Freeway Bottleneck Locations in the Denver Region

August 20, 2009

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Introduction

Travel delays have wide reaching effects. They affect the commuter who drives 50 miles per day as well as the person waiting anxiously at home for the plumber to arrive. They can increase the prices for goods that must be transported in congested conditions. Stop-and-go traffic also increases pollution.

Freeway bottlenecks are a major source of travel delays. Though freeway bottleneck delays will never be eliminated entirely, the severity of delay can be reduced by providing travel options and real-time information. The purpose of this report is to present information on 18 previously identified bottleneck locations on Denver's freeways and list possible actions to improve conditions. Some of the solutions are low-cost, such as the restriping of lanes or improving signage. Others are quite expensive and will need further detailed study.

Every freeway includes decision points that may affect the consistent speed of vehicles, such as on and off ramps, merge areas, weave areas, and lane drop locations. Freeways may also have design constraints that affect drivers, such as curves, climbs, underpasses, tunnels and narrow or non-existent shoulders. In many cases, these characteristics do not reduce the physical number of lanes of the freeway, but driver actions disrupt the consistent flow of vehicles. Bottlenecks are routine to the point of being predictable in cause, location, time of day, and duration. Nonrecurring bottlenecks may also occur due to random or infrequent occurrences, such as crashes or special events. This paper focuses on recurring bottleneck locations, many of which commuters hear about far too often during rush-hour traffic reports.

Webster's dictionary defines a bottleneck as "a narrow or obstructed portion of a highway or pipeline" or "a hindrance to production or progress". Certainly the elemental roots of a traffic bottleneck exist in these descriptions; namely, the narrow portion of highway and the hindrance to progress. However, a road need not physically narrow for a bottleneck condition to result, such as at traditional lane drop locations. Sharp curves, weaving vehicles, visual distractions, sun glare, or a steep ascent or descent may also hinder progress.

Traffic Trends in the Denver Region

Freeways across the region have experienced increased congestion over the past 20 years. While the population of the Denver region increased by about 45 percent since 1990, vehicle miles of travel (VMT) increased by about 80 percent. Recent economic factors, such as higher

petroleum prices and the local economic downturn have contributed to a flattening of VMT levels in past two years. If historic trends persist, average weekday VMT could grow from 71 million per day in 2005 to 124 million per day in 2035! However, there will be limited funding to construct additional lanes on freeways to accommodate growing demand. Financial responsibilities to maintain the aging transportation system will use most of the transportation funds available from traditional funding sources.

Denver Regional Demographic and VMT Data			
DRCOG Region Total	**2005**	**2035**	***Increase (2005 to 2035)***
Population	2,697,300	4,341,600	**1,644,300**
Employment	1,568,200	2,566,000	**997,800**
Weekday VMT	71,000,000	124,000,000	**53,000,000**

Source: 2035 Metro Vision Regional Transportation Plan

Reduction of congestion is a priority concern of the federal and state government. Federal legislation created ongoing funding categories such as the Congestion Mitigation and Air Quality (CMAQ) program. The Colorado Department of Transportation defined a specific funding program to address congestion relief. Federal planning rules require metropolitan planning organizations (MPOs) such as DRCOG to develop a congestion management process to monitor and develop multimodal mitigation strategies.

What Causes Bottleneck Delays?

Bottleneck delays occur on freeways because of many reasons, such as:

- Short or noncontiguous auxiliary lanes or acceleration lanes from on-ramps;
- Sections with high vehicle weaving movement between closely spaced on-ramps and off-ramps;
- Freeway sections and interchanges built many years ago to less efficient design standards and geometrics;
- Locations where the freeway loses a lane, also known as a lane drop;
- Steep upgrades/downgrades along the freeway;
- Tight curves that cause vehicles to slow down;
- Narrow lanes, or the perception of narrow lanes, that cause drivers to slow down as they approach the area (i.e. at tunnels, underpasses, or areas without shoulders;
- Joining of major roadways (i.e. traffic from one freeway merging with the traffic of another freeway); and

Any combination of the above characteristics may contribute to a higher incidence of traffic crashes, which leads to more congestion.

The types of vehicles in the traffic flow can also increase bottleneck delays, such as:

- Trucks and commercial vehicles;
- Heavy recreational vehicles (RVs);
- Personal vehicles pulling trailers; and
- Vehicles driven by persons unfamiliar with the location.

Of course, congestion at bottleneck locations is exasperated by work zones and bad weather.

Where are the Bottlenecks located in the Denver Region?

Freeway bottlenecks are located throughout the region. Figure 1 illustrates the freeway system and location of identified example freeway bottlenecks. Bottlenecks were first identified by DRCOG in the *2006 Annual Report on Traffic Congestion in the Denver Region.* The locations were based on knowledge of observed or quantified severe recurring congestion. Rigorous engineering analyses were not conducted to accurately rank these as the official "worst locations." Rather they serve as well known examples of congested freeway locations across the region, each of which may have distinct characteristics and possible mitigation strategies. Refinements to the identified locations were made following discussions with CDOT and the release of travel delay results from 2008.

Datasheets for all identified bottleneck locations are located in Appendix B. The datasheets present aerial photos, background characteristics, congestion measures, and possible mitigation strategies to be considered. Mitigation strategies may range from simple lower cost techniques with minimal adverse impacts to extremely high cost projects that would require major environmental impact analyses. This report does not specifically recommend any of the strategies. It will be up to the lead implementing agency (in most cases, CDOT) to work with DRCOG and the region's planning partners to fund and implement specific strategies.

For another source of information on Denver area bottleneck locations, the *2008 National Traffic Scorecard* can be viewed. The INRIX company analyzed 31,000 road segments in 100 metropolitan areas to determine the extent and amount of bottleneck congestion in each area. They acquired tens of billions of discrete "GPS-enabled probe vehicle" travel time reports from vehicles traveling the nation's roads, including taxis, airport shuttles, service delivery vans, long haul trucks, and consumer vehicles. The 2008 scorecard indicates the Denver region received a national congestion ranking of 16 out of 100, up two spots from 2007. INRIX identified 15 bottleneck locations in the Denver region. Many of bottleneck locations in the *2008 National Traffic Scorecard* match freeway bottleneck locations listed in this report. For more information on national congestion rankings, visit www.inrix.com.

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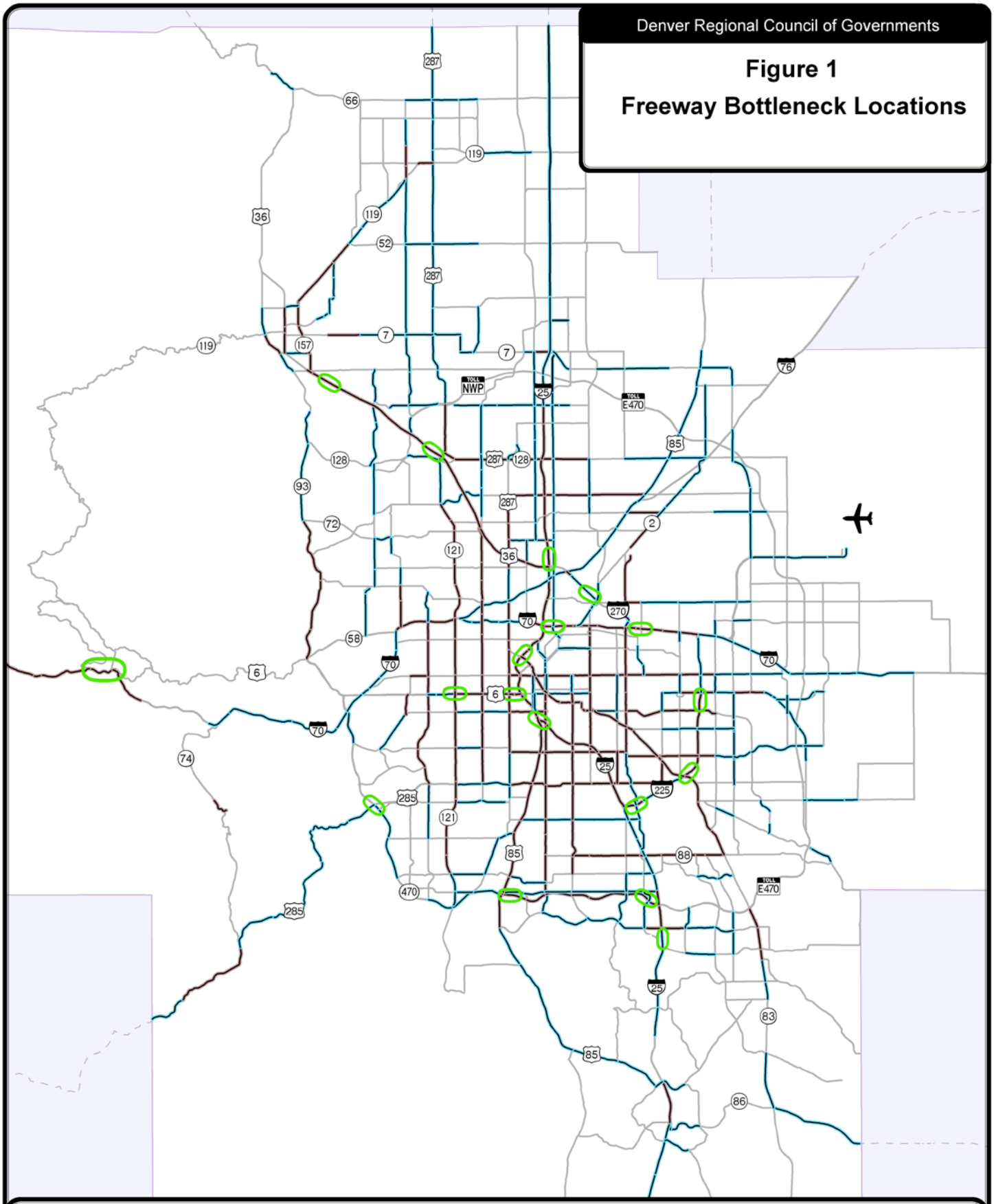
Figure 1
Freeway Bottleneck Locations



This map and the data it depicts are intended for informational purposes only. DRCOG provides this information on an "as is" basis and makes no representation or warranty that the data will be error free. DRCOG is not responsible to any user for any costs or damages arising from inconsistencies in its data.

Source: DRCOG

Projection: Colorado State Plane, NAD 83

6/10/2009 TW

Congestion Mobility Grade -- D or F

- 2006 Key Corridor
- 2035 Key Corridor

0 2.5 5 10 Miles

- Freeway Bottleneck Points
- Regional Roadway
- Road Outside MPO Boundary

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How Does DRCOG Measure Bottleneck Congestion?

Bottleneck delays are measured in different ways, each of specific interest or understanding to different people.

- **Severity** – How long of a delay in time do you face? This can be expressed as the amount of delay you encounter on a trip (e.g. 10 minutes of delay in a 30 minute trip) or the percent of time on a trip (e.g. 33 percent is delay time).
- **Duration** – How long do congestion conditions last? Some freeway bottlenecks may typically produce congested conditions for two hours per day, one in the morning and one in the late afternoon. Others may have congested conditions for more than five hours per day.
- **Magnitude –** How many people are affected by the bottleneck? A 10-lane freeway carrying 20,000 people in a congested hour will have more total delay (personal and vehicle) than a 4-lane freeway carrying 6,000 people in a congested hour.
- **Reliability and Variation** – How predictable are travel times? How much longer (minutes or percent) is the travel time in the peak rush-hour than in off-peak times? The typical daily variation may be known by regular commuters and commercial vehicle drivers, but 1) the variation may not be known by unfamiliar drivers and 2) the variation can become much more severe due to crashes and other incidents.

No single measure provides a definitive answer to proclaim the most congested bottleneck location in the region. There are many factors and perceptions to go along with each of the ways to calculate bottleneck congestion. Traffic engineers will need to complete robust analyses and model simulations of identified locations at a later date. While this report highlights several of the most congested freeway bottlenecks in the Denver region, it does not attempt to create a rank order list of bottleneck locations.

Annual Measures at the 18 Identified Bottleneck Locations

Person Hours of Delay/Year due to congestion at these locations	16,770,000 hours
Economic Cost of Bottleneck Delays/Year*	$444,300,000
*Cost to residents, businesses, commercial vehicle operators.	
Total Number of Motor Vehicle Crashes/Year	1,130 crashes

Appendix A

Acronym/Glossary of Bottleneck Terms

ADT - Average Daily Traffic

Auxiliary Lane – Travel lane on a freeway that exists for a short distance (e.g. between an on-ramp and the upcoming off-ramp) and does not continue through the following interchange.

BRT - Bus Rapid Transit

CDOT – Colorado Department of Transportation

CMP – Congestion Mitigation Program

Free flow Speed – The speed at which a vehicle can travel if following the posted speed limit or possibly higher if the majority of vehicles are traveling faster than the posted speed limit

Grade – Slope or steepness of the ascent of descent of a freeway (expressed as 2 percent, 3 percent, etc.)

HOT - High Occupancy Toll *(also see Managed Lane)*

HOV - High Occupancy Vehicle

Lane Drop - Section of the freeway where the freeway loses/drops a lane *(example: the left lane of three lane freeway merges into the middle lane, creating a two lane freeway)*

LOSS - Level of Safety Service – A measure calculated by CDOT for determining the relative safety performance of freeway segments. It is portrayed in the following ratings:

- LOSS I – Indicates much better than expected performance with a low potential for crash reduction;
- LOSS II – Indicates better than expected safety performance;
- LOSS III – Indicates less than expected safety performance;
- LOSS IV – Indicates poor safety performance and high potential for crash reduction.

Managed Lane – Set of travel lanes where operational strategies, such as tolls or lane restrictions, are proactively implemented to manage different types of vehicles in response to traffic congestion and other traffic conditions.

PDO - Property Damage Only crashes

Ramp Metering - A device, usually a two-section traffic signal (red and green only, no yellow) linked together with a signal controller that regulates the flow of traffic entering freeways

TDM – Transportation Demand Management

TIP – Transportation Improvement Program

Vehicle Weave Movements - Occur when one vehicle crosses from one lane to another into the path of another vehicle

VMT – Vehicle Miles Traveled

Appendix B

Freeway Bottleneck – Data Sheets

(Locations Shown on Figure 1)

C-470 (both directions) from US-285 to Quincy Ave.

C-470 (eastbound) east of Santa Fe Dr.

C-470 (both directions) from Yosemite St. to I-25

I-25 (southbound) south of County Line Rd.

I-25 (both directions) from Broadway to Alameda Ave.

I-25 (both directions) from Speer Blvd. to 20th St.

I-25 (both directions) north of US-36/I-270 Interchange

I-70 (both directions) from Twin Tunnels to Floyd Hill

I-70 (eastbound) from I-25 to York St.

I-70 (eastbound) east of I-270 EB Interchange

I-225 (westbound) from Yosemite St. to I-25

I-225 (southbound) from Alameda to 6th Ave.

I-225 (northbound) from Parker Rd. to Yale Ave.

I-270 (both directions) at Vasquez Blvd.

US-36 (eastbound) from Foothills Pkwy. to Davidson Mesa

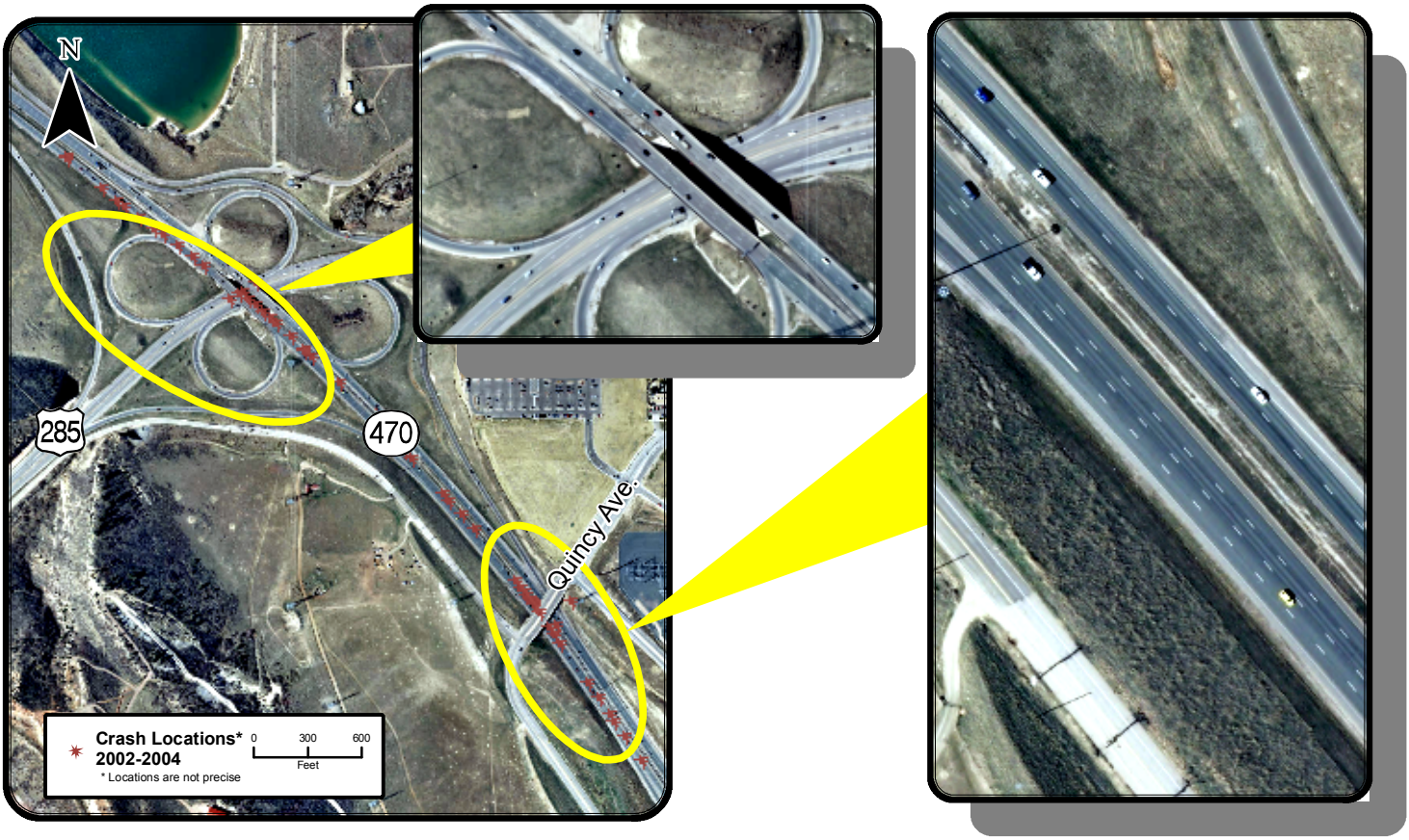
US-36 (both directions) from Interlocken Loop to Wadsworth Blvd.

US-6 (both directions) at Wadsworth Blvd.

US-6 (both directions) from Federal Blvd. to I-25

Congestion Mitigation Program - Bottleneck Data Sheet

C-470 (both directions) from US-285 to Quincy Ave.



Key Reasons For Bottleneck

Twelve (12) on/off-ramps in one mile

High number of vehicle weave movements

Southbound lane drop from three (3) lanes to two (2) lanes

Moderate grades

Possible Roadway Mitigation Strategies

Extend acceleration lanes

Reconstruct the interchange to improve geometric standards

Base Conditions

Two continuous through lanes in each direction

2-way ADT on C-470	67,000
Posted Speed (actual free flow speed is higher)	65 mph
Percent Trucks	3.6%
Distance* (miles)	2
Uncongested Travel Time* (per vehicle)	1 minute 40 seconds

* From Morrison Rd. to Quincy Ave.

Congestion Measures (2-way)

Typical peak hour without incidents

(Congestion extends beyond this location)

Congested Speed	61 mph
Percent Decrease from Free Flow Speed	13%
Delay (per vehicle) at this location*	18 seconds

Reported Crash Data 2002-2004

	Fatal	Injury	PDO	Total
Three Year Total	1	24	98	123

CDOT LOSS Rating*: III - Medium reduction in crashes possible

** CDOT LOSS (Level of Safety Service) determined by the number of vehicles traveling on a roadway segment and the frequency of crashes*

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Congestion Mitigation Program - Bottleneck Data Sheet

C-470 (eastbound) east of Santa Fe Dr.

Key Reasons For Bottleneck

Steep eastbound grade at on-ramp merge to C-470

Grade increase on eastbound C-470 between Santa Fe Dr. and Lucent Blvd.

Short eastbound acceleration lane

Base Conditions

Two continuous through lanes in each direction

2-way ADT on C-470	95,000
Posted Speed (actual free flow speed is higher)	65 mph
Percent Trucks	4%
Distance* (miles)	1.4
Uncongested Travel Time* (per vehicle)	1 minute 13 seconds

* From Santa Fe Dr. to Lucent Blvd.

Recorded Crash Data 2002-2004

	Fatal	Injury	PDO	Total
Three Year Total	0	31	84	115

CDOT LOSS Rating*: III - Medium reduction in crashes possible

** CDOT LOSS (Level of Safety Service) determined by the number of vehicles traveling on a roadway segment and the frequency of crashes*

Possible Roadway Mitigation Strategies

TIP Project 2003-112: C-470 and Santa Fe Dr. interchange reconstruction

Extend eastbound on-ramp acceleration/auxiliary lane to Lucent Blvd. off-ramp

Reconstruct Santa Fe Dr. interchange with flyover ramp for southbound to eastbound traffic*

Widen C-470 to add four (4) general purpose or managed toll lanes with continuous auxiliary lanes*

* C-470 Corridor Environmental Assessment

Congestion Measures (2-way)

Typical peak hour without incidents

(Congestion extends beyond this location)

Congested Speed	39 mph
Percent Decrease from Free Flow Speed	44%
Delay (per vehicle) at this location*	57 seconds

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Congestion Mitigation Program - Bottleneck Data Sheet

C-470 (both directions) from Yosemite St. to I-25

Key Reasons For Bottleneck

- Convergence point of two major regional freeways
- Grade increase on C-470 eastbound approaching off-ramps to I-25
- Eastbound sun glare
- High number of vehicle weave movements in both directions
- Westbound lane drop at Quebec St.

Base Conditions

Two continuous through lanes in each direction

2-way ADT on C-470	87,000
Posted Speed (actual free flow speed is higher)	65 mph
Percent Trucks	4.3%
Distance* (miles)	1.4
Uncongested Travel Time* (per vehicle)	1 minute 13 seconds

* From Quebec St. to I-25

Reported Crash Data 2002-2004

	Fatal	Injury	PDO	Total
Three Year Total	2	27	92	121

CDOT LOSS Rating*: IV - High reduction in crashes possible

** CDOT LOSS (Level of Safety Service) determined by the number of vehicles traveling on a roadway segment and the frequency of crashes*

Possible Roadway Mitigation Strategies

- Diagrammatic signage improvements - eastbound C-470
- Extend westbound auxiliary lane 1/2 mile past Quebec St.
- Widen C-470 to add four (4) general purpose or managed toll lanes with continuous auxiliary lanes*

* C-470 Corridor Environmental Assessment

Congestion Measures (2-way)

Typical peak hour without incidents

(Congestion extends beyond this location)

Congested Speed	49 mph
Percent Decrease from Free Flow Speed	30%
Delay (per vehicle) at this location*	29 seconds

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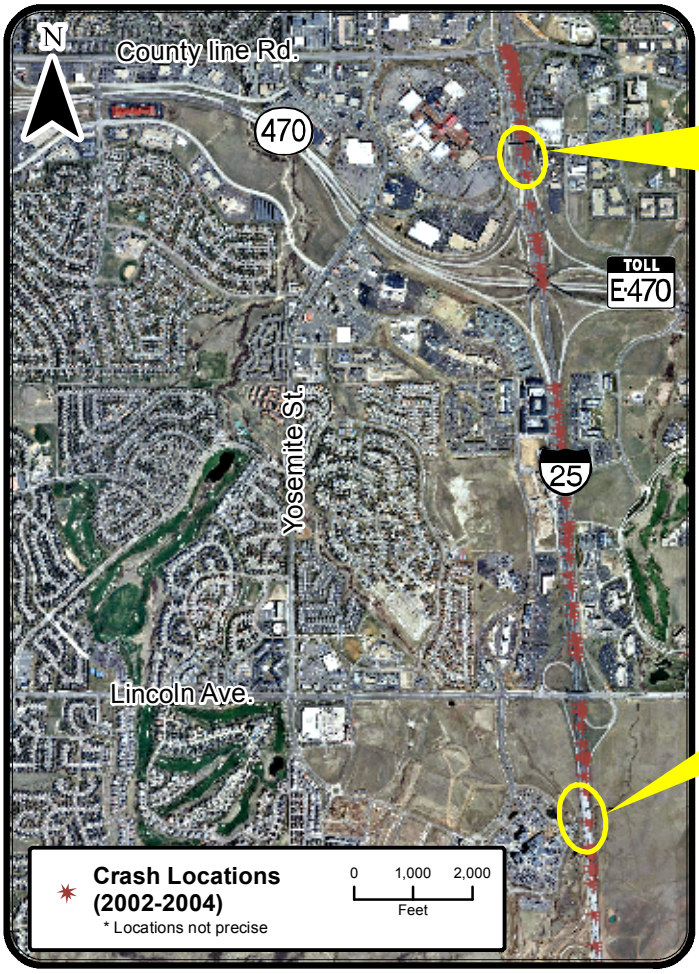
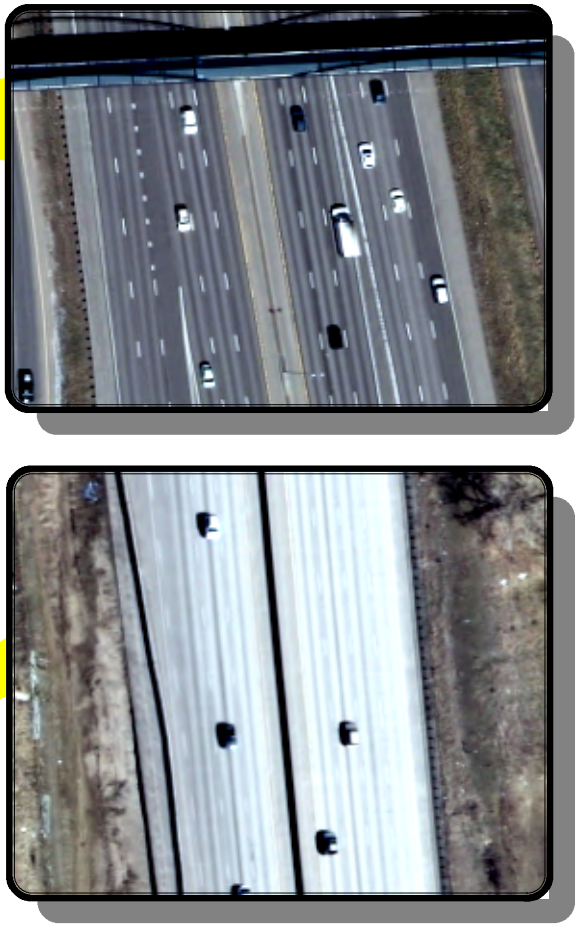
Congestion Mitigation Program - Bottleneck Data Sheet

I-25 (southbound) south of County Line Rd.





Key Reasons For Bottleneck

Four/Five (4/5) southbound lanes merging to three (3)
- between County Line Rd. and C-470
- on I-25 south of Lincoln Ave.

High number of vehicle weave movements
Grade increase south of Lincoln Ave.

Base Conditions

Three continuous through lanes in both directions

2-way ADT on I-25	102,000
Percent Trucks	6.6%
Posted Speed (actual free flow speed is higher)	65 mph
Distance* (miles)	3.06
Uncongested Travel Time* (per vehicle)	2 minutes 35 seconds

* From County Line Rd. to Mainstreet

Reported Crash Data 2002-2004

	Fatal	Injury	PDO	Total
Three Year Total	1	69	255	325

CDOT LOSS Rating*: III - Medium reduction in crashes possible

** CDOT LOSS (Level of Safety Service) determined by the number of vehicles traveling on a roadway segment and the frequency of crashes*

Possible Roadway Mitigation Strategies

TIP Project 1999-001: Roadway widening from Douglas Ln/ Crystal Valley to Lincoln Ave.

Improve directional/guidance signage along I-25

Ramp metering at southbound ramp from County Line Rd. onto I-25

Widen I-25 to provide four continuous through lanes at C-470

Congestion Measures (2-way)

Typical peak hour without incidents

(Congestion extends beyond this location)

Congested Speed	59 mph
Percent Decrease from Free Flow Speed	16%
Delay (per vehicle) at this location*	31 seconds

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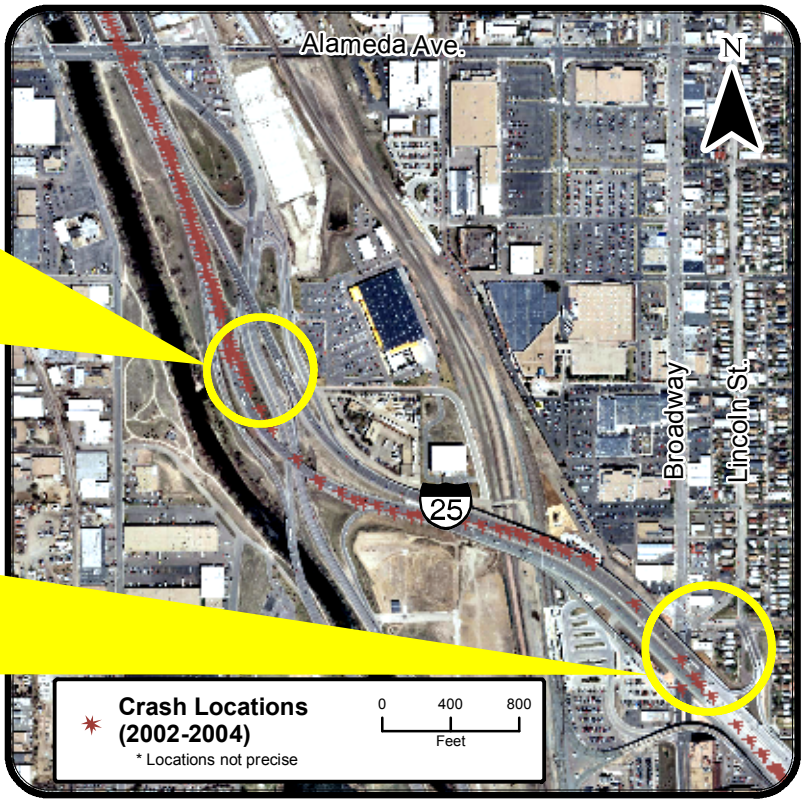
Congestion Mitigation Program - Bottleneck Data Sheet

I-25 (both directions) from Broadway to Alameda Ave.



Key Reasons For Bottleneck

Convergence point of multiple regional roadways

Left-hand on-ramps

Lane drop on I-25 at Santa Fe Dr.

Moderate grades approaching the viaduct

Curve in I-25 east of Santa Fe Dr.

Base Conditions

Three continuous through lanes in both directions

2-way ADT on I-25	210,000
Percent Trucks	5.3%
Posted Speed (actual free flow speed is higher)	55 mph
Distance (miles)	1.03
Uncongested Travel Time (per vehicle)	1 minute

Reported Crash Data 2002-2004

	Fatal	Injury	PDO	Total
Three Year Total	0	46	236	282

CDOT LOSS Rating*: IV - High reduction in crashes possible

** CDOT LOSS (Level of Safety Service) determined by the number of vehicles traveling on a roadway segment and the frequency of crashes*

Possible Roadway Mitigation Strategies

TIP Project 2007-158: Santa Fe Dr. to Alameda interchange improvements

Ramp metering improvements to interchange ramps

Continuous auxiliary lanes on I-25*

Tight diamond interchange at I-25 & Broadway*

Single point interchange for I-25 and Santa Fe Dr. & for I-25 and Alameda with flyover ramp for northbound traffic*

Widen I-25 to provide four continuous through lanes at Santa Fe Dr. - must relocate existing railroad*

* Valley Highway Environmental Impact Statement

Congestion Measures (2-way)

Typical peak hour without incidents

(Congestion extends beyond this location)

Congested Speed	36 mph
Percent Decrease from Free Flow Speed	40%
Delay (per vehicle) at this location	43 seconds

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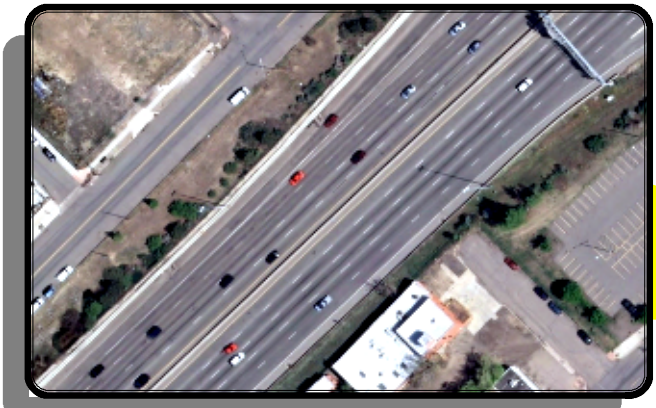
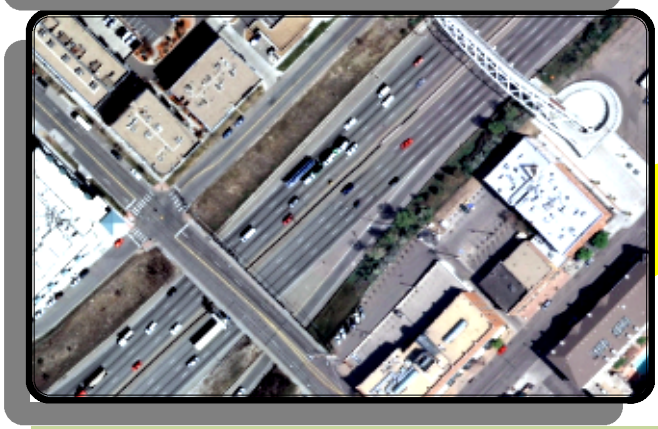
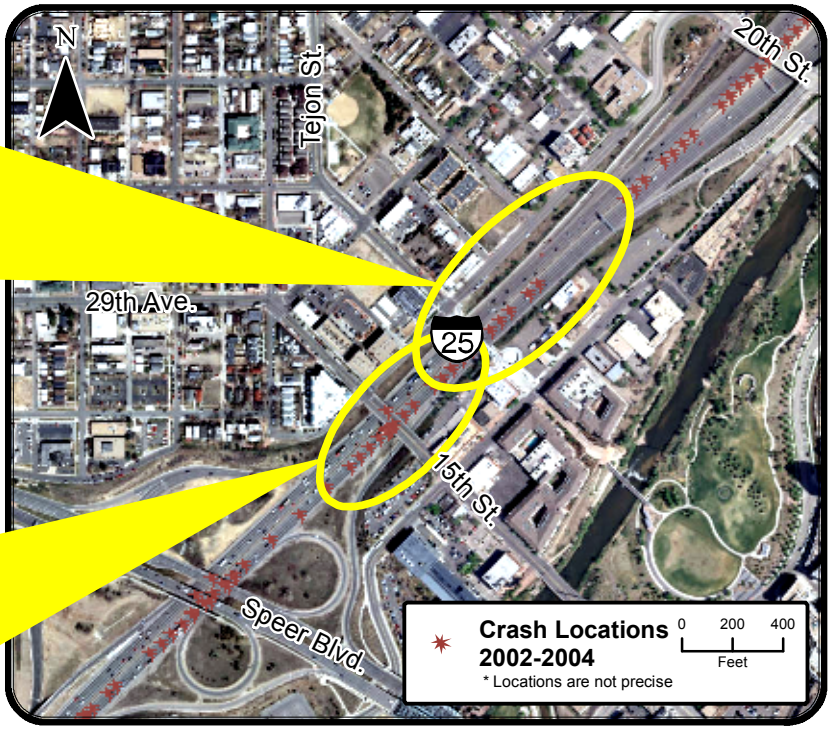
Congestion Mitigation Program - Bottleneck Data Sheet

I-25 (both directions) from Speer Blvd. to 20th St.







Key Reasons For Bottleneck

Numerous vehicles weaving between Speer Blvd. and 20th St.

Southbound merge of HOT lane with general purpose lanes north of Speer Blvd. exit

High percentage of truck traffic using I-25

Low clearance under Speer Blvd. overpass

No southbound auxiliary lane between 20th St. and Speer Blvd.

Street bridge over 15th St. constricts southbound traffic

Base Conditions

Four continuous through lanes in each direction

2-way ADT on I-25	211,000
Posted Speed (actual free flow speed is higher)	55 mph
Percent Trucks	9%
Distance (miles)	.6
Uncongested Travel Time (per vehicle)	35 seconds

Reported Crash Data 2002-2004

	Fatal	Injury	PDO	Total
Three Year Total	1	51	182	234

CDOT LOSS Rating*: IV - High reduction in crashes possible

** CDOT LOSS (Level of Safety Service) determined by the number of vehicles traveling on a roadway segment and the frequency of crashes*

Possible Roadway Mitigation Strategies

TIP Project 2007-040: Construct a two (2) lane collector distributor road adjacent to southbound I-25 from 20th St. to Speer Blvd. and replace 15th St. overpass bridge

Improvements to HOV entrance and HOV merge lanes

Reconstruct Speer Blvd. overpass

Improve directional/guidance signage on I-25

Congestion Measures (2-way)

Typical peak hour without incidents

(Congestion extends beyond this location)

Congested Speed	26 mph
Percent Decrease from Free Flow Speed	57%
Delay (per vehicle) at this location	47 seconds

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Congestion Mitigation Program - Bottleneck Data Sheet

I-25 (both directions) north of US-36/I-270 Interchange

Key Reasons For Bottleneck

Northbound lane drop from five (5) to three (3) lanes
High southbound on-ramp volumes (104th-84th)
On-ramp at the northern terminus of HOT lanes
Southbound lefthand exits to HOT lanes & SH-270 EB
High percentage of truck traffic
Grade increase northbound

Possible Roadway Mitigation Strategies

Construct HOT lanes in I-25 in each direction
Widen I-25 from US-36 to Thornton Pkwy.

Base Conditions

2-way ADT on I-25	178,000
Posted Speed(actual free flow speed is higher)	55 mph
Percent Trucks	8%
Distance* (miles)	1.5 mph
Uncongested Travel Time* (per vehicle)	1 minute 30 seconds

* From north of US-36/I-270 interchange to 84th Ave.

Congestion Measures (2-way)

Typical peak hour without incidents

(Congestion extends beyond this location)

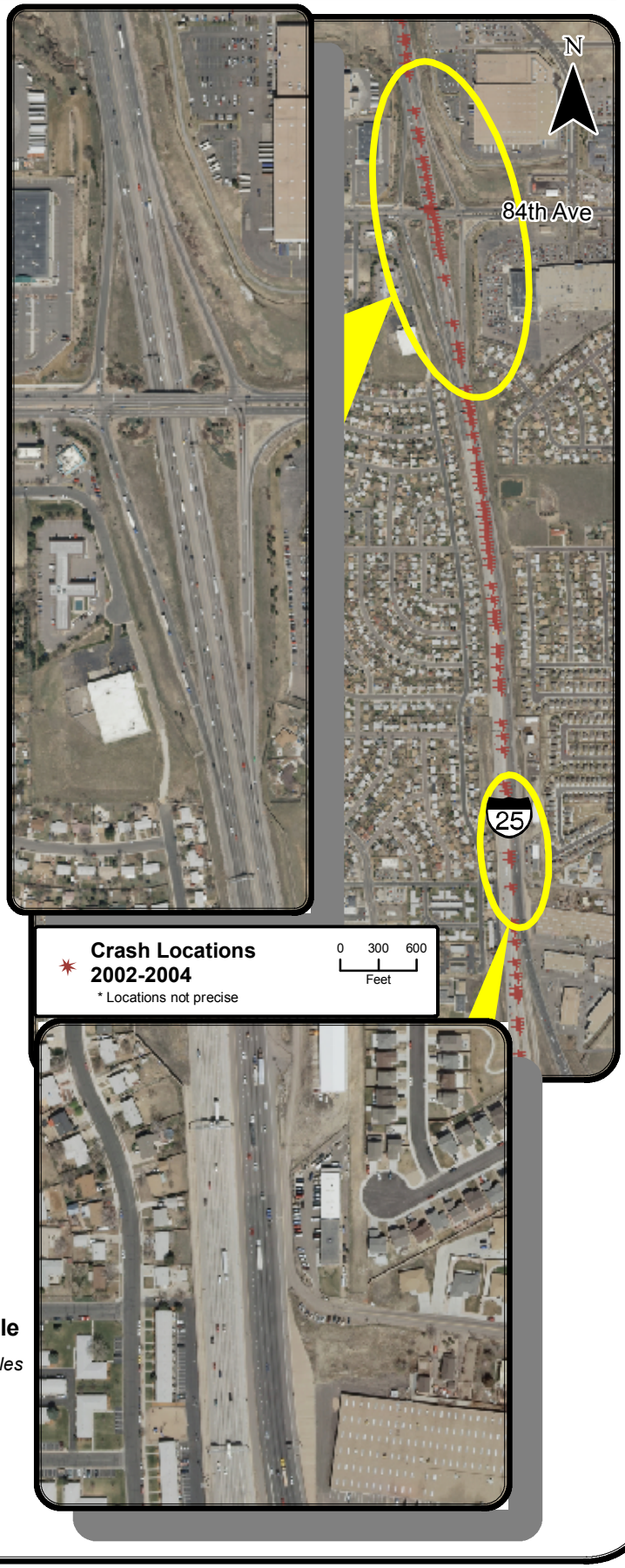
Congested Speed	24 mph
Percent Decrease from Free Flow Speed	60%
Delay (per vehicle) at this location*	2 minutes 15 seconds

Reported Crash Data 2002-2004

	Fatal	Injury	PDO	Total
Three Year Total	2	179	465	646

CDOT LOSS Rating*: IV - High reduction in crashes possible

** CDOT LOSS (Level of Safety Service) determined by the number of vehicles traveling on a roadway segment and the frequency of crashes*



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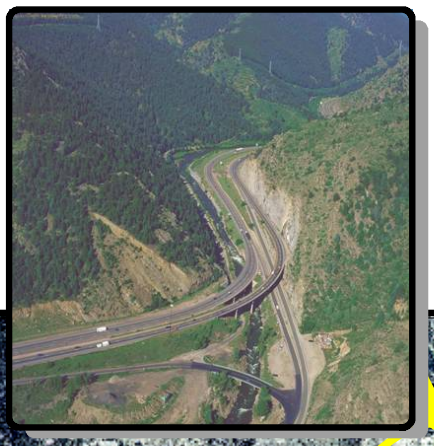
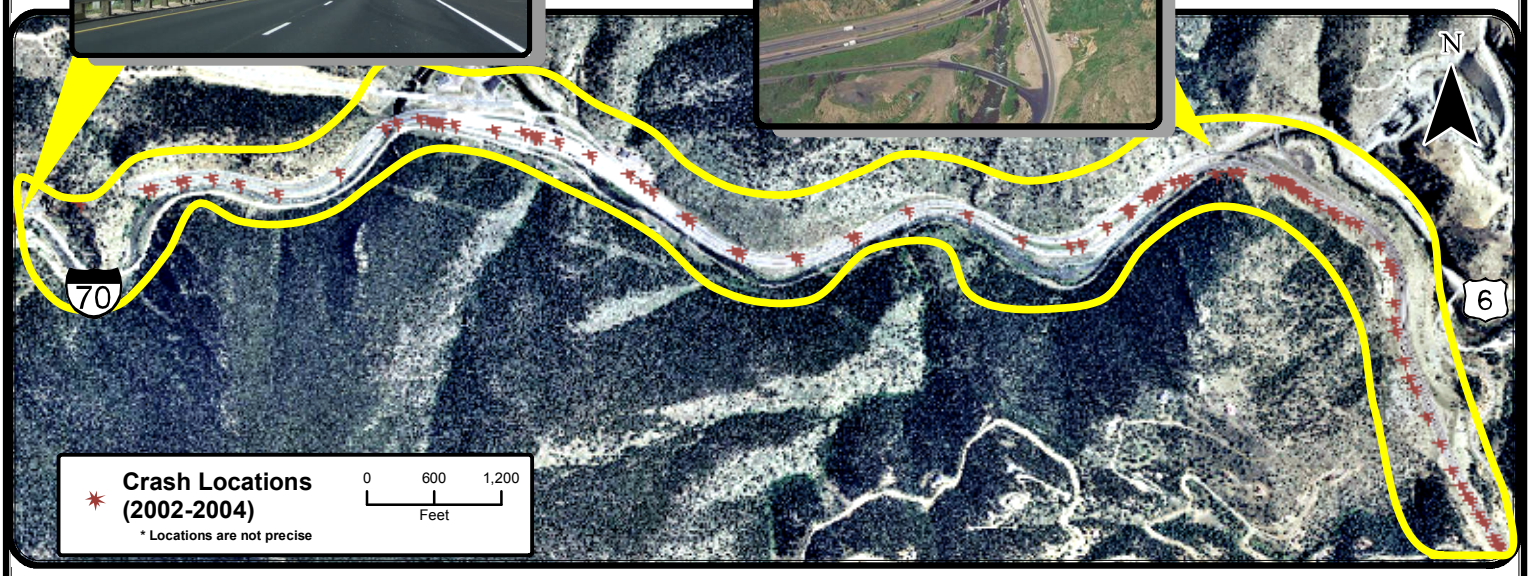
Congestion Mitigation Program - Bottleneck Data Sheet

I-70 (both directions) from Twin Tunnels to Floyd Hill





Key Reasons For Bottleneck

- Steep grades
- Left-hand on/off ramps
- Wildlife along roadside
- Winter driving conditions
- Slow moving vehicles
- Sharp turns
- Westbound lane drop at Floyd Hill

Base Conditions

Two continuous through lanes in both directions

2-way ADT on I-70	43,000
Percent Trucks	8.4%
Posted Speed (actual free flow speed is higher)	60 mph
Distance (miles)	3.2
Uncongested Travel Time (per vehicle)	2 minutes 57 seconds

Reported Crash Data 2002-2004

	Fatal	Injury	PDO	Total
Three Year Total	0	73	215	288

CDOT LOSS Rating*: III - Medium reduction in crashes possible

** CDOT LOSS (Level of Safety Service) determined by the number of vehicles traveling on a roadway segment and the frequency of crashes*

Possible Roadway Mitigation Strategies

- Add auxiliary lanes*
- Curve modification (higher design speed)*
- Interchange improvments*
- Six-lane highway with reversable HOV/HOT lane*
- Eastbound tunnel under Floyd Hill*

* I-70 Mountain Corridor Draft Environmental Impact Statement

Congestion Measures (2-way)

Typical peak hour without incidents

(Congestion extends beyond this location)

Congested Speed (weekend)	18 mph
Percent Decrease from Free Flow Speed	72%
Delay (per vehicle) at this location	7 minutes 43 seconds

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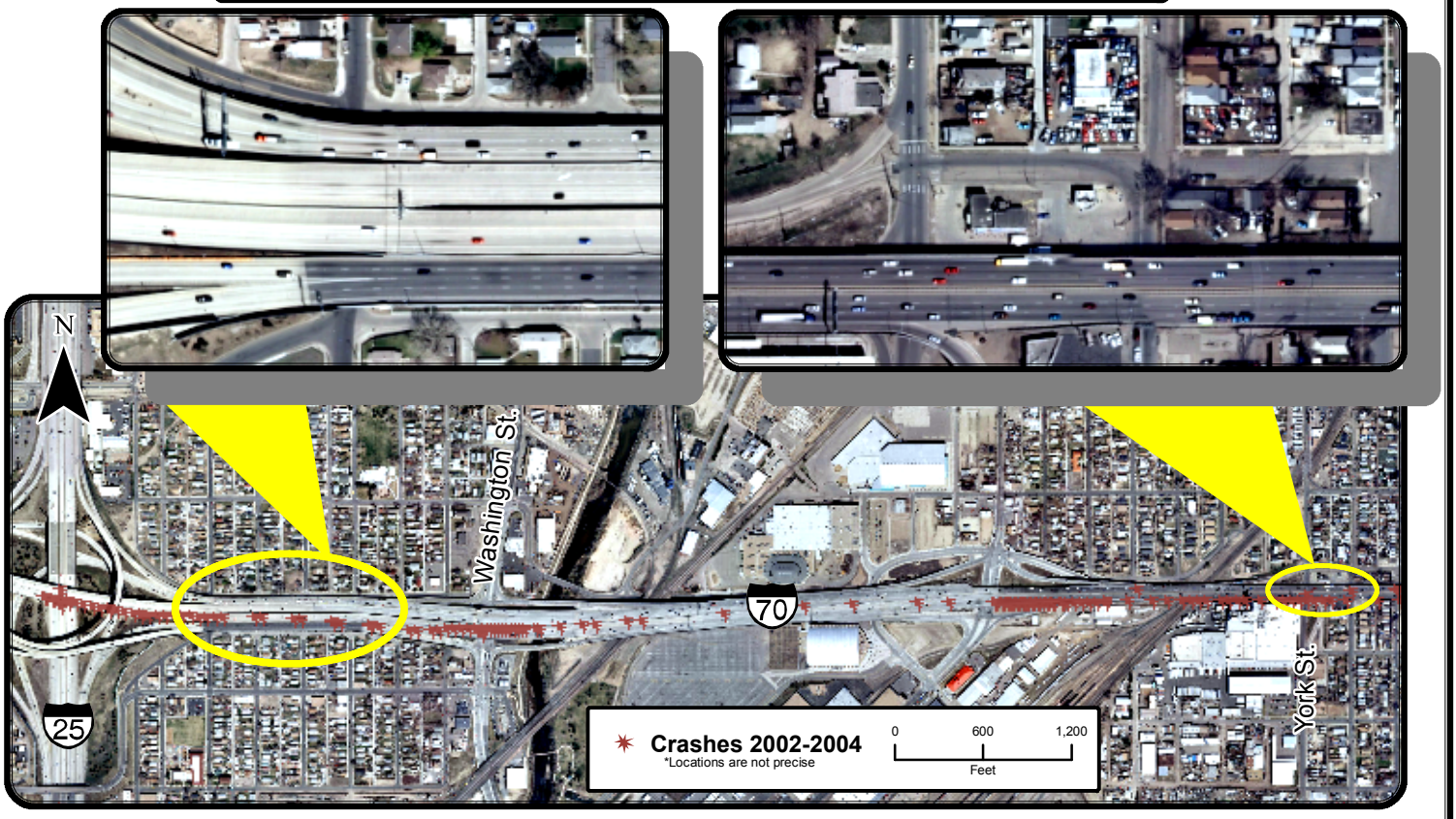
Congestion Mitigation Program - Bottleneck Data Sheet

I-70 (eastbound) from I-25 to York St.



Key Reasons For Bottleneck

Steep eastbound grade at the on-ramp merge point from I-25 northbound

Numerous vehicle weaving movements between I-25 on-ramp and York St. off-ramp

No shoulders and narrow corridor width east of Brighton Blvd.

Lane drop at York St.

Possible Roadway Mitigation Strategies

TIP Project 2005-091: Repair portions of viaduct deck from Brighton Blvd. to Colorado Blvd.

Construct new HOT/toll lanes*

Rebuild I-70 viaduct (eliminate York St. ramps)*

Move I-70 to new allignment*

* I-70 East Draft Environmental Impact Statement

Base Conditions

Three continuous through lanes in each direction

2-way ADT on I-70	141,000
Posted Speed (actual free flow speed is higher)	55
Percent Trucks	7.3%
Distance (miles)	1.6
Uncongested Travel Time (per vehicle)	1 minute 36 seconds

Congestion Measures (2-way)

Typical peak hour without incidents

(Congestion extends beyond this location)

Congested Speed	25 mph
Percent Decrease from Free Flow Speed	58%
Delay (per vehicle) at this location	2 minutes 14 seconds

Reported Crash Data 2002-2004

	Fatal	Injury	PDO	Total
Three Year Total	2	143	440	585

CDOT LOSS Rating*: IV - High reduction in crashes possible

** CDOT LOSS (Level of Safety Service) determined by the number of vehicles traveling on a roadway segment and the frequency of crashes*

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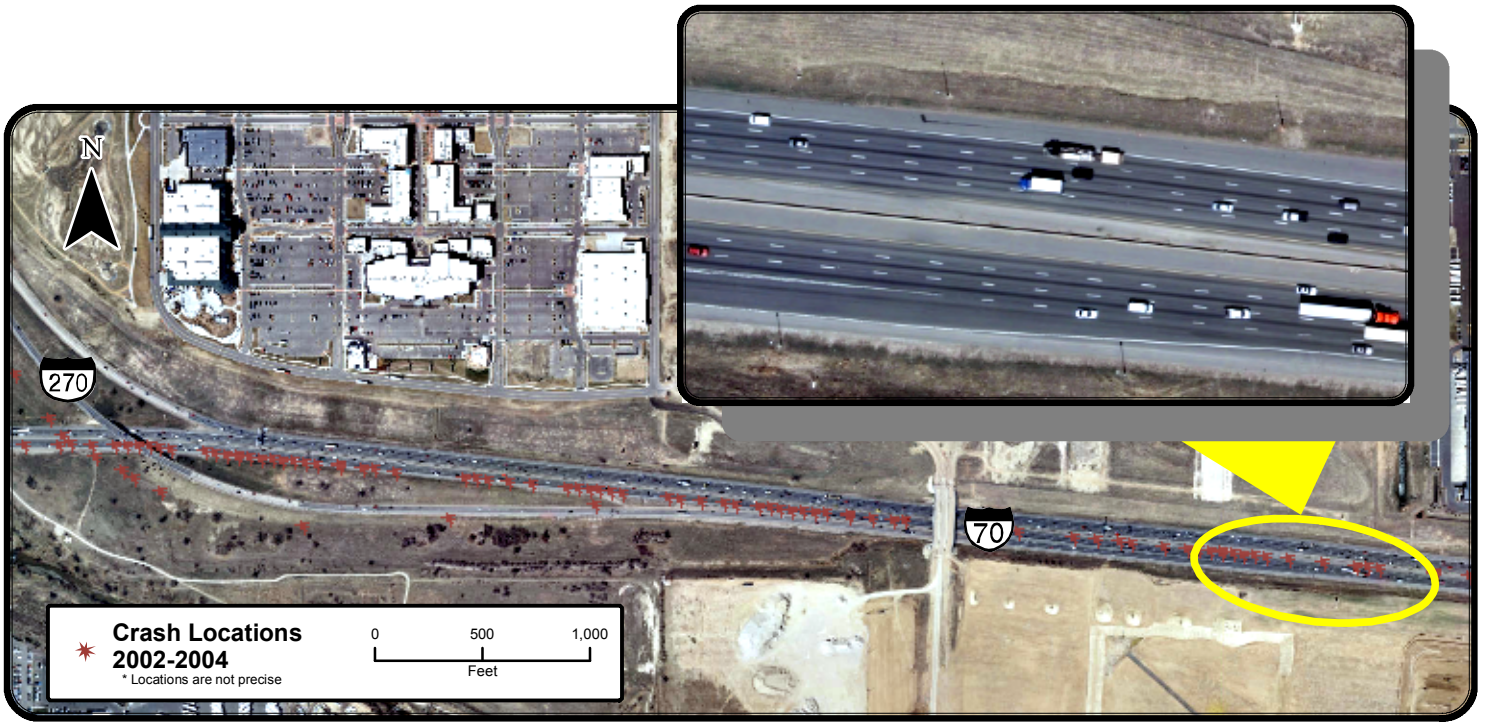
Congestion Mitigation Program - Bottleneck Data Sheet

I-70 (eastbound) east of I-270 EB Interchange



Key Reason For Bottleneck

Five (5) eastbound lanes (I-270 + I-70) merging into four (4) freeway lanes

High percentage of truck traffic

Low-speed off-ramps at Havana St.

Vehicles weaving between I-270 and Havana St.

Possible Roadway Mitigation Strategies

TIP Project 2007-083: New interchange with braided ramps connections with I-270 and I-70 between Quebec St. and Havana St.

Lengthen merge lanes onto I-70 eastbound

Widen I-70*

* I-70 East Draft Environmental Impact Statement

Base Conditions

Four continuous through lanes going eastbound

2-way ADT on I-70	148,000
Percent Trucks	9%
Posted Speed (actual free flow speed is higher)	55 mph
Distance* (miles)	2
Uncongested Travel Time* (per vehicle)	2 minutes 4 seconds

* From Quebec St. to Havana St.

Congestion Measures (2-way)

Typical peak hour without incidents

(Congestion extends beyond this location)

Congested Speed	20 mph
Percent Decrease from Free Flow Speed	67%
Delay (per vehicle) at this location*	4 minutes

Reported Crash Data 2002-2004

	Fatal	Injury	PDO	Total
Three Year Total	0	31	77	108

CDOT LOSS Rating*: III - Medium reduction in crashes possible

** CDOT LOSS (Level of Safety Service) determined by the number of vehicles traveling on a roadway segment and the frequency of crashes*

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Congestion Mitigation Program - Bottleneck Data Sheet

I-225 (southbound) from Yosemite St. to I-25

Key Reasons For Bottleneck

Convergence point of two major regional freeways

Numerous vehicles weaving between Tamarac Pkwy. and ramps to I-25

Congested traffic on I-25 causing ramp back-ups

Lane drop from four (4) lanes north of Yosemite St. to two (2) lanes at Tamarac Pkwy.

Possible Roadway Mitigation Strategies

Improve directional/guidance signage along I-225

Construct additional through lane from Tamarac Pkwy. to I-25

Braid ramps from DTC Blvd. to northbound and southbound I-25

Base Conditions

Three continuous through lanes southbound	
2-way ADT on I-225	101,000
Percent Trucks	4.5%
Posted Speed (actual free flow speed is higher)	55 mph
Distance (miles)	.70
Uncongested Travel Time (per vehicle)	42 seconds

Congestion Measures (2-way)

Typical peak hour without incidents

(Congestion extends beyond this location)

Congested Speed	37 mph
Percent Decrease from Free Flow Speed	38%
Delay (per vehicle) at this location	28 seconds

Reported Crash Data 2002-2004

	Fatal	Injury	PDO	Total
Three Year Total	1	17	88	106

CDOT LOSS Rating*: No post T-Rex LOSS data available for this segment

** CDOT LOSS (Level of Safety Service) determined by the number of vehicles traveling on a roadway segment and the frequency of crashes*

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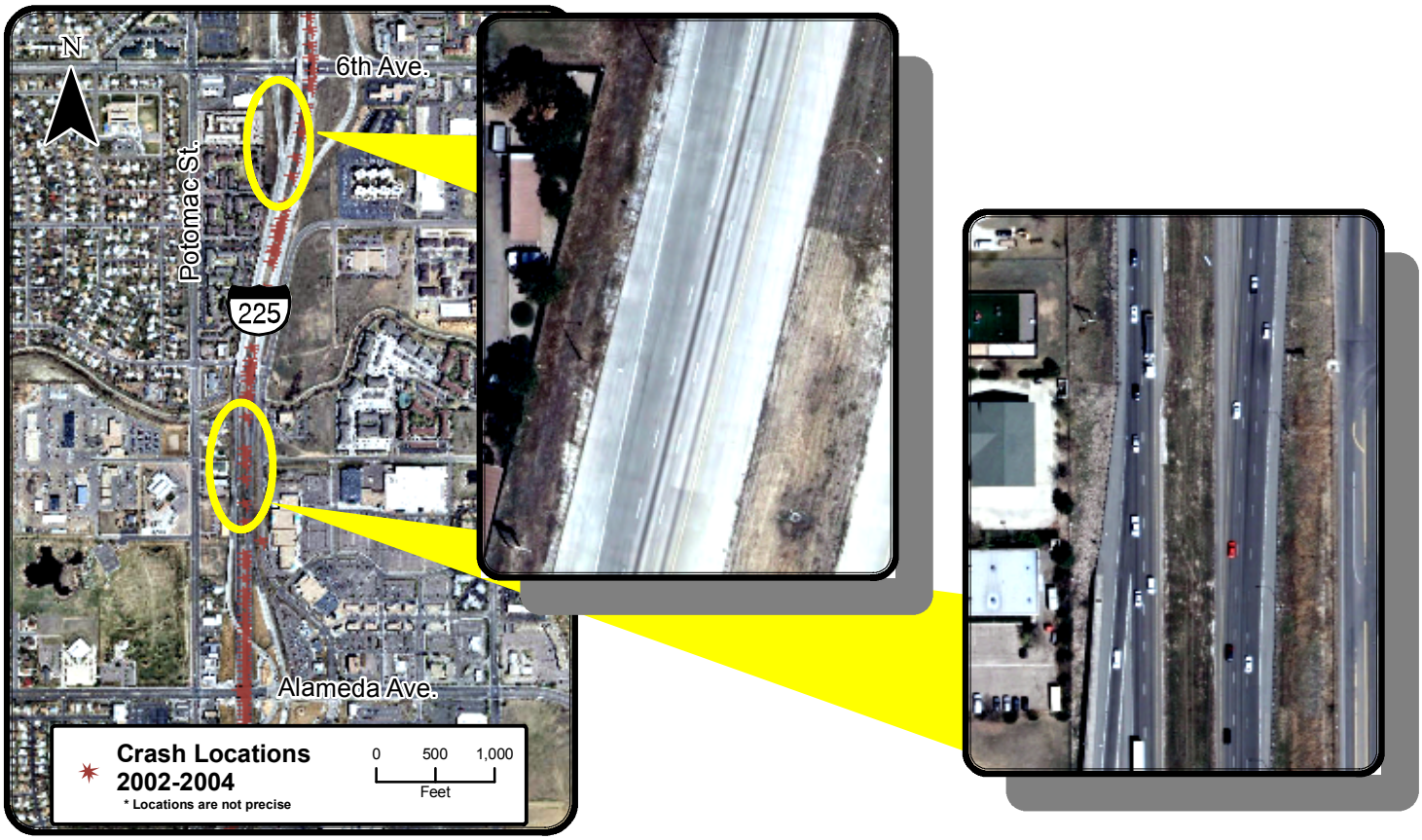
Congestion Mitigation Program - Bottleneck Data Sheet

I-225 (southbound) from 6th Ave. to Alameda Ave.



Key Reasons For Bottleneck

Vehicle weave movements between 6th Ave. and Alameda Ave.

Insufficient number of lanes to manage traffic entering/leaving I-225

I-225 southbound drops from three (3) lanes to two (2)

Possible Roadway Mitigation Strategies

Widen I-225 from four (4) to six (6) lanes from 6th Ave. south to Parker Rd. - allow for future widen to eight (8) lanes*

Add continuous auxiliary lanes along I-225

Construct managed/HOT lanes along I-225

* I-225 Widening Environmental Assessment

Base Conditions

Two continuous through lanes in each direction	
2-way ADT on I-225	108,000
Percent Trucks	6%
Posted Speed (actual free flow speed is higher)	55
Distance (miles)	1
Uncongested Travel Time (per vehicle)	1 minute 7 seconds

Congestion Measures (2-way)

Typical peak hour without incidents

(Congestion extends beyond this location)

Congested Speed	18 mph
Percent Decrease from Free Flow Speed	70 %
Delay (per vehicle) at this location	2 minutes 13 seconds

Reported Crash Data 2002-2004

	Fatal	Injury	PDO	Total
Three Year Total	0	64	162	226

CDOT LOSS Rating*: III - Medium reduction in crashes possible

** CDOT LOSS (Level of Safety Service) determined by the number of vehicles traveling on a roadway segment and the frequency of crashes*

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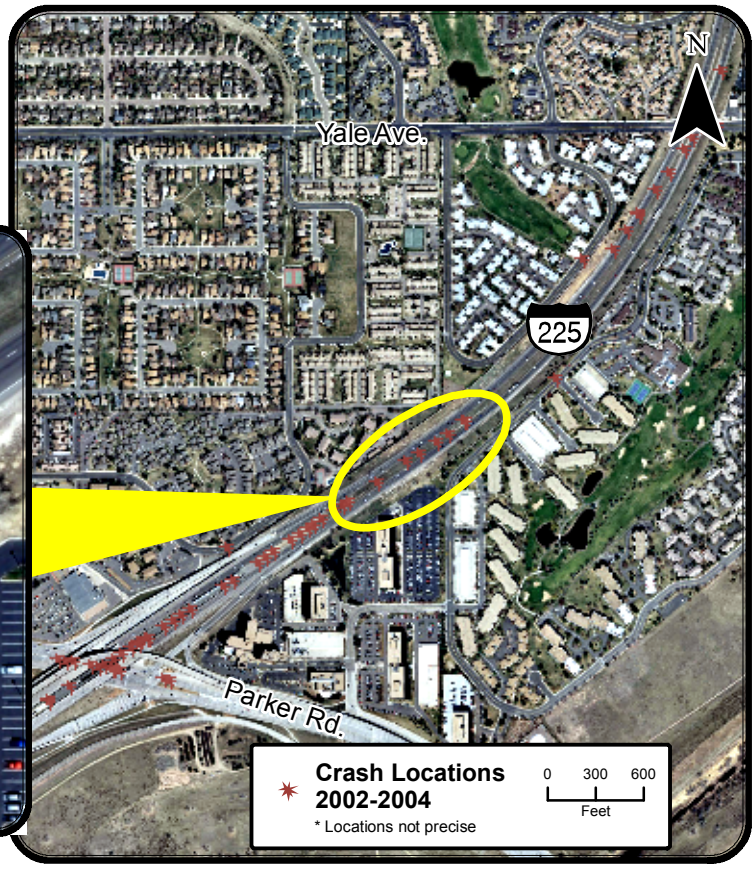
Congestion Mitigation Program - Bottleneck Data Sheet

I-225 (northbound) from Parker Rd. to Yale Ave.



Key Reasons For Bottleneck

Heavy merging traffic: I-225 northbound on-ramp from Parker Rd.

Short acceleration lane : I-225 northbound on-ramp from Parker Rd.

I-225 northbound lane drop from three (3) lanes to two (2) lanes at Parker Rd.

Base Conditions

Two continuous through lanes in each direction

2-way ADT on I-225	100,000
Posted Speed (actual free flow speed is higher)	55 mph
Percent Trucks	5%
Distance (miles)	1
Uncongested Travel Time (per vehicle)	1 minute 7 seconds

Reported Crash Data 2002-2004

	Fatal	Injury	PDO	Total
Three Year Total	5	115	256	376

CDOT LOSS Rating*: II Moderate reduction in crashes possible

** CDOT LOSS (Level of Safety Service) determined by the number of vehicles traveling on a roadway segment and the frequency of crashes*

Possible Roadway Mitigation Strategies

Widen I-225 from four (4) lanes to six (6) lanes - to allow for future widening to eight (8) lanes*

Additional main lane in each direction

Construct auxiliary lanes between Parker Rd. and Iliff Ave. intersections*

* I-225 Widening Environmental Assessment

Congestion Measures (2-way)

Typical peak hour without incidents

(Congestion extends beyond this location)

Congested Speed	21 mph
Percent Decrease from Free Flow Speed	65 %
Delay (per vehicle) at this location	1 minute 44 seconds

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Congestion Mitigation Program - Bottleneck Data Sheet

I-270 (both directions) at Vasquez Blvd.

Key Reasons For Bottleneck

- Seven (7) on/off ramps in 900 feet; substandard interchange configuration
- High percentage of truck traffic
- Sharp curves of interchange ramps slow down merging traffic
- High number of vehicle weaving movements

Possible Roadway Mitigation Strategies

- Reconfigure the interchange to better incorporate merging traffic*
- Extend westbound acceleration lane past RR bridge
- Widen I-270 to three lanes in each directon

* Highway 85 Corridor Study

Base Conditions

- Two continuous through lanes in both directions
- About 2,000 vehicles merge onto I-270
- About 1,000 loop-ramp on/off weaving vehicles

2-way ADT on I-270	95,000
Percent Trucks	11%
Posted Speed(actual free flow speed is higher)	55 mph
Distance* (miles)	4
Uncongested Travel Time* (per vehicle)	4 minutes

* On I-270 from Quebec St. to York St.

Congestion Measures (2-way)

Typical peak hour without incidents

(Congestion extends beyond this location)

Congested Speed	28 mph
Percent Decrease from Freeflow Speed	53%
Delay (per vehicle) at this location*	4 minutes 34 seconds

Reported Crash Data 2002-2004

	Fatal	Injury	PDO	Total
Three Year Total	1	43	98	142

CDOT LOSS Rating*: III - Medium reduction in crashes possible

** CDOT LOSS (Level of Safety Service) determined by the number of vehicles traveling on a roadway segment and the frequency of crashes*

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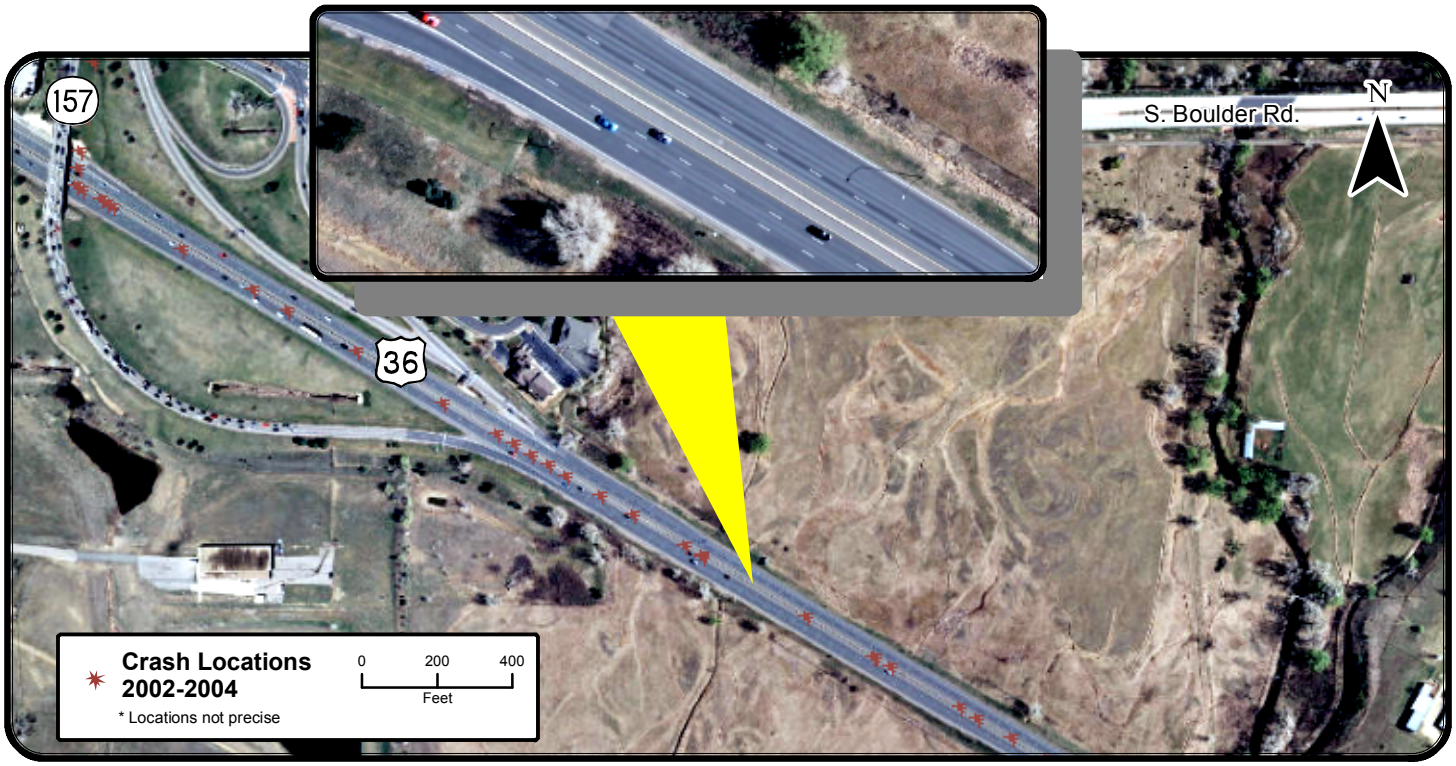
Congestion Mitigation Program - Bottleneck Data Sheet

US-36 (eastbound) from Foothills Pkwy. to Davidson Mesa



Key Reasons For Bottleneck

Heavy merging traffic from S. Boulder Rd. and Foothills Pkwy.

Grade increase from Foothills Pkwy. to Davidson Mesa

Base Conditions

Two continuous through lanes in each direction

2-way ADT on US-36	66,000
Percent Trucks	2.7%
Posted Speed (actual free flow speed is higher)	65 mph
Distance (miles)	4
Uncongested Travel Time (per vehicle)	3 minutes 25 seconds

Reported Crash Data 2002-2004

	Fatal	Injury	PDO	Total
Three Year Total	1	84	146	230

CDOT LOSS Rating*: III - Medium reduction in crashes possible

** CDOT LOSS (Level of Safety Service) determined by the number of vehicles traveling on a roadway segment and the frequency of crashes*

Possible Roadway Mitigation Strategies

TIP Project 2007-085: Roadway operational improvements from I-25 to Table Mesa Dr.

Eastbound climbing lane from Foothills Pkwy. to top of Davidson Mesa*

Construct manged/BRT lanes*

* US-36 Corridor Environmental Impact Statement

Congestion Measures (2-way)

Typical peak hour without incidents

(Congestion extends beyond this location)

Congested Speed	48 mph
Percent Decrease from Freeflow Speed	31%
Delay (per vehicle) at this location	1 minute 35 seconds

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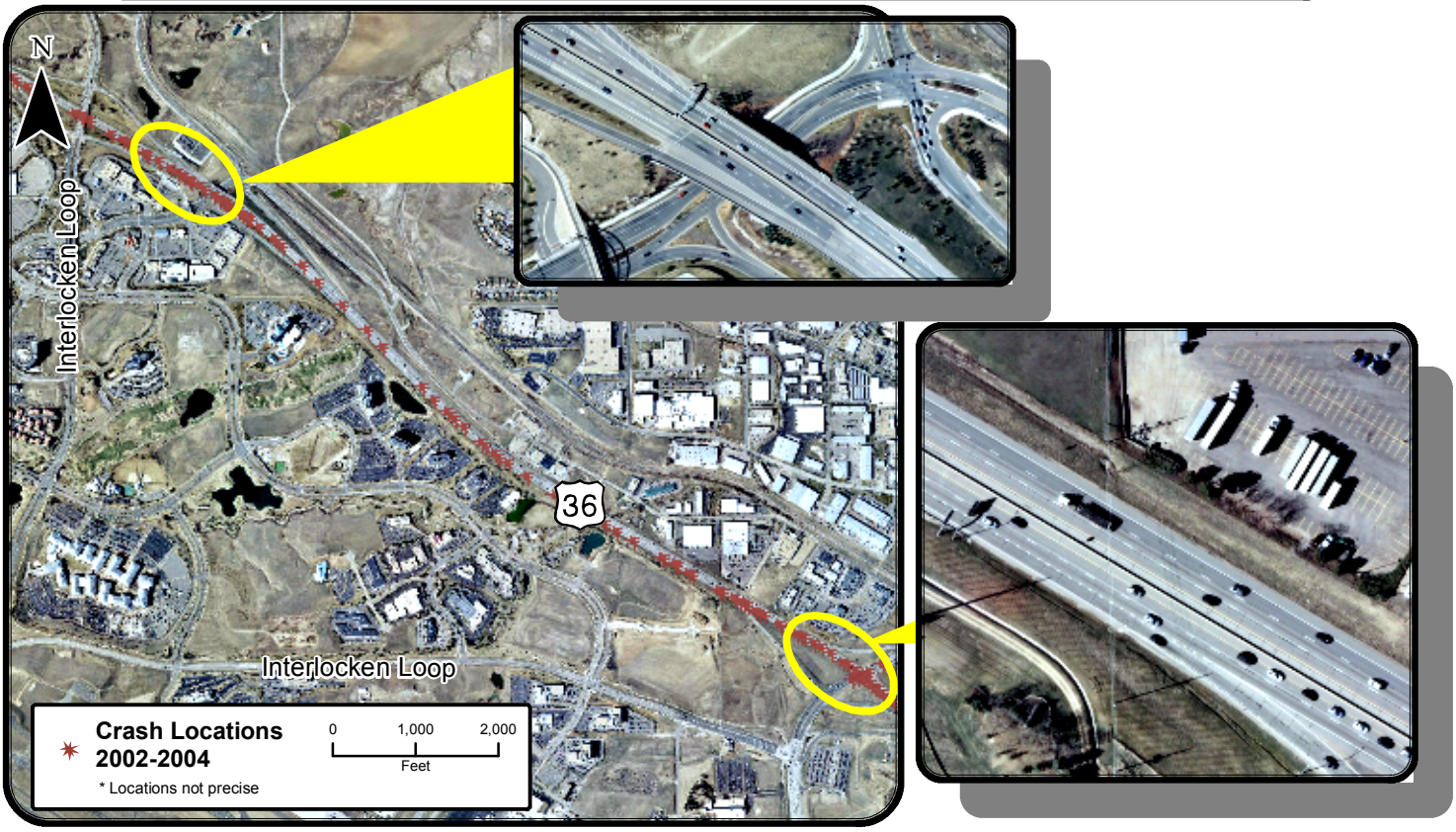
Congestion Mitigation Program - Bottleneck Data Sheet

US-36 (both directions) from Interlocken Loop to Wadsworth Blvd.



Key Reasons For Bottleneck

Vehicle weave movements on US-36 eastbound from Interlocken Loop to Wadsworth Blvd.

Heavy merging traffic from Wadsworth Blvd.

Possible Roadway Mitigation Strategies

Extend manged lanes from Pecos St. to Table Mesa Dr.*

BRT improvements along US-36 corridor*

Construct ramp to ramp auxiliary lanes along US-36

* US-36 Corridor Environmental Impact Statement

Base Conditions

Two continuous through lanes in each direction

2-way ADT on US-36	76,000
Percent Trucks	3%
Posted Speed (actual free flow speed is higher)	65 mph
Distance (miles)	2.2
Uncongested Travel Time (per vehicle)	1 minute 53 seconds

Congestion Measures (2-way)

Typical peak hour without incidents

(Congestion extends beyond this location)

Congested Speed	51 mph
Percent Decrease from Free Flow Speed	27%
Delay (per vehicle) at this location	42 seconds

Reported Crash Data 2002-2004

	Fatal	Injury	PDO	Total
Three Year Total	0	40	179	219

CDOT LOSS Rating*: III Medium reduction in crashes possible

** CDOT LOSS (Level of Safety Service) determined by the number of vehicles traveling on a roadway segment and the frequency of crashes*

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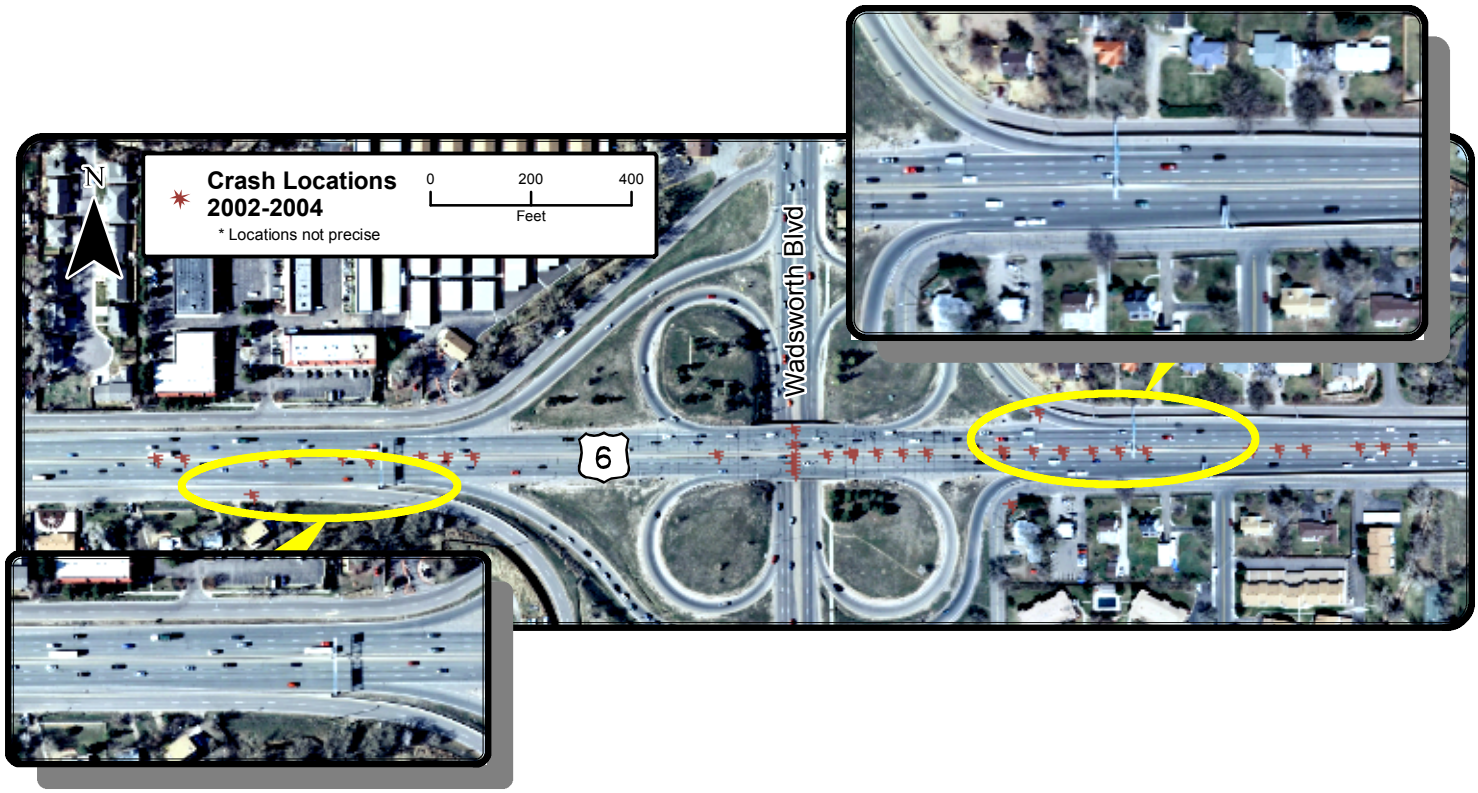
Congestion Mitigation Program - Bottleneck Data Sheet

US-6 (both directions) at Wadsworth Blvd.



Key Reasons For Bottleneck

- Heavy weaving caused by traffic merging onto and off of US-6
- Substandard interchange configuration
- Insufficient number of lanes to manage traffic entering/leaving US-6
- Short acceleration lanes
- Sharp curves on on-ramps and off-ramps

Possible Roadway Mitigation Strategies

- Extend on-ramp accleration lanes*
- Reconfigure on/off-ramps from US-6 to Wadsworth Blvd.*
- Ramp meter new ramps from Wadsworth Blvd. to US-6

* US-6/Wadsworth Blvd. Environmental Assessment

Base Conditions

Three continuous through lanes in each direction

2-way ADT on US-6	118,000
Percent Trucks	2.6%
Posted Speed (actual free flow speed is higher)	65 mph
Distance (miles)	1.6
Uncongested Travel Time (per vehicle)	1 minute 22 seconds

Congestion Measures (2-way)

Typical peak hour without incidents

(Congestion extends beyond this location)

Congested Speed	49 mph
Percent Decrease from Free Flow Speed	30 %
Delay (per vehicle) at this location	35 seconds

Reported Crash Data 2002-2004

	Fatal	Injury	PDO	Total
Three Year Total	0	28	116	144

CDOT LOSS Rating*: III Medium reduction in crashes possible

** CDOT LOSS (Level of Safety Service) determined by the number of vehicles traveling on a roadway segment and the frequency of crashes*

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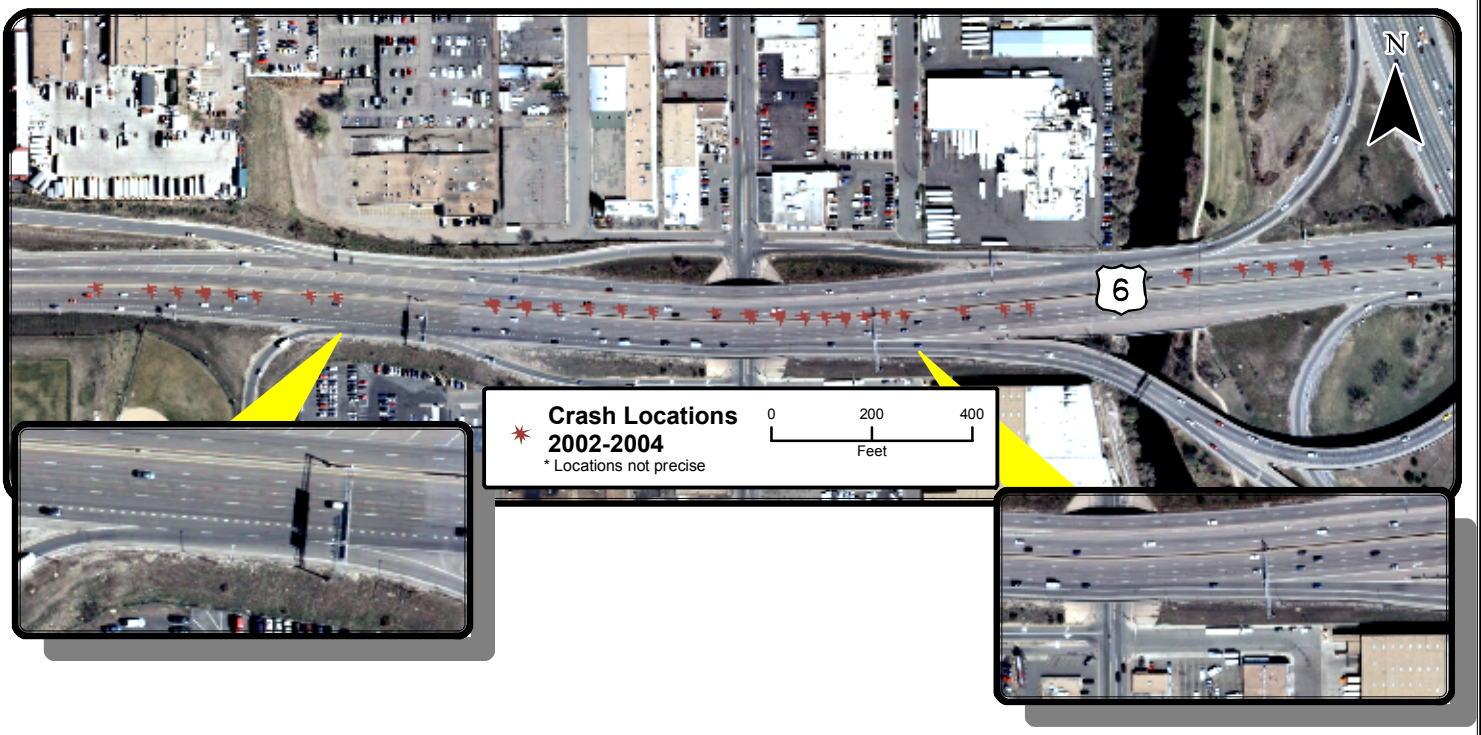
Congestion Mitigation Program - Bottleneck Data Sheet

US-6 (both directions) from Federal Blvd. to I-25



Key Reasons For Bottleneck

Heavy weaving traffic between Federal Blvd. and I-25

Inadequate ramp spacing between Federal Blvd. and I-25

Substandard interchange configuration

Discontinuous lanes between Federal Blvd. and I-25

Base Conditions

Two (2) continuous through lanes westbound and three (3) continuous through lanes eastbound

2-way ADT on US-6	148,000
Percent Trucks	2%
Posted Speed(actual free flow speed is higher)	55 mph
Distance (miles)	.6
Uncongested Travel Time (per vehicle)	36 seconds

Reported Crash Data 2002-2004

	Fatal	Injury	PDO	Total
Three Year Total	1	50	163	214

CDOT LOSS Rating*: IV - High reduction in crashes possible

** CDOT LOSS (Level of Safety Service) determined by the number of vehicles traveling on a roadway segment and the frequency of crashes*

Possible Roadway Mitigation Strategies

Close ramps to Bryant St.*

Ramp metering for reconstructed on-ramp from Federal Blvd. to US-6 eastbound

Construct collector-distributor roads to manage traffic between Federal Blvd. and I-25*

Reconfigure ramp access from I-25 northbound to US-6 westbound*

Braid eastbound on-ramp to allow for traffic traveling east on US-6 to avoid traffic exiting off onto I-25*

Reconstruct US-6 and Federal Blvd. interchange as diamond interchange*

* Valley Highway Environmental Impact Statement

Congestion Measures (2-way)

Typical peak hour without incidents

(Congestion extends beyond this location)

Congested Speed	45 mph
Percent Decrease from Free Flow Speed	25%
Delay (per vehicle) at this location	12 seconds

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