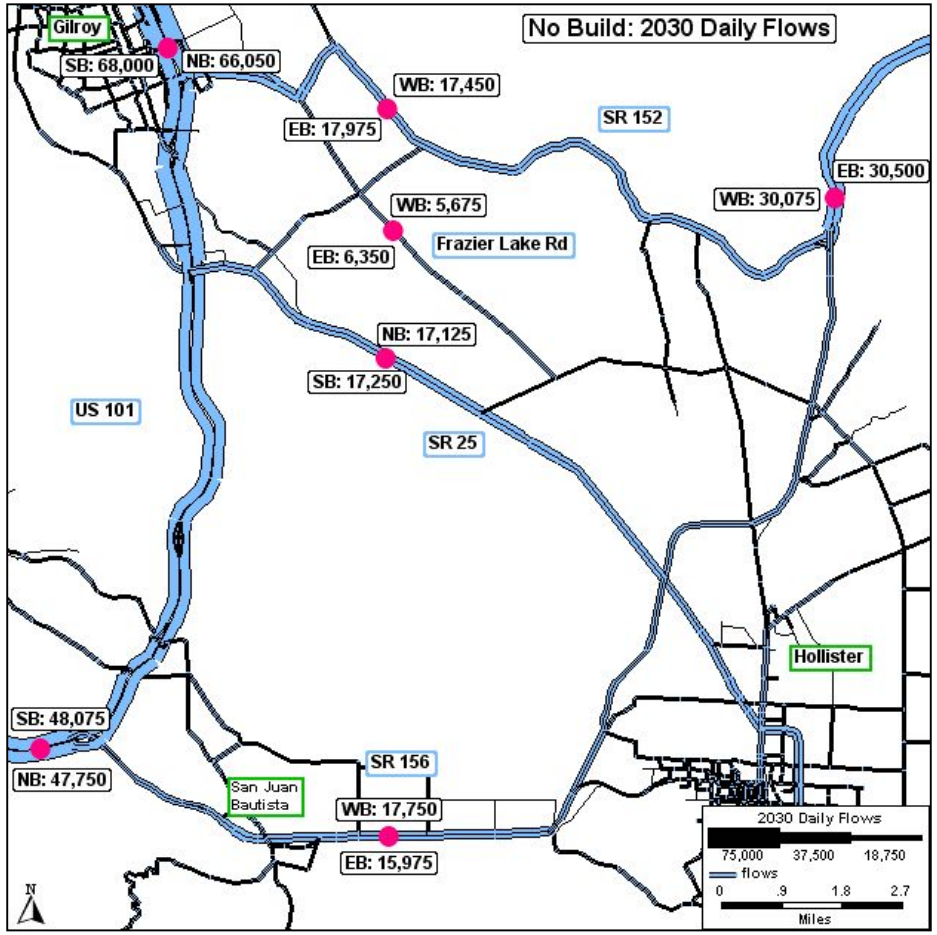

System Analysis Study
Northern San Benito &
Southern Santa Clara Counties
Farmlands
Prime Farmland
Farmland of Statewide Importance
Unique Farmland
Farmland of Local Importance
Grazing Land
Urban and Built-Up Land
Other Land
Water
City Boundaries
Note: Prime Farmlands data is from
California Department of Conservation
0 0.5 1 2 Miles
N
Diablo Range
Santa Clara Co
San Benito Co
Santa Cruz Mtns
Santa Cruz Co
Monterey Co
Morgan Hill
Gilroy
Hollister
San Juan Bautista
101
156
25

APPENDIX G. Environmental Scoping Report

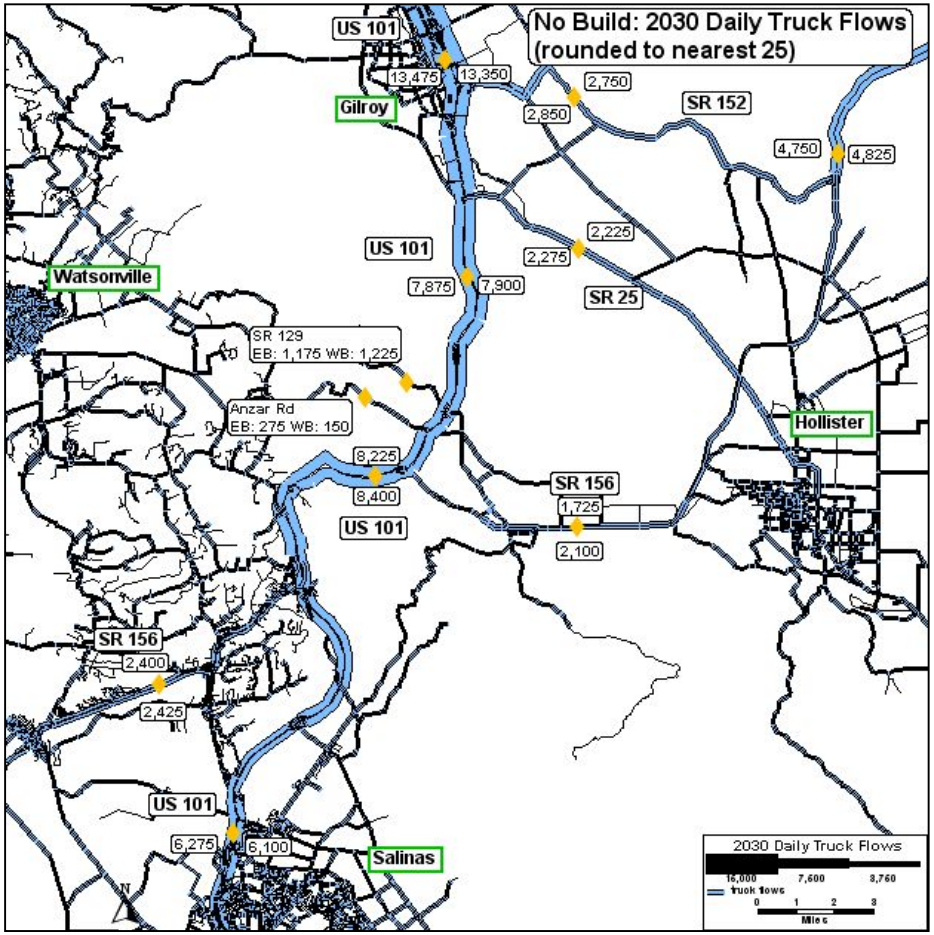
A full report with details on the environmental scoping is available from Caltrans D5 staff upon request.

APPENDIX H. 2030 Daily Total and Daily Truck Flows

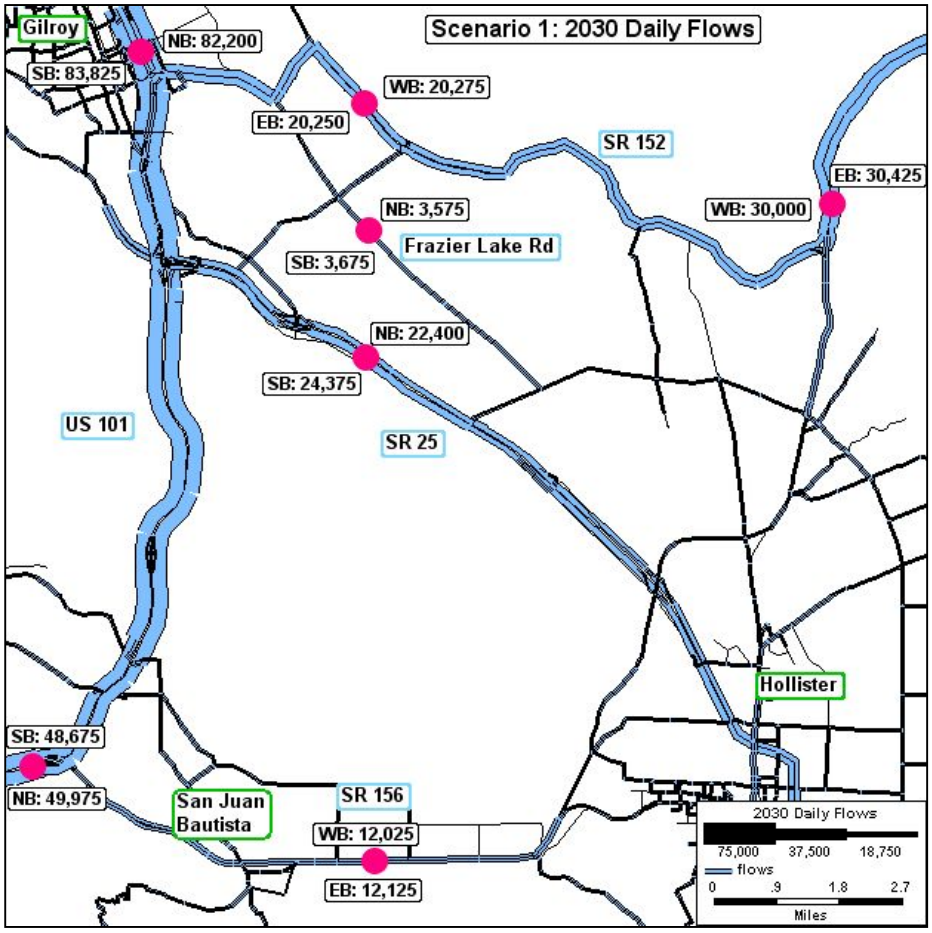
No Build Scenario: 2030 Daily Flows



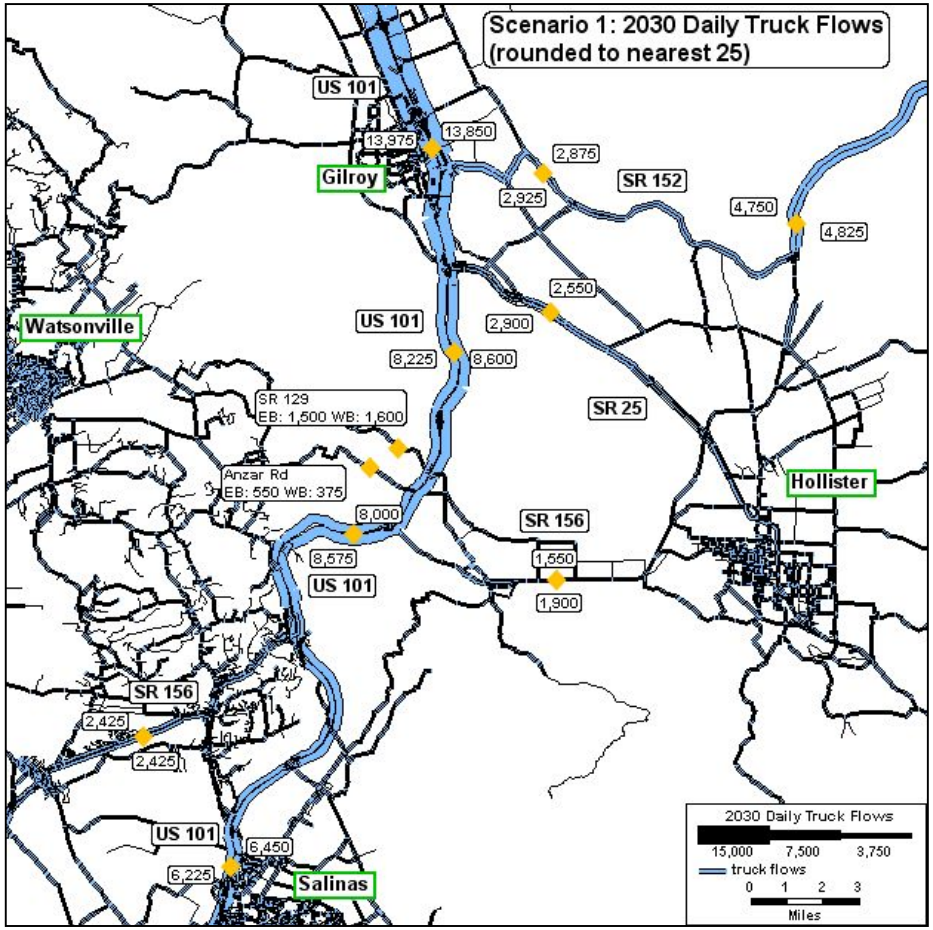
No Build Scenario: 2030 Daily Truck Flows



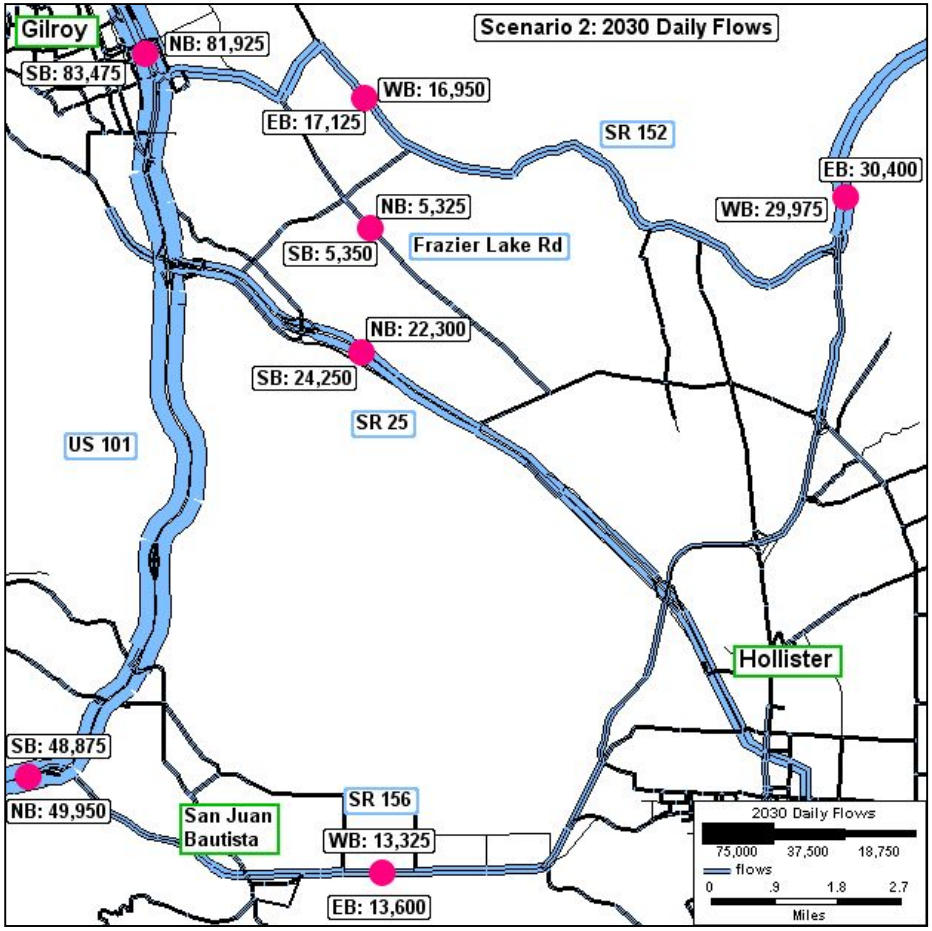
Scenario 1: 2030 Daily Flows



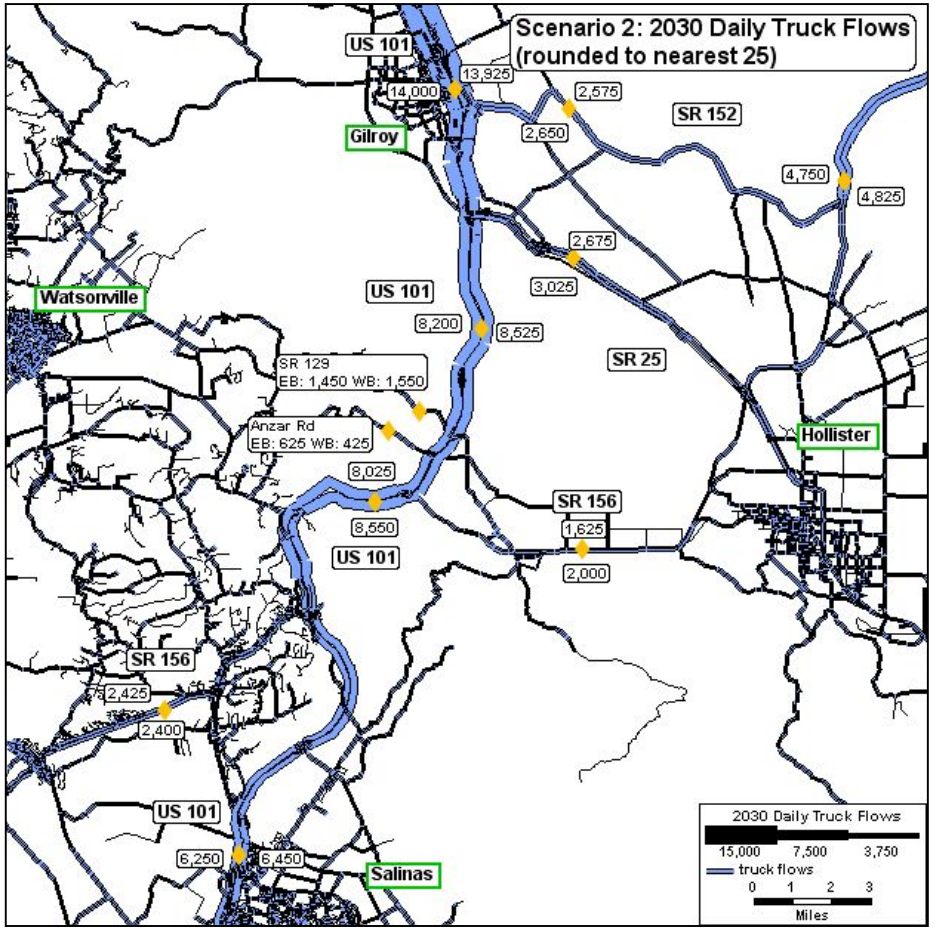
Scenario 1: 2030 Daily Truck Flows



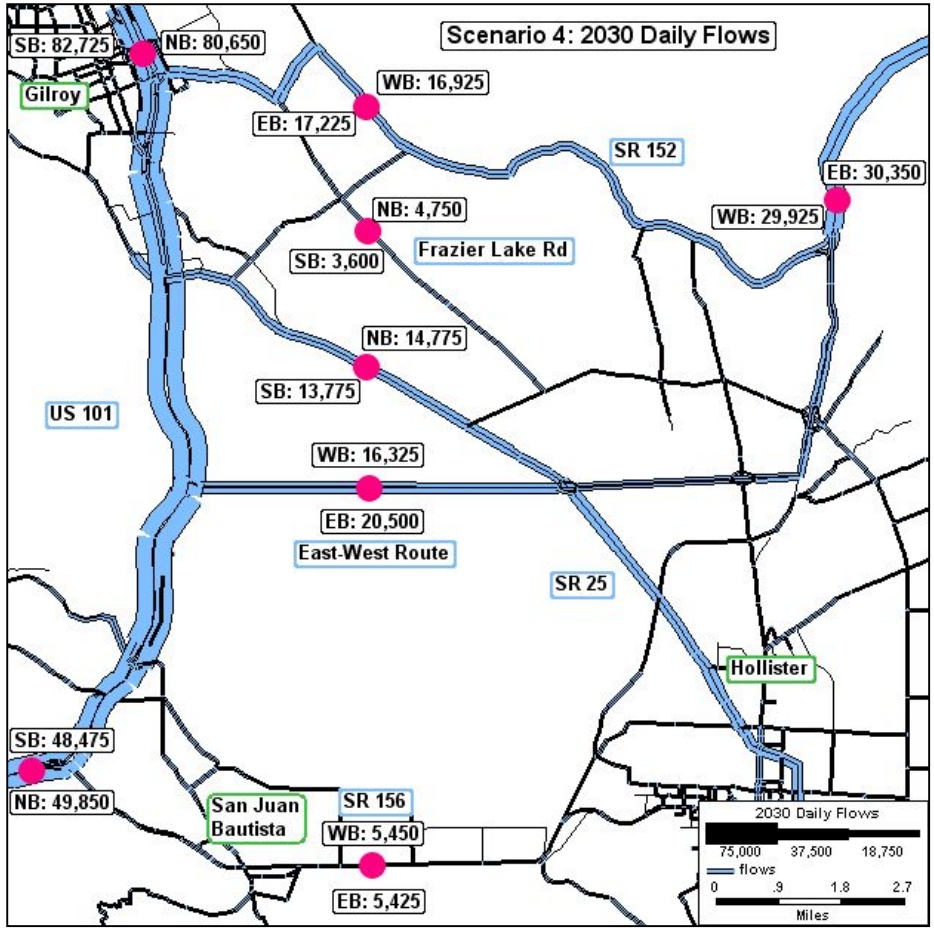
Scenario 2: 2030 Daily Flows



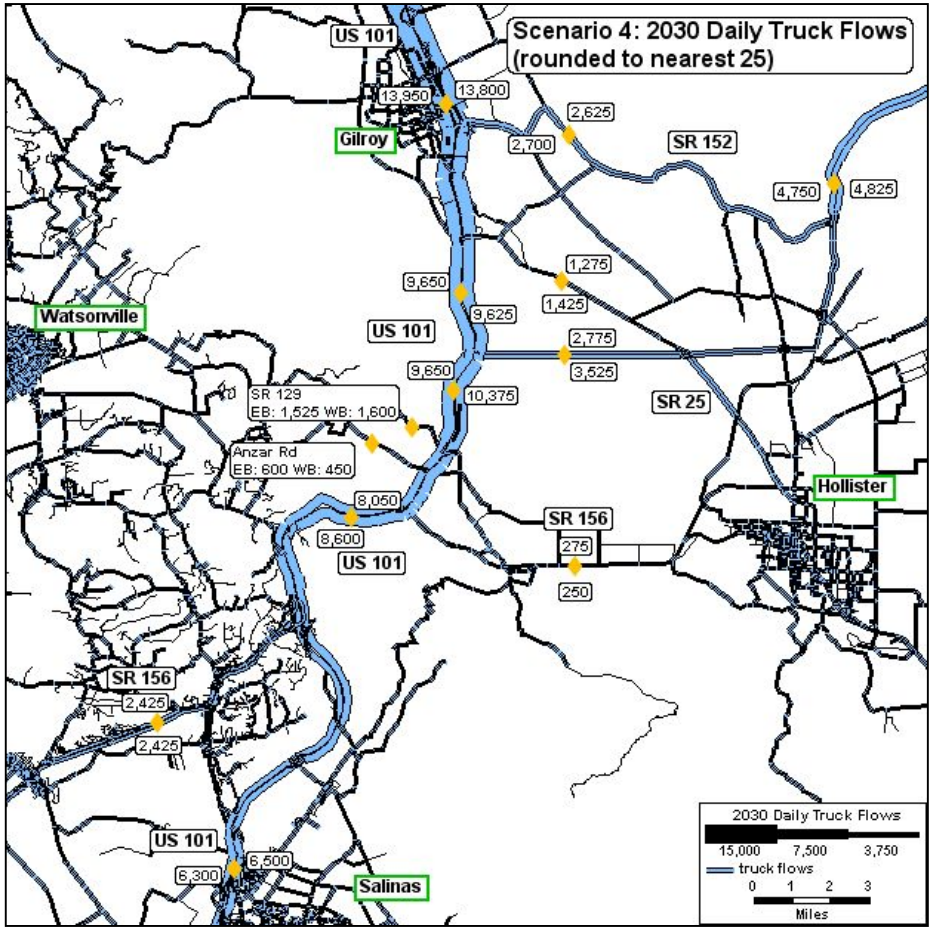
Scenario 2: 2030 Daily Truck Flows



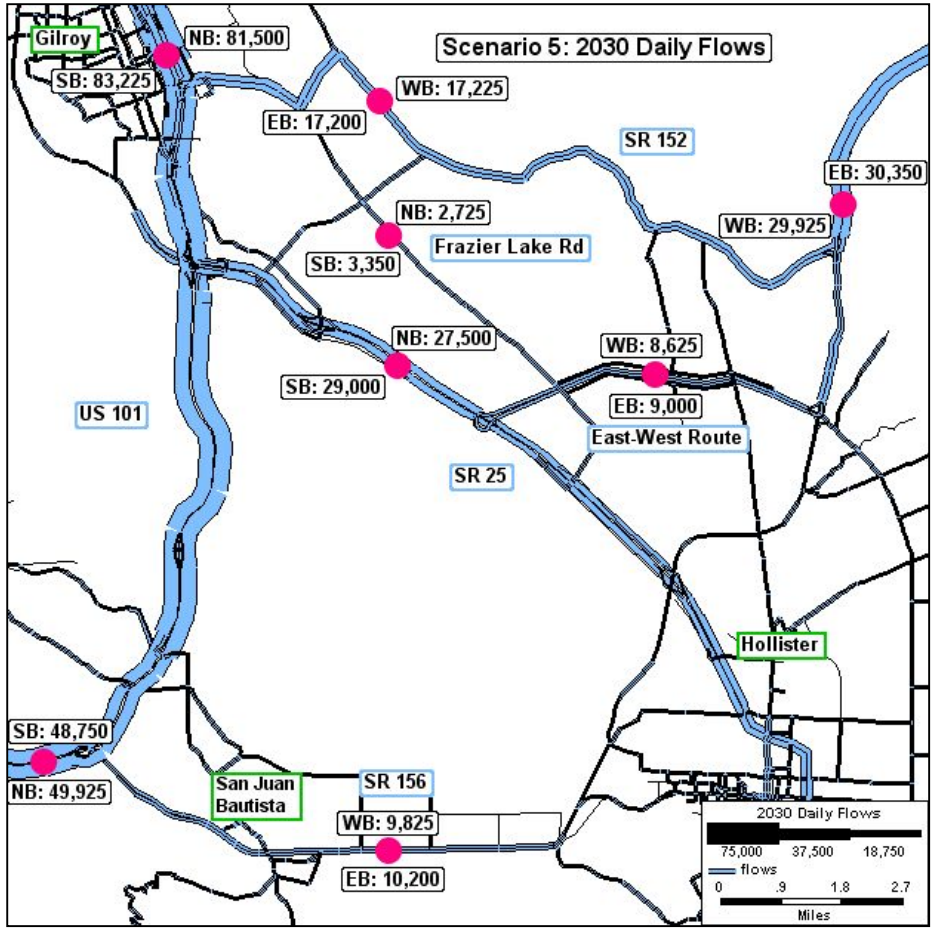
Scenario 4: 2030 Daily Flows



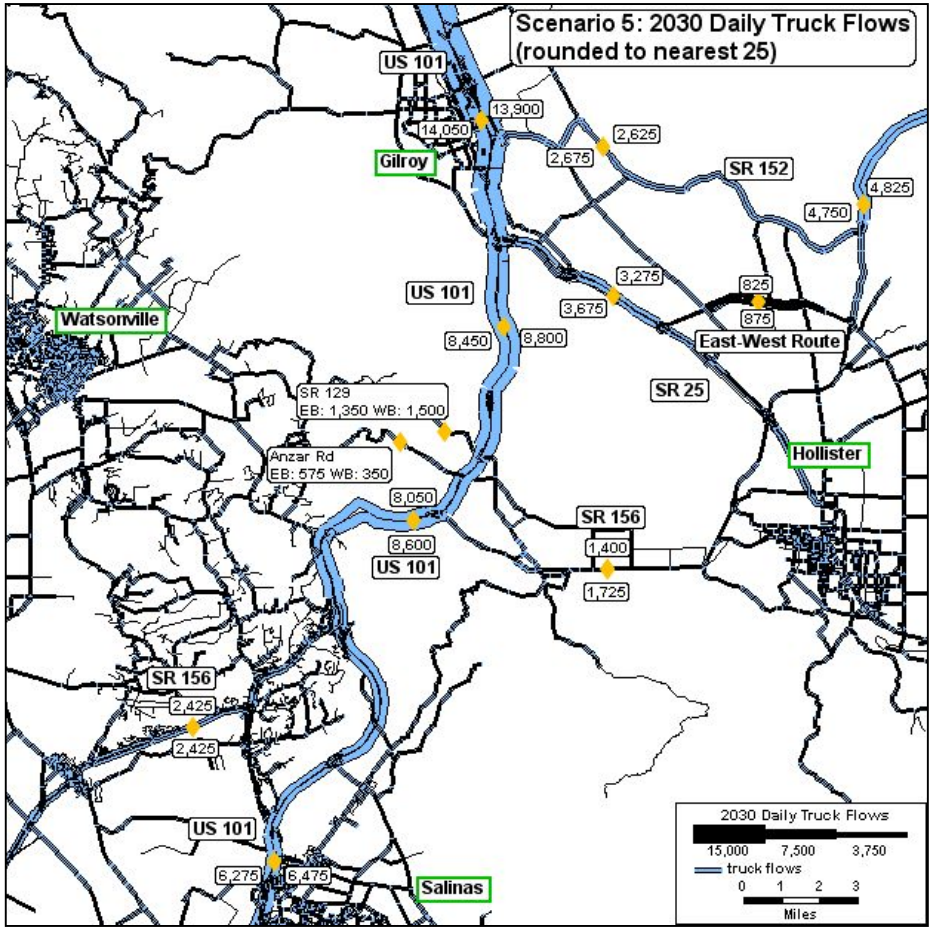
Scenario 4: 2030 Daily Truck Flows



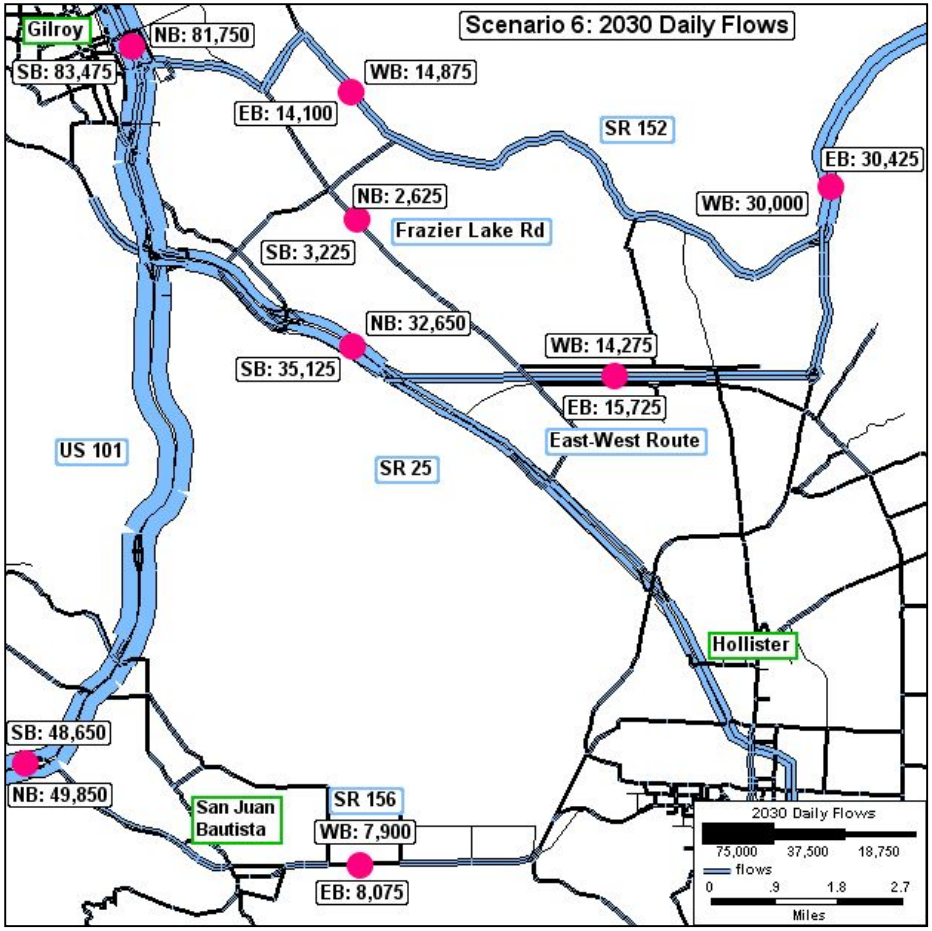
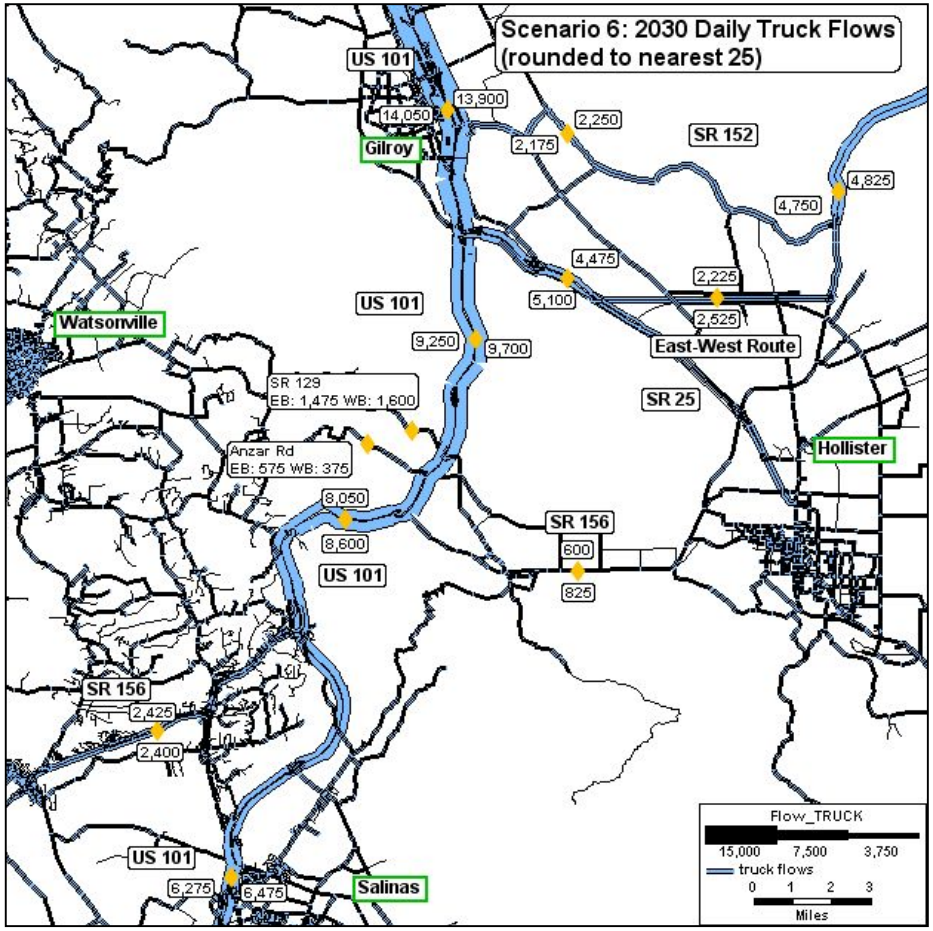
Scenario 5: 2030 Daily Flows



Scenario 5: 2030 Daily Truck Flows



Scenario 6: 2030 Daily Flows



Scenario 6: 2030 Daily Truck Flows