CITY AND COUNTY OF SAN FRANCISCO
BOARD OF SUPERVISORS
BUDGET AND LEGISLATIVE ANALYST

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Policy Analysis Report

To: Supervisor Mar
From: Budget and Legislative Analyst's Office
Re: Analysis of Altering Speed Limits
Date: February 4, 2015

Summary of Requested Action

Your office requested that the Budget and Legislative Analyst determine which entities have the authority to alter speed limits in San Francisco and under what circumstances. Your office also requested the Budget and Legislative Analyst conduct a review of jurisdictions that have reduced their speed limits and analyze the impact that the speed limit change has had on vehicle collisions and injuries, the economy and the environment. Lastly, your office requested that the Budget and Legislative Analyst provide policy options that the City and County of San Francisco could consider at the local and state level to reduce speed limits.

For further information about this report, contact Fred Brousseau at the Budget and Legislative Analyst's Office.

Executive Summary

- There were 3,111 vehicle collisions in San Francisco in 2011 that resulted in non-fatal injuries and 28 collisions that resulted in fatalities, according to the San Francisco Metropolitan Transportation Authority. Fatalities increased in the subsequent years, with 42 in 2011, 41 in 2013 and 40 in 2014, according to the San Francisco Police Department. The primary cause of one-fifth of all injury collisions was unsafe vehicle speed, which may have also been a secondary cause for additional injury collisions.
- Of the 3,111 collisions with injuries that occurred in 2011, 844 were between vehicles and pedestrians and 630 were between vehicles and bicyclists, or 27 and 20 percent of total collisions with injuries, respectively. Of the 28 fatal collisions that occurred in 2011, 17 were between vehicles and pedestrians and four were between vehicles and bicyclists.

- The City and County of San Francisco has limited authority over altering speed limits as local speed limits are largely governed by State law which allows for speeds of between 25 and 65 miles per hour (mph) only. Adjustments within that range are only allowed if demonstrated to be needed by an Engineering and Traffic Survey which finds that 85 percent of free flowing traffic is travelling at speeds higher or lower than the existing speed limit.
- Unless a different speed limit has been established based on an Engineering and Traffic Survey in a residential district, commercial district, school zone (within 500 feet of a school) or near a senior center, State law imposes a prima facie speed limit of 25 mph in such areas.
- With the exception of within 500 feet of schools, blind alleyways and uncontrolled or blind railroad crossings or intersections, local jurisdictions in California cannot lower their speed limits below 25 mph.
- Studies conducted by the U.S. Department of Transportation and Institute for Road Safety Research of the Netherlands show that automobile drivers traveling at higher speeds have an increased risk of getting into a collision compared to drivers traveling at slower speeds and collisions that occur at higher speeds result in more serious injuries or death.
- A study conducted by the United Kingdom's Department of Transportation found that the probability of a pedestrian being killed when struck by a vehicle is nine times greater when the vehicle's speed is 30 mph than when the vehicle's speed is 20 mph and 17 times greater than when the vehicle's speed is 40 mph. A U.S. Transportation Research Board study found that the probability of serious injury or death when struck by a vehicle increases with age.
- In 2012, the U.S. National Safety Council estimated the average comprehensive cost for motor vehicle crashes per injured person in the United States ranged from $28,000 for a possible injury to $230,000 for an incapacitating injury to $4,538,000 for a crash resulting in a death. These costs cover wage and productivity loss, medical and administrative expenses, vehicle damage, employers' uninsured costs and the value of lost quality of life which was measured through empirical studies of peoples' willingness to pay to reduce their safety and health risks.
- A study by the Transport Research Laboratory of the United Kingdom found that, for most cities, a one mph increase or decrease in average traffic speed is associated with a five percent increase or decrease in collisions with injuries.
- Speed reduction programs have been implemented in cities throughout the U.S. and the world, including citywide reductions in speed limits, speed limit reductions in "slow zones" in designated areas, installation of traffic calming measures, and enhanced speed limit enforcement initiatives. Some jurisdictions with various types of speed limitation programs in place include:

- 33 cities in the United Kingdom, including 400 areas in Greater London and the cities of Portsmouth and Bristol, the cities of Graz, Austria, Dublin, Ireland, Barcelona, Paris, Zurich and Buxtehude, Germany.
- In the U.S., New York City, Portland, Seattle and at least 134 other cities. The San Francisco Metropolitan Transportation Agency has implemented a program for installing traffic calming measures in select neighborhoods.

- The Budget and Legislative Analyst reviewed evaluations of the results of speed reduction programs in six cities: London, New York City, Bristol, England, Portsmouth, England, Graz, Austria, and Portland, Oregon. Key results of those evaluations include:
  - Average speeds for all six jurisdictions and the average number of collisions for the five cities where it was measured declined following implementation of speed reduction programs.
  - The most significant results and the most exhaustive evaluation reviewed was a twenty year study of 385 20 mph slow zones with traffic calming measures in Greater London. That evaluation reported that the establishment of the slow zones was associated with a 40 percent decrease in collisions and collisions with injuries.
  - While all cities reported reductions in average speeds and, for those reporting it, total collisions, two cities reported an increase in collisions with serious injuries, three cities reported decreases in such collisions and one city did not report serious injuries or deaths. The speed reduction program for the two cities with increased collisions with serious injuries consisted of lowered speed limits but without traffic calming measures or enhanced enforcement. Both of these measures have proven relatively more effective at reducing average speeds and collisions.
  - All of the evaluation studies except those for London and Portland, Oregon covered relatively short time spans and may not have fully captured long-term program impacts.
- The results of numerous studies that have attempted to analyze the relationship between emission rates and vehicle speed have been mixed, with variations based on vehicle and fuel types, driver behavior, traffic conditions, emission type and other assumptions that may be built into the study.

Policy Alternatives

Based on an analysis of current State law, research on the topic and evaluations of speed reduction programs in other cities, the Budget and Legislative Analyst developed the following six policy alternatives for consideration by the Board of Supervisors to meet the objectives of reducing vehicle speeds in San Francisco and the impacts of higher speeds on collisions, injuries, the economy and the environment:

1) Enhance enforcement of current speed limits using additional police officers.
2) Advocate for amendments to State law to allow for enhanced enforcement through Automated Speed Enforcement (ASE) technology.
3) Advocate for changes in State law to allow City speed limits lower than 25 mph and to eliminate the requirement that speed limits be set at the actual speed of most drivers.
4) Advocate for changes in State law to allow City speed limits lower than 25 mph and to eliminate requirement that speed limits be set at actual speed of most drivers and enhance enforcement of new speed limits.
5) Implement or enhance City traffic calming measures.
6) Implement traffic calming measures, advocate for changes in State law to allow City speed limits lower than 25 mph and to eliminate requirement that speed limits be set at actual speed of most drivers, and enhance enforcement of new speed limits.

Each alternative was evaluated for its: likely impact on reducing vehicle speeds and collisions; unit implementation costs for: a) capital improvements such as speed bumps or Automated Speed Enforcement equipment and b) advocating for State legislative changes, including the costs of labor, outside counsel and consultants; and, unit enforcement personnel costs, which refers to costs associated with one unit of enforcement personnel such as a sworn police officer and related support costs. The results of this analysis are presented in Exhibit A.

Exhibit A: Speed Reduction Policy Alternatives Measured against Evaluation Criteria

Speed Limit Program	Effectiveness in Reducing Vehicle Speed	Implementation Costs			Total Cost
		One-time Capital Improvement Unit Cost	One-time Legislative Advocacy Costs	Ongoing Enforcement Personnel Unit Cost	
Alternative 1: Enhance Enforcement with Police Dept. labor	Low - Moderate	-	-	$$	$$
Alternative 2: Advocate for legislative change to allow enhanced enforcement with Automated Speed Enforcement cameras	Moderate	$	$	$$	$$$$
Alternative 3: Advocate for changes to State law to allow speed limit reductions not based on current actual speeds	Low		$	-	$
Alternative 4: Advocate for changes to State law to allow speed limit reductions not based on current actual speeds; enhance enforcement of new speed limits	Moderate		$	$$	$$$
Alternative 5: Implement/enhance traffic calming treatments	Moderate - High	$	-	-	$
Alternative 6: Advocate for changes to State law to allow speed limit reductions not based on current actual speeds; enhance enforcement; implement/enhance traffic calming	High	$$	$	$$	$$$$$

This evaluation of policy alternatives shows that Alternative 6, the combination of reducing speed limits in the City through advocating for a change in State law, enhancing speed limit enforcement and installation of traffic calming measures would be most effective at reducing vehicle speed and collisions. This alternative would also incur the highest costs though speed reduction programs could be phased by neighborhood and extent of implementation if it is not possible to fund completely at one time.

Authority over Speed Limits

Speed limits in California are determined by the State pursuant to the California Vehicle Code. However, State law allows local authorities to make adjustments to speed limits in their jurisdictions under certain circumstances. The overriding principle of the State's speed laws is the Basic Speed Law, which is codified in California Vehicle Code Section 22350 and states that no driver shall drive at a speed greater or lower than what is reasonable or prudent considering the weather, visibility, traffic conditions, surface width of the roadway, or at a speed that would endanger the safety of people or property.[1]

The Basic Speed Law provides for driver discretion as it does not specify a speed at which it is illegal to drive above or below. It allows for consideration of environmental factors such as road conditions and current traffic speeds in order for drivers to determine a reasonable speed, regardless of the posted speed limit. For example, during traffic congestion or inclement weather, drivers are expected to alter their speed to below the posted speed limit pursuant to the Basic Speed Law; however, a driver may be violating the Basic Speed Law if he or she is driving below the posted speed limit when the majority of traffic is driving much faster.[2]

Despite the discretion afforded to drivers by the Basic Speed Law, local jurisdictions can establish posted speed limits to inform drivers of whether their speed is consistent with the speed the majority of drivers consider safe and reasonable, according to Caltrans' California Manual for Setting Speed Limits, though, with a few exceptions, these speeds must be between 25 and 65 mph. Posted speed limits also allow for fair enforcement for drivers who are driving substantially faster or slower than what the majority of drivers consider safe and reasonable. Additionally, from a traffic engineering perspective, established speed limits influence other street design criteria such as the size of signs or yellow light timing.[3]

Determining the Speed Limit

The California Manual on Uniform Traffic Control Devices states that setting speed limits can be controversial and therefore a rational and defensible process should be in place to

[1] California Department of Motor Vehicles, Cal. Vehicle Code 22350 (1963).
[2] California Department of Transportation, Division of Traffic Operations*, 2014 California Manual for Setting Speed Limits*.
[3] Ibid.

ensure public confidence.[4] A report published by the U.S. Department of Transportation on methods for setting speed limits describes the following four general approaches, or processes, for setting speed limits:[5]

1) Engineering approach: A two-step process where the base speed limit is determined according to the 85th percentile speed or the speed up to which 85 percent of free-flowing traffic travels on a roadway, which is then adjusted in accordance with traffic and infrastructure conditions.
2) Expert system approach: A computer program sets the speed limit by using an accumulated knowledge and experience base and a set of rules for applying this knowledge to the conditions of a particular road segment.
3) Optimization: The speed limit is determined to minimize the total societal costs of transport including travel time, vehicle operating costs, road crashes, traffic noise and air pollution.
4) Injury minimization or safe system approach: Speed limits are set according to crash types that could likely occur, the impact forces and the human body's tolerance to withstand these forces.

Jurisdictions in the United States typically use the engineering approach or, less frequently, the expert system approach, which is also applied in Australia. In some other countries, notably Sweden and the Netherlands, the injury minimization approach is more common.

To set a specific speed limit on a roadway, State law requires that local jurisdictions conduct an Engineering and Traffic Survey (E&TS) which is an objective evaluation of a street's prevailing speed, roadway design, collision record, residential density, pedestrian and bicyclist safety and other factors. Such surveys are required to determine an appropriate speed limit or to revise prima facie speed limits. Prima face speed limits is a State designation for default speeds on certain types of streets when no other speed limits are posted.[6] Consistent with the engineering approach above, the California Manual for Setting Speed Limits recommends that the speed limit be set within 5 mph of the 85th percentile speed of free flowing traffic as measured by an E&TS. The 85th percentile speed is the speed that 85 percent of free-flowing traffic does not exceed.[7]

[4] California Department of Transportation, *California Manual on Uniform Traffic Control Devices 2014,* Section 2B.13 Speed Limit Sign (R2-1).
[5] Forbes, G et. Al. (2012) Method and Practices for Setting Speed Limits. U.S. Department of Transportation.
[6] California Department of Motor Vehicles, Cal. Veh. Code 22358.4 (2008), Cal. Veh. Code 627 (2001), Cal. Veh. Code 22358 (1996).
[7] California Department of Transportation, Division of Traffic Operations*, 2014 California Manual for Setting Speed Limits*. Available online at: http://www.dot.ca.gov/hq/traffops/engineering/mutcd/pdf/california-manual-for-setting-speed-limits.pdf [Accessed October 2014].

The 85th percentile speed principle is used because it assumes that the majority of drivers are rational and will drive at a speed that is reasonable and safe given road conditions and roadway design.[8] The remaining 15 percent of drivers that drive a speed that is faster than the 85th percentile speed have a higher probability of getting into a collision according to research conducted in the 1960s by the U.S. Department of Commence-Bureau of Public Roads. This study is the basis of the 85th percentile speed principle.[9]

Caltrans reports that speed limits that are set too high or too low can increase the risk of collision. Speed limits that are set too high or too low may not coincide with the speed that the majority of drivers feel safe traveling, causing some drivers to adhere to the posted speed limit and others to drive at speeds at which they feel comfortable. These two speeds may differ and the variation in driver speed increases the risk of collision.[10] Speed limits set near the 85th percentile of free flowing traffic create a more consistent and predictable traffic flow, according to Caltrans. The agency further reports that arbitrarily low speed limits can cause a disproportionate amount of drivers to be in violation of the posted speed limit, which would require constant enforcement and could impede the orderly movement of traffic.[11]

By State law, the maximum allowed speed limit on two-lane undivided roadways for all roadways in California is 55 miles per hour (mph) and 65 mph on all other roadways.[12] With a few exceptions, discussed further below, the minimum allowable speed limit in California is 25 mph.

For residential districts, business districts, school zones (within 500 feet of a school) and when passing a senior center,, 25 mph is the prima facie speed limit established by California Vehicle Code Section 22352 and is in effect as long as no other speed limit is posted. Section 22352 of the California Vehicle Code establishes 15 mph as a speed limit for alleyways and uncontrolled or blind railroad crossings or intersections. Local authorities do not need to conduct an E&TS to set a prima facie speed limit; however, if local authorities find that prima facie or other statutorily defined speed limits are not appropriate for existing conditions, the speed limit can be altered to between 25-65 mph for most streets, according to Section 22358 of the California Vehicle Code.

[8] Ibid.
[9] Solomon, David (July 1964, Reprinted 1974). "Accidents on main rural highways related to speed, driver, and vehicle". Technical report, U.S. Department of Commerce/Bureau of Public Roads (precursor to Federal Highway Administration).
[10] California Department of Transportation, Division of Traffic Operations*, 2014 California Manual for Setting Speed Limits*. Available online at: http://www.dot.ca.gov/hq/traffops/engineering/mutcd/pdf/california-manual-for-setting-speed-limits.pdf [Accessed October 2014].
[11] Ibid.
[12] Department of Motor Vehicles, Cal. Vehicle. Code 22349 (2000).

The California Manual for Setting Speed Limits directs local authorities to round the 85th percentile speed to the nearest five mph increment; however special provisions such as collision rates and bicycle or pedestrian safety factors allow a jurisdiction to reduce the speed limit by an additional five mph but no less.

California Vehicle Code Section 22358.4 allows a local authority to reduce the 25 mph prima facie speed limit in school zones to 20 mph or 15 mph, even if an Engineering and Traffic Survey finds that the 25 mph is more than reasonable and safe given the local conditions. In 2007, Section 22358.4 was amended and provides local jurisdictions the authority to reduce the school zone speed limit to 15 mph without an E&TS if the road approaching the school is in a residential district, has no more than two traffic lanes and has a speed limit of 30 mph or less. Local authorities can also extend the 25 mph school zone to 1,000 feet from the school. [13]

In San Francisco, any changes to speed limits require approval by the San Francisco Municipal Transportation Agency (SFMTA) Board of Directors by resolution pursuant to Chapter 8A of the San Francisco Charter.

Vehicle Speed: Impact on Traffic Collisions, the Economy and the Environment

This section provides an overview of research on how vehicle speed affects traffic collisions, the severity of injuries in traffic collisions, the economy and the environment.

Traffic Collisions and Injuries

Studies conducted by the U.S. Department of Transportation and researchers from the Institute for Road Safety Research in the Netherlands show that automobile drivers traveling at higher speeds have an increased risk of getting into a collision compared to drivers traveling at slower speeds and that collisions that occur at higher speeds result in more serious injuries or death. [14] [15] Drivers have less reaction time to avoid a collision when traveling at a higher speed as it takes a vehicle a longer distance to stop the faster it

[13] (n.d.) California School Zones. Available online at: http://california.drivinguniversity.com/driving-safety/california-school-zones [Accessed online January 2015].
[14] Aarts L and van Schagen I. (2006) Driving Speed and the Risk of Crashes: A review. Accident Analysis and Prevention 38
[15] Leaf, W.A. and D.F. Preusser. (1999) Literature Review on Vehicle Travel Speeds and Pedestrian Injuries Among Selected Racial/Ethnic Groups. U.S. Department of Transportation National Highway Traffic Safety Administration. Retrieved from http://www.nhtsa.gov/people/injury/research/pub/HS809012.html

is moving.[16] For example, a vehicle traveling at 30 mph will need 109 feet to stop, including the time and distance it takes to react and decelerate, while a vehicle traveling at 20 mph will need only 62 feet to stop.[17]

Exhibit 1 is a combination of results from two studies that assessed the probability of a pedestrian being killed when struck by a vehicle at various speeds. The results found in the second column are from a study conducted in the United Kingdom and show that the probability of a pedestrian being killed when struck by a vehicle is nine times greater when the vehicle's speed is 30 mph than when the vehicle's speed is 20 mph and 17 times greater than when the vehicle's speed is 40 mph.

Another study conducted in the United States stratified the probability of being killed when struck by a vehicle by age, as also shown in Exhibit 1, and found that the risk of death from being struck by a vehicle increases with age. A person over the age of 60 has only an eight percent chance of surviving if hit by a car traveling 40 mph.

Exhibit 1: Probability of Death for Pedestrians Struck by Vehicles by Pedestrian Age and Vehicle Speed

Vehicle speed (mph)	Probability of pedestrian fatality if struck by vehicle	Probability of struck pedestrian fatality if age 14	Probability of struck pedestrian fatality if ages 15 -59	Probability of struck pedestrian fatality if age 60
20	5%	1%	1%	3%
30	45%	5%	7%	62%
40	85%	16%	22%	92%

Source: U.K. Department of Transportation, Killing Speed and Saving Lives, London, 1987 and Davis, G. A., "A Simple Threshold Model Relating Pedestrian Injury Severity to Impact Speed in Vehicle/Pedestrian Crashes," Transportation Research Record 1773, Transportation Research Board, Washington, D.C. 2001, pp. 108-113.

A study conducted by researchers for the U.K.'s Transport Research Laboratory reviewed international speed studies to understand the effect of speed and speed limits on road collisions. The researchers analyzed before and after vehicle speed and collision data from more than ten cities around the world that had reduced their speed limits and collected data on the effects. Although the study had several limitations that were largely due to the differences in the various cities' data calculation methods, traffic conditions and other

[16] Aarts L and van Schagen I. (2006) Driving Speed and the risk of crashes: A review. Accident Analysis and Prevention 38
[17] Vehicle Stopping Distance and Time. (n.d.) University of Pennsylavania School of Engineering and Applied Science Lab Lecture. Available online at: http://www.seas.upenn.edu/~ese302/lab-content/STOPPING_DISTANCE_DOC.pdf. [Accessed November 2014]

influential variables, the data showed that for most cities, a one mph increase or decrease in the average traffic speed is associated with a five percent increase or decrease in collisions with injuries. [18]

Economic Impact

In 2012, the National Safety Council estimated the average comprehensive cost for motor-vehicle crashes per injured person in the United States, which is shown in Exhibit 2 below.

Exhibit 2: Average Comprehensive Cost, by Injury Severity, 2012

Injury Severity	Average Cost
Death	$4,538,000
Incapacitating Injury [1]	$230,000
Non-Incapacitating Evident Injury [2]	$58,700
Possible Injury [3]	$28,000
No Injury	$2,500

Source: National Safety Council

[1] An injury that prevents the injured person from walking, driving or normally continuing the activities the person was capable of performing prior to the collision.[19]

[2] An injury that is evident to observers at the scene of the collision such as a lump on the head or a bruise. [20]

[3] Not fatal but an incapacitating injury or a non-incapacitating injury such as momentary unconsciousness, limping, nausea or hysteria.[21]

The average costs reported in Exhibit 2 include wage and productivity loss, medical and administrative expenses, vehicle damage, employers' uninsured costs and the value of lost quality of life which is measured through empirical studies of peoples' willingness to pay to reduce their safety and health risks.[22]

Reducing speed limits could also lead to decreased health care costs as research by the National Safety Council showed that slower moving traffic improves some pedestrians and bicyclists' perceptions of safety as well as parents' perception of safety for their children

[18] Finch DJ et. al.(1994) Speed, Speed Limits and Accidents. Transport Research Laboratory. Project Report 58.
[19] National Safety Council (2007) Manual on Classification of Motor Vehicle Traffic Accidents . 7th ed. Available online at: http://www-nrd.nhtsa.dot.gov/Pubs/07D16.pdf [Accessed December 2014].
[20] Ibid.
[21] Ibid.
[22] National Safety Council (2012) Estimating the Costs of Unintentional Injuries. Available online at: http://www.nsc.org/NSCDocuments_Corporate/Estimating-the-Costs-of-Unintentional-Injuries-2014.pdf [Accessed December 2014]

who play near the street or walk to school. [23] A safer walking and bicycling environment due to slower traffic speeds may encourage someone to walk or bike to their destination instead of driving or may support a parent's decision to allow their child to walk or bike to school. Walking and bicycling increases physical activity which could lead to lower health care costs related to obesity and cardiovascular health for both children and adults.[24]

Environmental Impact

Air Pollution

Numerous studies have been conducted analyzing the relationship between emission rates and vehicle speed; specifically, studies have tried to determine whether emissions increase or decrease as speed changes. The results, however, have been mixed and vary based on vehicle and fuel types, driver behavior, traffic conditions, emission types and other assumptions that may be built into the study.

For example, a study conducted in Germany by an environmental scientist and transportation and urban planning researcher found that when vehicle speed is reduced from 30 mph to 20 mph, there is a decrease in emissions; however, the reduction in two emission types (volatile organic compounds and oxides of nitrogen) is greater for calmer drivers than for aggressive drivers who tend to accelerate and decelerate at faster rates, as shown in Exhibit 3 below. Aggressive drivers who accelerate and decelerate quickly also burn more fuel than calmer drivers.[25]

Exhibit 3: Variations in Change in Vehicle Emission and Fuel Use Resulting from Reduced Speed by Driver Type

Emission Type	Heavy Acceleration/Deceleration Drivers	Lighter Acceleration/Deceleration Drivers
Carbon Monoxide	-17	-13
Volatile Organic Compounds	-10	-22
Oxides of Nitrogen	-32	-48
Fuel Use	+7	-7

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Source: Newman and Kenworthy, 1992

[23] James P, Ito K, and Arcaya M. (2014) Health Impact Assessment Speed Limit. Metropolitan Area Planning Council.
[24] Pucher J, et al. (2010) Infrastructure, programs, and policies to increase bicycling: An international review. Preventative Medicine. Available online at: http://www.industrializedcyclist.com/Pucher_Dill_Handy10.pdf [Accessed December 2014]
[25] Newman, P., and J. Kenworthy. (1992) Winning Back the Cities. Pluto Press, Leichhardt NSW, Australia, pp. 39–40. Quoted in: Expanding Metropolitan Highways: Implications for Air Quality and Energy Use (1995) Transportation Research Board.

A study conducted by the Transport and Environmental Analysis Group at Imperial College London measured and compared emission rates for gasoline and diesel vehicles that drove on roads within one of London's 20 mph speed zones and on roads with a 30 mph speed limit. As shown in Exhibit 4, the researchers found that particulate matter (PM_{10}) emissions decreased by 8.3 percent when speed limits were reduced from 30 mph to 20 mph for both gasoline and diesel vehicles while nitrogen oxide (NO_x) and carbon dioxide (CO_2) emissions both increased for gasoline vehicles.[26] The environmental benefits are greater for diesel vehicles as they produce less nitrogen oxide and carbon dioxide when traveling at 20 mph than at 30 mph.

Exhibit 4: Gasoline and Diesel Vehicle Emission Comparison: 20 mph versus 30 mph

Vehicle Type[1]	Speed	NO_x (g/km)	PM_{10} (g/km)	CO_2 (g/km)
Gasoline Vehicles	20	0.0726	0.00218	271.95
Gasoline Vehicles	30	0.0673	0.00237	266.35
% Change with Reduction		**7.9%**	**-8.3%**	**2.1%**
Diesel Vehicles	20	0.7437	0.01758	201.58
Diesel Vehicles	30	0.8104	0.01917	203.48
% Change with Reduction		**-8.2%**	**-8.3%**	**-0.9%**

Source: Williams D and North Robin. (2013) An Evaluation of the Estimated Impacts on Vehicle Emissions of a 20 mph Speed Restriction in Central London. Centre for Transport Studies Imperial College London.

[1]All vehicles are assumed to have a 1.4-2.0 liter engine.

Despite the differences in individual study results, research on the topic generally shows that vehicles produce the largest amount of emissions and consume the most fuel during periods of acceleration as vehicles burn gasoline or diesel to increase speed.[27] Vehicles produce the least amount of emissions when traveling at moderate and uninterrupted speeds.[28] Given this information, strategies that reduce vehicle speed such as speed bumps and stop signs could lead to increased emissions as they force vehicles to decelerate and then accelerate again. Conversely, though traffic circles are likely to cause some deceleration, they may cause fewer emissions than speed bumps and stop signs as drivers do not have to decelerate as much or come to a complete stop and there is less

[26] Williams D and North Robin. (2013) An Evaluation of the Estimated Impacts on Vehicle Emissions of a 20 mph Speed Restriction in Central London. Centre for Transport Studies Imperial College London.
[27] Barth M and Boriboons K. (2008) Real World CO2 Impacts of Traffic Congestion. Transportation Research Board. Available online at: http://uctc.net/research/papers/846.pdf [Accessed November 2014]
[28] Ibid.

vehicle idle time.[29] As previously noted, the type of traffic calming measure may increase or decrease emissions but overall emission levels are also influenced by road conditions, driving behavior and vehicle type.

Reducing traffic speed can also indirectly decrease vehicle emissions by encouraging transportation mode shifts. Multiple studies and surveys by transportation and public health researchers have found that some people do not feel comfortable bicycling or walking on streets that carry large volumes of traffic moving at high speeds for fear of being hit by a vehicle.[30] [31] Reducing traffic speeds may encourage people to shift from driving a gasoline or diesel fueled vehicle to a more sustainable mode of transportation such walking or bicycling which produce zero emissions.

Noise

Noise is produced from a vehicle's engine, transmission, exhaust and tires.[32] The level of noise produced is based on traffic volume, the number of heavy trucks that traverse the roadway and vehicle speed. According to the United States Department of Transportation, a vehicle traveling at 55 mph is twice as loud as the same vehicle traveling 15 mph.[33]

Similar to vehicle emission rates, vehicle noise levels are at their loudest point during periods of acceleration and deceleration as noise from the engine and breaks increase during these activities, respectively. [34] Therefore, traffic calming measures that cause regular deceleration and acceleration events would increase noise levels as well as emission rates while treatments that reduce stop events such as traffic circles would likely produce less noise.

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[29] Mandavilli S, Russell E and Rys M. (2003) Impact of Modern Roundabouts on Vehicular Emissions. Proceedings of the 2003 Mid-Continent Transportation Research Symposium, Ames, Iowa, August 2003. Available online at: http://www.ctre.iastate.edu/PUBS/midcon2003/MandavilliRoundabouts.pdf [Accessed November 2014].

[30] Sanders, Rebecca. (2013) Examining the Cycle: How Perceived and Actual Bicycling Risk Influence Cycling Frequency, Roadway Design Preferences, and Support for Cycling Among Bay Area Residents. University of California Transportation Center. Available online at: http://www.uctc.net/research/UCTC-DISS-2013-03.pdf

[31] Mandavilli S, Russell E and Rys M. (2003) Impact of Modern Roundabouts on Vehicular Emissions. Proceedings of the 2003 Mid-Continent Transportation Research Symposium, Ames, Iowa, August 2003. Available online at: http://www.ctre.iastate.edu/PUBS/midcon2003/MandavilliRoundabouts.pdf [Accessed November 2014].

[32] U.S. Department Of Transportation, Federal Highway Administration (1980) Highway Traffic Noise. Available online at: http://www.nonoise.org/library/highway/traffic/traffic.htm [Accessed October 2014]

[33] Ibid.

[34] Tsunokawa B and Hoban C. (Eds.) (1997) Impacts of the Noise Environment, *Roads and the Environment: A Handbook.* (pp.154-164) Washington D.C. Available online at: http://siteresources.worldbank.org/INTTRANSPORT/Resources/336291-1107880869673/covertoc.pdf [Accessed November 2014].

Case Studies: London, New York City, Bristol, Graz, Portsmouth, and Portland, Oregon

Over the last 20 years, cities and towns around the world have implemented different strategies aimed at reducing vehicle speeds as a way to reduce collisions, fatalities and the severity of injuries caused by collisions. Five of the most common approaches are: 1) citywide speed limit reductions, 2) traffic calming measures such as traffic circles and speed bumps, 3) "slow zones" where speeds are reduced through traffic calming measures or by simply reducing the speed limit within a specified area or neighborhood, 4) automated speed enforcement (ASE) which is the use of speed cameras to capture drivers speeding, and 5) enhanced or focused enforcement by law enforcement personnel, or some combination of these five approaches.

Examples of the use of these speed reduction approaches in the U.S. and in other countries include the following:

- There are currently 33 cities in the United Kingdom that have established 20 mph *citywide* speed limits.
- The cities of Dublin, Barcelona, Paris, Zurich and Buxtehude, Germany created 20 mph slow zones that reduce the speed limit to 20 mph within certain neighborhood boundaries.
- Several of the cities that have established 20 mph citywide speed limit and 20 mph slow zones have also enhanced speed limit enforcement with law enforcement personnel.
- London and New York City created slow zones in selected neighborhoods, including installation of traffic calming measures.
- The cities of Seattle and Portland have created "neighborhood greenways" which are 20 mph routes on residential streets that are designed for lower vehicle speed and volume and also provide access to schools, trails, parks, transit and neighborhood businesses. Typical neighborhood greenway elements include neighborhood greenway signs and pavement markings, improved crosswalk and curb ramps, traffic circles, speed bumps and enhanced landscape features.
- In the United States, there are currently 136 jurisdictions in 15 states that have automated speed enforcement programs. This technology is being used in more than 75 countries around the world.[35] San Francisco has implemented a program for installing traffic calming measures in select neighborhoods.

[35] DC StreetSafe: Automated Speed Enforcement.(n.d.) DC.gov Available online at: http://mpdc.dc.gov/page/dc-streetsafe-automated-speed-enforcement. [Accessed January 2015]

For this report, the Budget and Legislative Analyst reviewed speed reduction programs in six cities that have implemented one or more of the speed reduction approaches listed above, or a combination of approaches, and conducted evaluations of their program results. An attempt was made to assess each program's impact on average speeds, collisions, collisions with injuries, the economy and the environment. Given the data available and scope of each evaluation, not all of these impacts could be reviewed for each program in each jurisdiction. For example, of the five cities and evaluations reviewed - only Bristol, England evaluated and reported the environmental impacts of their speed reduction program.

Variations in the scope and methods used for the evaluation studies reviewed means that not all program results can be compared across the studies. Each study evaluated their programs over different time spans and variable measures. Rates were not used in any of the evaluations to allow for comparisons within and between cities (e.g., number of collisions for every 1,000 vehicle miles driven).

The Greater London evaluation study appears to be the most useful in that it evaluates twenty years of results for 385 areas where "slow zones" were implemented. The other studies covered more limited geographic areas and time spans, resulting in smaller numbers of collision and incident data reported, and more limitations on the conclusions that can be drawn.

With the exception of the Portland, Oregon study, none of the studies compared the results of the speed reduction programs with control zones, or areas where the programs were not implemented. As a result, it is not possible to determine if changes in vehicle speeds and collisions in the speed reduction program areas were entirely the result of the speed reduction programs or if other factors that may have affected speeds driven in other parts of the city were also responsible for changes in speeds driven and number of collisions. Finally, the studies did not consistently report on any changes in enforcement that may have occurred, or changed, while the programs were underway, possibly affecting changes in vehicle speeds.

Greater London: 20 mph Slow Zones with Traffic Calming Measures

Of all speed reduction programs reviewed by the Budget and Legislative Analyst, Greater London has the longest history and greatest number of programs in place, with 400 slow zones implemented throughout the metropolitan area. Further, the evaluation of these programs was the most in-depth of all evaluations reviewed by the Budget and Legislative Analyst, covering twenty years of results in 385 locations within Greater London.

Greater London's first 20 mph slow zone was established as a pilot project in 1991. Eight years later, legislation was passed that authorized local authorities to implement 20 mph zones without approval from the central government.[36] By 2013, 400 20 mph zones had been implemented throughout Greater London.[37]

On July 20, 2014, the speed limit within the historic core City of London was changed to 20 mph, with the exception of several thoroughfares. [38] [39] This report will focus on Greater London's slow zones as there is more robust data available about those programs compared to the newly implemented citywide speed limit in just the City of London.

Greater London's 20 mph slow zones are marked by physical and visual traffic calming measures such as speed bumps and cushions, chicanes, raised intersections, road narrowing, roundabouts, striped pedestrian crossings, street markings and slow zone entrance and exit signs. [40] These self-enforcing traffic calming measures are designed to prevent motorists from driving faster than 20 mph.

In order to create a 20 mph slow zone in Greater London, local authorities from individual boroughs must first select the area and design the slow zone. Feedback is obtained from community members, advocates and relevant parties such as emergency service organizations.[41] Funding for slow zone programs comes from various government programs which, depending on the program, evaluate proposed programs and award funding based on predicted reductions in collisions, establishment of a School Travel Plan, and whether the slow zone will be part of a new development. Boroughs can also use their own funds, such as parking fine revenue, to finance slow zones.[42]

Impact on Vehicle Collisions and Vehicle Speeds

In the most exhaustive evaluation of speed reduction programs reviewed by the Budget and Legislative Analyst, researchers from the London School of Hygiene and Tropical

[36] 20 mph Zones and Speed Limits. (2012) Road Safety Information. The Royal Society for the Prevention of Accidents. Available online at: http://www.rospa.com/roadsafety/advice/highway/info/20-mph-zone-factsheet.pdf. [Accessed November 2014].
[37] Greater London is comprised of the core City of London, the 1.12 square mile historic and financial district within London, and 32 surrounding boroughs. The City of London refers only to the 1.12 square mile historic core and financial district.
[38] Cedeno M and Kilbane-Dawe I. (2013) Effects of 20mph zones on cycling and walking behaviors in London. Par Hill Research. Available online: https://static.squarespace.com/static/5006f1cc84ae2a41e73b7aad/t/5152f637e4b08d37aa3e5388/1364391479536/Effect%20of%2020mph%20zones%20on%20walking%20and%20cycling%20Stage%201%20Report.pdf. [Accessed October 2014].
[39] Rucki A. All roads in the City will have 20mph speed limit by the end of month. London Evening Standard. Available online at: http://www.standard.co.uk/news/transport/all-roads-in-the-city-will-have-20mph-speed-limit-by-the-end-of-the-month-9582113.html [Accessed December 2014].
[40] A chicane is an artificial feature creating extra turns in a road, used in motor racing and on streets to slow traffic for safety.
[41] Grundy, C, Steinback, R, Edwards, P, Green, J. (2008) *20 mph Zones and Road Safety in London*: A Report to the London Road Safety Unit. London: London School of Hygiene and Tropical Medicine.
[42] Ibid

Medicine collected 20 years of data on street collisions and injuries in 385 of Greater London's 20 mph slow zones and found that the establishment of 20 mph slow zones was associated with a 40 percent decrease in collisions and collisions with injuries.[43] The researchers found that the 20 mph slow zones had an even greater impact on children ages 1-15 years old as the 20 mph zones were associated with a 49 percent reduction in all injury collisions involving children and a 50 percent reduction in collisions with children that caused serious injuries or death. In addition, average vehicle speeds within London's slow zones decreased by nine mph.

Fiscal Impact

According to Great Britain's Department for Transport's 2013 Annual Report on nationwide road casualties, the average cost of a vehicle collision resulting in a fatality is approximately $3,000,000, a serious injury is approximately $350,000 and a slight injury is approximately $37,000, as shown in Exhibit 5 below.[44] These amounts include the victim's loss of earnings, ambulance and hospital care, property damage, police labor, insurance administrative costs and suffering endured by the victim and victim's loved ones based on their willingness to pay to avoid such pain. [45]

The total estimated average cost for vehicle collisions in Greater London in 2013 was approximately $2.1 billion, as shown in Exhibit 5. This was estimated by multiplying the average cost per injury type caused by a vehicle collision by the number of reported injuries in London in 2013, as reported by Transport for London.[46] This is a conservative cost estimate as vehicle collisions that did not result in an injury but may have resulted in property damage are not included in the calculations nor were unreported collisions.

[43] Ibid.
[44] Reported Road Casualties Great Britain: 2013 Annual Report (2013) Department for Transport. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/359311/rrcgb-2013.pdf [Accessed December 2014].
[45] Reported Road Casualties in Great Britain: 2012 Annual Report (2012) Department for Transport Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/244913/rrcgb2012-02.pdf. [Accessed October 2014]
[46] Transport for London is the local government body that governs the transportation system in Greater London.

Exhibit 5: Average Cost of Injuries Caused by Vehicle Collisions in Greater London, 2013

Collision Injury Severity	Average Cost Per Injury[1]	Number of Reported Injuries Caused by Collisions in London	Total Cost
Fatal	$3,054,154	132	$403,148,328
Serious	$349,954	2,192	$767,099,168
Slight	$36,804	24,875	$915,499,500
Total	**n/a**	**27,199**	**$2,085,746,996**

Source: Department for Transport's Reported Road Casualties Great Britain: 2013, Annual Report and Transport for London. Transport for London Surface Transport Casualties in Greater London during 2013, June 2014.

[1] This is based on costs reported in the Department for Transport's Reported Road Casualties Great Britain: 2013 Annual Report converted to dollars using the 2013 conversion rate of 1.5632.

Collisions of all severities in Greater London have steadily declined over the last five years resulting in an overall cost savings in each subsequent year. In 2013, there were two fewer fatalities resulting from vehicle collisions, 694 fewer serious injuries and 887 fewer slight injuries resulting from vehicle collisions than in 2012, resulting in a cost savings of $281,621,225.

New York City: Reduced Speed Limit and Traffic Calming in Neighborhood Slow Zones

In 2010, New York City's Department of Transportation (NYCDOT) published the New York City Pedestrian Safety Study and Action Plan (Action Plan) which provides a set of policies and programs expected to reduce pedestrian fatalities and severe injuries. One of the proposed programs included in the Action Plan was a neighborhood slow zone program, which consisted of reducing the speed limit to 20 mph and installing traffic calming treatments in certain neighborhoods or areas within neighborhoods to slow traffic. NYCDOT piloted the Neighborhood Slow Zone Program a year later in 2011.

New York City's Neighborhood Slow Zone pilot program was implemented in Claremont, a neighborhood in the Bronx that has several schools and had a relatively high number of vehicle collisions. As part of the pilot program, the speed limit in the Claremont Neighborhood Slow Zone was reduced from 30 mph to 20 mph and speed bumps, road markings and signage were installed. Gateways, which are signs and markings located at intersections near the entrance of a slow zone, were created to alert drivers that they were entering the Neighborhood Slow Zone.

In 2012, NYCDOT opened the first round of funding to expand the Neighborhood Slow Zone program beyond the pilot project in Claremont. To ensure community engagement

and support for Neighborhood Slow Zones, NYCDOT created a competitive application process in which eligible community associations such as community boards, civic associations, elected officials or schools and churches could submit applications. Community members submitted over 100 applications and 14 projects were selected during the first round of funding.

NYCDOT staff evaluates applications based on the following criteria: area collision history, community support, proximity to schools, senior centers, daycare facilities and subway stations and whether the area has distinct neighborhood boundaries such as major streets, highways, large parks or elevated train tracks. Because emergency vehicles and buses need to maintain faster speeds, areas with fire stations, hospitals and bus or truck routes are not preferable. In 2013, a second round of funding occurred and 16 more communities were selected for the Neighborhood Slow Zone program.

Impact on Vehicle Collisions and Vehicle Speeds

To assess whether the Neighborhood Slow Zone pilot project in Claremont had an impact on vehicle collisions, NYCDOT collected data on vehicle speeds and collisions three years before and two years after program implementation.

Based on this initial data, the average number of total crashes declined by seven percent; from an average of 97.7 total crashes the three years before implementation of the Neighborhood Slow Zones to an average of 90.5 the two years after implementation. The average number of crashes that caused injuries to either vehicle drivers, pedestrians or cyclists increased by 17 percent from 19.7 crashes with injuries the three years before implementation of the Neighborhood Slow Zones to an average of 23 the two years after implementation. The severity of injuries was not reported in the evaluations provided by NYCDOT staff.

Data collected for just seven streets in the Claremont Neighborhood Slow Zone indicates that average vehicle speed decreased by one percent after program implementation. The range for the seven sample streets was between a 16 percent reduction in vehicle speed to a 12 percent increase in vehicle speed. Although the average speed did not decrease, the 85th percentile speed for these seven streets decreased by seven percent.

Unlike the twenty year span of the Greater London evaluation cited above, only two years of data was collected following implementation of the slow zone in the Claremont District, which may not be sufficient evidence to draw conclusions about the program's impact. Further, since the evaluation is of just one neighborhood, the total numbers are low, meaning that one significant collision in a year can skew the collision statistics and trends.

However, over the last five years, the fewest number of total crashes occurred in FY 2012-13, a year after the program was implemented.

Fiscal Impact

According to the 2010 New York City Pedestrian Safety Report, NYCDOT staff estimated that the annual cost of all traffic fatalities in New York City was $4.29 billion. This estimate was calculated by NYCDOT staff using the State of New York's $20 billion combined cost of both fatal and non-fatal collisions estimated by the U.S. DOT in 2000, updated for inflation, and applied to the 256 traffic fatalities that occurred in New York City in 2009. This resulted in an estimated average cost per fatality in New York City of $16 million which is much higher than the $4.5 million average cost per fatality estimated by the National Safety Council. The difference in cost estimates is due, in part, to the different methods used to calculate the cost per fatality. NYCDOT did not calculate the fiscal impact of the change in the number of collisions as a result of the Neighborhood Slow Zones project.

Bristol, England: Speed Limit Reductions in Selected Neighborhoods

In 2010, the City Council in Bristol, England, a city of approximately 438,000, launched a 20 mph speed limit reduction pilot project in the Inner South and Inner East Bristol neighborhoods. The pilot project encompassed 200 streets in Inner South Bristol and 300 streets in Inner East Bristol. The locations of the pilot project were selected based on the number of pedestrian and bicyclist injury collisions, street types and layout, proximity to schools and community centers, and existing traffic volume and speed.

During the development of the pilot project, the City was considering reducing the speed limit to 20 mph on roads with average speeds of 24 mph or below which would likely have excluded main roads and/or arterials. However, after receiving community feedback, the City Council decided to reduce the speed limit to 20 mph for all streets within the pilot project area including main roads/arterials, even if their average speed was higher than 24 mph. Ultimately, several strategic through routes were exempted from the speed limit reduction and their speed limit remained 30 mph while the speed limit for the majority of streets in Inner South and Inner East Bristol was reduced to 20 mph.[47]

Unlike the slow zones in New York City and London, traffic calming treatments were not implemented in the Inner South and Inner East Bristol neighborhoods. Instead, the pilot neighborhoods were defined by speed limit signs that were placed at the entry points leading into the 20 mph area, signs that were installed at regular intervals within the pilot

[47] A through route is a road designed to transport people to and from a downtown center.

project area, vehicle activated signs that flash "20" and 20 mph road markings. Signs were installed in such a manner that minimized street clutter, redundancy and driver confusion.

In addition to signage, the City of Bristol executed a public awareness campaign that included encouraging professional drivers to adhere to the new speed limits, advertising the pilot project in local media outlets and giving presentations about the pilot project at community meetings.

According to research conducted by the University of the West of England, Bristol police initially opposed the 20 mph speed limit on busier streets with mean average speeds of 24 mph, arguing that the speeds would not be self-enforcing and would require additional police resources. Bristol police did not agree to provide enhanced enforcement efforts to support the new speed limits. Bristol's police agency is reportedly now working with the Bristol City Council to address enforcement needs.[48]

Impact on Vehicle Collisions and Vehicle Speeds

Based on traffic studies on streets within the pilot areas and after the new speed limits were implemented, the average vehicle speed on streets within the pilot project areas decreased. According to the City of Bristol's 2012 20 mph Speed Limit Pilot Areas Monitoring Report, the average reduction in speeds on all of the 20 mph streets in the program pilot areas was 1.4 mph in Inner South Bristol and 0.9 mph in Inner East Bristol.[49] The results were measured for streets where the speed limit was reduced to 20 mph compared to those where the speed limit remained 30 mph.

The Monitoring Report also found that the number of collisions in the pilot areas in Inner East Bristol was reduced from an average of 148 collisions per year in the three years prior to the 20 mph speed limit program to an average of 143 per year for the two years after implementation. This decrease represents a 3.3 percent decrease in collisions in Inner East Bristol. Collisions statistics were not provided for Inner South Bristol. [50]

The results for the average number of collisions with injuries is mixed though the number of total incidents reported is small and a few major collisions with injuries in a single year can cause a statistical spike even if the overall number of collisions is reduced. In addition, the evaluation period was for only two years after implementation of the program and may not reflect long term trends. The average number of collisions with injuries in Inner

[48] Toy S. (2012) Delivering soft measures to support signs-only 20mph limits: Report on research findings. Bristol Social Marketing Centre.
[49] Bristol City Council,(2012)20mph Speed Limit Pilot Areas Monitoring Report.
[50] Ibid.

East London decreased by 3 percent two years after the pilot program while collisions with injuries in Inner South London increased by 24 percent. As more data points are collected, the results for accidents with injuries should show a more reliable trend.

Environmental Impact

The City of Bristol's Environment Team estimated the changes in vehicle noise and emissions in Inner South and Inner East Bristol based on actual reductions in vehicle speed recorded after the pilot was introduced using modeling techniques. Based on the decreases realized in vehicle speed, City staff estimated a decrease in the noise level of 0.1 to 0.5 decibels, which would be unperceivable to most residents.

The estimated changes in nitrous oxide emissions varied by individual street, ranging from a reduction of 46 pounds of nitrous oxide ($NO_{x)}$ per year to an increase of 51 pounds of NO_x a year in Inner South Bristol and a reduction of 136 pounds a year to an increase of 211 pounds a year in Inner East Bristol. To put this in context, the U.S. Environmental Protection Agency (EPA) reports that the average emission rate per year for one passenger vehicle is 18.32 pounds a year; therefore a decrease of 46 pounds of NO_x a year in Inner South Bristol would be equivalent to removing 2.5 vehicles from the road.[51]

The City of Bristol did not report fiscal impacts of the speed limit pilot projects.

In 2012, two years following implementation of the speed limit pilot projects, the Bristol City Council established a 20 mph speed limit citywide that governs 90 percent of roads in Bristol.

Graz, Austria: Citywide Speed Limit Reduction

Graz, Austria, with a population of approximately 300,000, was the first European city to reduce the speed limit on all of its residential streets to 20 mph and all of its main arterials to 30 mph. Large vehicle-activated speed limit signs were installed to remind drivers of their speed and police officers used mobile and stationary speed detection equipment to determine driver speeds. Police officers gave drivers several months to familiarize themselves with the new speed limits then began an enhanced enforcement effort, issuing speeding tickets to drivers that were in violation of the new speed limit.

[51] Average Annual Emissions and Fuel Consumption for Gasoline-Fueled Passenger Cars and Light Trucks (2008) United States Environmental Protection Agency. Available Online at: http://www.epa.gov/otaq/consumer/420f08024.pdf [Accessed December 2014].

Impact on Vehicle Collisions and Vehicle Speeds

Data that was collected one year prior to the implementation of the pilot program and during the first year the pilot program was implemented showed that there was a 12 percent reduction in collisions with injuries, a 24 percent reduction in serious injuries and a 17 percent reduction in pedestrian injuries.[52] The pilot program became permanent after the reduced speed limits produced positive results.

The City of Graz continued to collect data after the first year of the pilot program's implementation and five years after the pilot program was implemented, the number of collisions had slightly increased but had not reached pre-pilot program collision levels.[53] Adjustments for other factors such as changes in the level of enforcement or changes in number of vehicles in Graz over the five years were not accounted for in the analysis. Unlike the installation of permanent traffic calming devices, enforcement efforts for a citywide speed limit reduction such as that in Graz can affect the program's results as enforcement can be enhanced or reduced over time, with potential impacts on the number of collisions.

Although there was a significant reduction in the number of collisions after implementation of the speed limit reduction program in Graz, the reduction in average speed was only 0.5 mph. One study suggests that the significant decrease in collision rates but the nominal decrease in average speed could be due to the extensive outreach campaign and enforcement efforts which created an overall culture of safety leading to a decrease in collisions. [54]

The City of Graz did not report fiscal impacts.

Portsmouth, England: Speed Limit Reductions on Residential Streets Only

Portsmouth, England, a densely populated city of approximately 200,000, was the first city in the United Kingdom to change the speed limit from 30 mph to 20 mph on most residential streets. Portsmouth's speed reduction program, implemented in 2007, utilized terminal signs, repeater speed signs and street markings to inform drivers of the speed limit but did not include traffic calming measures or enhanced enforcement efforts.

[52] A. Mackie. (1998) Urban Speed Management Methods. Transportation Research Laboratory. Accessed online at: http://www.20splentyforus.org.uk/UsefulReports/TRLREports/trl363AMackie.pdf [Accessed November 2014].
[53] Hoenig M. (2000) The Graz Traffic Calming Model and its Consequences for Cyclists. City of Graz, Department of Transportation.
[55] Interim Evaluation of the Implementation of 20 mph Speed Limits in Portsmouth (2010) Department for Transport. Available online at: http://www.ctc.org.uk/sites/default/files/speed-limits-portsmouth.pdf [Accessed November 2014]

The City of Portsmouth carried out a public awareness campaign that included neighborhood meetings and published informational materials in newspapers and other media outlets. Enforcement efforts were enhanced with targeted enforcement on streets known for speeding, a road policing unit and a community speed watch program that allowed residents to send license plate numbers of speeding vehicles to police department staff who would issue warnings to speeding drivers.

Impact on Vehicle Collisions and Vehicle Speeds

The City of Portsmouth collected three years of traffic speed and vehicle collision data before and two years of data after implementation of the program. The after data that was collected indicated that mean speeds on residential streets decreased 1.3 mph, from 19.8 mph to 18.5 mph after implementation of the program. On streets where the average speed before the program was greater than 24 mph, there was an average speed reduction of seven mph from 24 to 17 mph.[55] There was an eight percent increase in collisions that resulted in a fatality or severe injury but an overall decrease of 21 percent in the number of vehicles involved in collisions.[56]

Fiscal impacts were not reported for Portsmouth.

Portland, Oregon: Automated Speed Enforcement (ASE)

In 1995, the Oregon State Legislature authorized the City of Portland to conduct a two-year automated speed enforcement (ASE) pilot program which uses photo radar to detect vehicle speed and capture an image of the speeding vehicle. Prior to this authorization, there was no statute in existence that addressed this type of enforcement.

As part of the ASE pilot program, the Oregon State Legislature required that the Portland Bureau of Transportation (PBOT) conduct a public information campaign prior to implementation of the pilot program and a program evaluation after. The Oregon State Legislature also created implementation requirements, including: 1) limiting the speed cameras to be used only on streets in residential areas or school zones, 2) limiting the operation of the speed camera to a maximum of four hours per day, 3) requiring that the speed cameras be operated by a sworn police officer out of a marked police vehicle, 4)

[55] Interim Evaluation of the Implementation of 20 mph Speed Limits in Portsmouth (2010) Department for Transport. Available online at: http://www.ctc.org.uk/sites/default/files/speed-limits-portsmouth.pdf [Accessed November 2014]
[56] Ibid.

installing signs informing drivers of the cameras, and 5) mailing the citation to the registered vehicle owner within 6 business days of the alleged violation, to name a few.[57]

After the successful completion of the pilot project, the Oregon State Legislature extended the ASE program and it is still in effect today. As of 2012, the City operates four marked radar vans, two of which uses video film with the other two using digital photography. Portland City Ordinance #172517 expanded the locations that the ASE program could operate by including construction zones and areas in the City that are known for having a high volume of speeding violations and speed-related collisions, in addition to residential and school zones.

Impact on Vehicle Collisions and Vehicle Speeds

In 2006, a research firm conducted a study for the U.S Department of Transportation that evaluated the impact of ASE on vehicle speeds in Portland's school zones.[58] Speeds were measured during a two month period in five school zones where ASE was deployed, referred to as the demonstration zones, an average of two to three times per week and in five other school zones where ASE was not deployed, or the comparison zones.

The researchers found that the mean and 85th percentile speed in the demonstration zones were reduced by 5 mph when ASE was present and by 1 mph to 2 mph in the demonstration zones when ASE was not present indicating that ASE still had a lasting effect on driver speed even when the photo radar vans were not present. The researchers also found that the proportion of traffic that had exceeded the speed limit by 10 mph or more had decreased by approximately two-thirds, or 67 percent, when ASE was deployed in the demonstration zones and by one-quarter, or 25 percent, when ASE was not deployed in the demonstrations zones. Vehicle speeds at the comparison locations where ASE was not deployed were unchanged.

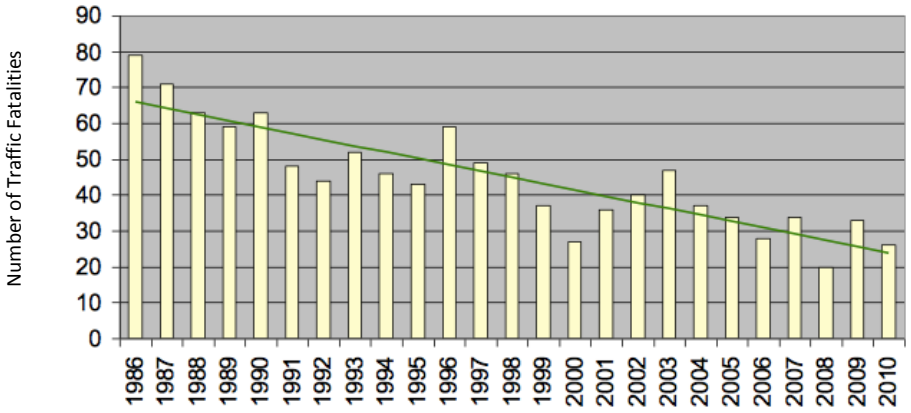
Several researchers from Portland State University analyzed the City of Portland's ASE records from 1996 to 2004 including the vans' hours of deployment, number of vehicles passing the vans, the number of violators and the number of citations issued. The researchers also obtained collision data from the Oregon State Department of Transportation. During this eight year time frame, the number of vehicles that passed the photo radar vans had increased by approximately 6.5 percent; however the number of

[57] Automated Enforcement for Speeding and Red Light Running. (2012) Transportation Research Board NCHRP Report 729. Available online at: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_729.pdf. [Accessed January 2014].
[58] Freedman M. et. al. (2006) Demonstration of Automated Speed Enforcement in School Zones in Portland, Oregon. Office of Research and Technology, National Highway Traffic Safety Administration, U.S. Department of Transportation.

speed limit violations decreased by 5.8 percent suggesting that the photo radar vans may have caused a reduction in vehicle speed over time.[59]

Before and after collisions rates were not reported in either of the two studies for the City of Portland noted above; however, the City of Portland's Photo Radar Project Report, 2009-2010 shows that traffic fatalities in Portland have continued to decline since ASE implementation in 1995, as shown in Exhibit 6 below. Other factors that may have also contributed to this reduction were not addressed in the report.[60]

Exhibit 6: Portland Total Traffic Fatalities, 1986 - 2010



Source: Sergeant Davis T. (2011) City of Portland Photo Radar Project Report 2009-2010. Portland Police Bureau, Traffic Division.

Summary of Case Study Findings

Based on our case study review, average vehicle speeds in all cities decreased after establishing a speed reduction program with the exception of New York City's Claremont District which experienced no change in average speed; however, the Claremont District did experience a seven percent reduction in the 85th percentile speed, or speed up to which 85 percent of free-flowing traffic is travelling, as shown in Exhibit 7 below. One of the City of Portland's evaluations also reported a reduction in the 85th percentile speed after implementation of the City's automated speed enforcement program.

[59] Monsere C et. al. Exploring Spatial and temporal Performance Measurement in Metropolitan Transportation Safety Improvement. Program Proceedings of the 9th International Conference on Computers in Urban Planning and Urban Management, London, United Kingdom, June 29, 2005. Quoted in Automated Enforcement for Speeding and Red Light Running. (2012) Transportation Research Board NCHRP Report 729. Available online at: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_729.pdf. [Accessed January 2014].

[60] Sergeant Davis T. (2011) City of Portland Photo Radar Project Report 2009-2010. Portland Police Bureau, Traffic Division.

The slow zones with traffic calming installations in London appear to have most effectively reduced vehicle speeds and collisions, while Portland's ASE program is the second most effective strategy, according to the evaluations and available data reviewed in the cases studies presented above. The cities that implemented a 20 mph citywide speed limit and, 20 mph slow zones without traffic calming measures realized reductions in average speeds, but by smaller amounts.

Although the evaluation data available does not comport in all cases to the model cited above that a one mph reduction in average speed is associated with a five percent reduction in collisions,[61] all of the cities that experienced speed reductions also experienced reductions in average vehicle collisions. For the cities that reported vehicle collisions, London and Portsmouth had relatively higher average speed reduction results and also experienced higher average percentage reductions in vehicle collisions at 40 percent and 21 percent, respectively. The severity of injuries sustained was not measured in all the studies.

Exhibit 7: Case Study Comparison

Speed Reduction Program	City	Change in Average Speed	Average Percentage Change in Collisions
20 mph Slow Zone with Traffic Calming	London	- 9 mph	-40%
	New York City (Claremont District)	0 mph (-7 mph change in 85th percentile)	-7%
20 mph Slow Zone - No Traffic Calming	Inner East Bristol	- 0.9 mph	- 3.3%
	Inner South Bristol	- 1.4 mph	Not Reported
Citywide 20 mph Speed Reduction	Portsmouth	- 1.3 mph	- 21%
	Graz	-0.5 mph	- 12%
Automated Speed Enforcement	Portland	- 5 mph	Not Reported

Source: Created by the Budget & Legislative Analyst based on case study review

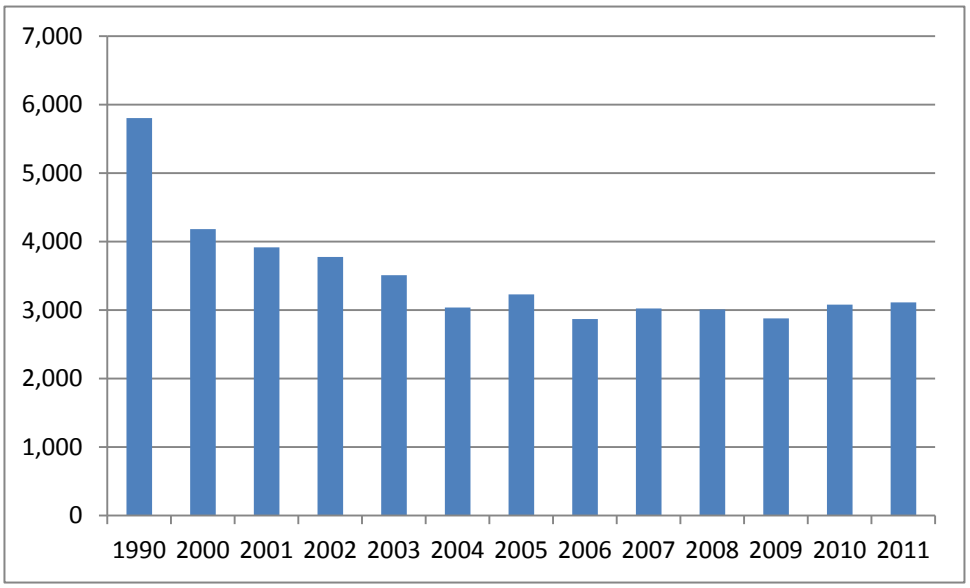
Vehicle Collisions in San Francisco

[61] Finch DJ et. al. (1994) Speed, Speed Limits and Accidents. Transport Research Laboratory. Project Report 58.

In 2011, there were 3,111 vehicle collisions in San Francisco that resulted in non-fatal injuries and 28 collisions that resulted in fatalities, according to the San Francisco Metropolitan Transportation Authority's (SFMTA's) 2010-2011 San Francisco Collisions Report. The Collisions Report found that that the primary cause of one-fifth of all injury collisions was unsafe vehicle speed which may have also been a secondary cause for additional injury collisions. A map that shows where collisions primarily caused by speeding occurred between 2008 and 2013 is shown in Appendix A.

Non-fatal injury collisions declined from 1990 to 2006, as shown in Exhibit 8, and remained relatively constant at approximately 3,000 collisions with injuries per year from 2006 to 2011.

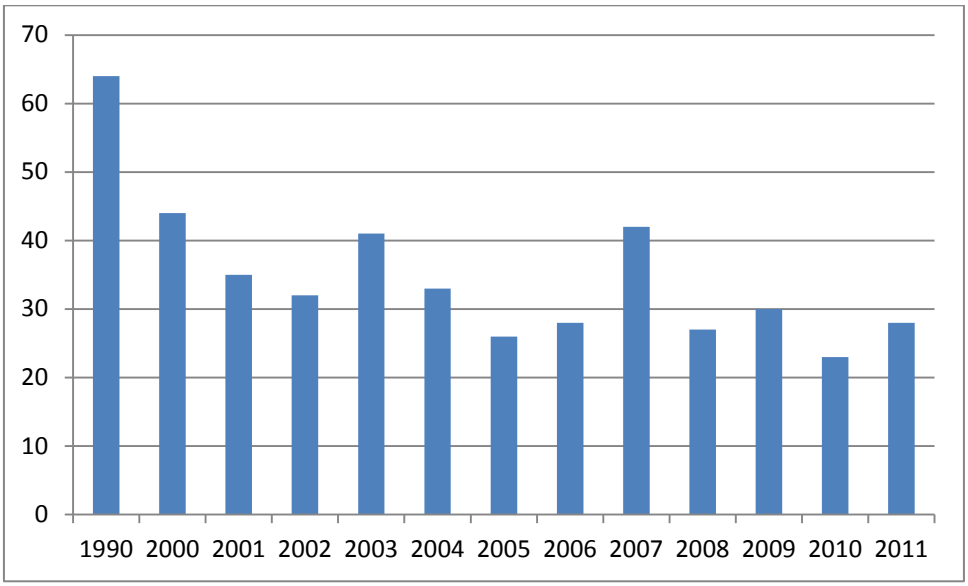
Exhibit 8: Collisions Resulting in Injuries in San Francisco 1990 - 2011



Source: SFMTA's 2010-2011 San Francisco Collisions Report

There was a decline in fatal injuries caused by collisions between 1990 and 2005 and, since 2005, there have been less than 30 fatalities each year with the exception of 2007, as shown in Exhibit 9 below. Collision data provided by the SFPD that is more recent than the data included in SFMTA's 2010-2011 San Francisco Collisions report indicates that there has been an increase in fatalities since 2011. In 2012, there were 42 fatalities, a 46 percent increase from the 28 fatalities reported by SFMTA in 2011, 41 in 2013 and 40 in 2014, according to SFPD.

Exhibit 9: Collisions Resulting in Fatalities in San Francisco 1990 - 2011



Source: SFMTA's 2010-2011 San Francisco Collisions Report

Of the 3,111 collisions with injuries that occurred in 2011, 844 were between vehicles and pedestrians and 630 were between vehicles and bicyclists, or 27 and 21 percent of total collisions with injuries, respectively. Of the 40 fatal collisions that occurred in 2014, 18 were between vehicles and pedestrians and three were between vehicles and bicyclists.[62] Historical data shows fatal collisions involving pedestrians have decreased slightly since 2000; however, the City still averages about one pedestrian fatality per month.

Bicyclist fatalities have ranged between one and four each year since 2002. In 2011, there were four fatal collisions that involved bicyclists which was the highest in almost ten years.[63]

The map in Appendix B provides a geographical display of locations where pedestrians were killed or seriously injured in a vehicle collision in San Francisco between 2007 and 2011; Appendix C provides the same information for bicyclists. Pedestrian fatalities and

[62] 2010-2011 San Francisco Collisions Report (2012) San Francisco Metropolitan Transportation Agency. Available online at: http://archives.sfmta.com/cms/rtraffic/documents/Collision_report_2010_2011_000.pdf [Accessed December 2014].
[63] Ibid.

injuries are prevalent along the Market Street, 19th Avenue, Geary Street and Mission Street corridors.

The cost of injury and fatality collisions in San Francisco in 2011 was approximately $455,482,937. This number is based on the number of collisions with injuries and fatalities that occurred in 2011 (3,111 injury collisions and 28 fatal collisions) and the average costs for collisions with injuries and collisions with fatalities developed by the National Safety Council, as discussed above.[64] Based on an average cost of $105,567 for injury collisions and $4,538,000 for 28 fatal collisions, the cost of traffic collision injuries was $328,418,937 and the cost of traffic collision fatalities was $127,064,000 which, together, totals $455,482,937.

Local and State Policy Alternatives

Six speed reduction approaches are now presented that could be implemented in San Francisco to reduce average vehicle speeds and collisions or the severity of injuries sustained due to collisions caused by unsafe vehicle speeds. As shown below, each alternative could be implemented independently or combined with one or more of the other alternatives.

1) Enhance enforcement of current speed limits using additional police officers.
2) Advocate for amendments to State law to allow for enhanced enforcement through Automated Speed Enforcement (ASE) technology.
3) Advocate for changes in State law to allow City speed limits lower than 25 mph and to eliminate requirement that speed limits be set at the actual speed of most drivers.
4) Advocate for changes in State law to allow City speed limits lower than 25 mph and to eliminate requirement that speed limits be set at actual speed of most drivers and enhance enforcement of new speed limits.
5) Implement or enhance City traffic calming measures.
6) Implement traffic calming measures, advocate for changes in State law to allow City speed limits lower than 25 mph and to eliminate requirement that speed limits be set at actual speed of most drivers, and enhance enforcement of new speed limits.

[64] Because the SFMTA's 2010-2011 Collisions Report did not report the severity of injuries from collisions, the average of the average cost of incapacitating, non- incapacitating and possible injuries was used in this calculation which was $105,567.

These alternatives could be implemented Citywide or in specific zones depending on available resources and road types. The location(s) of speed reduction alternatives should be selected based on specific criteria such as areas with high concentrations of pedestrian and cyclist collisions or speeding hotspots. Based on the approaches used in other cities, it appears that implementation of a speed reduction program benefits from a community engagement campaign.

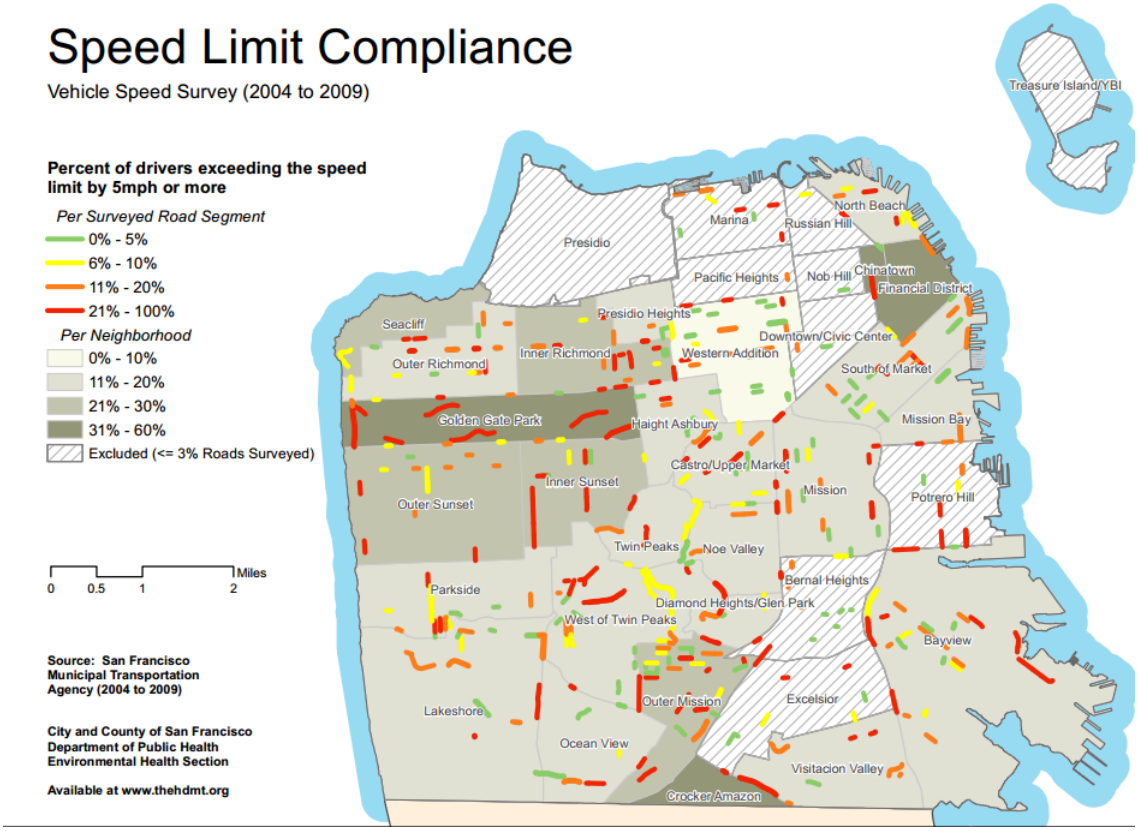
The Budget and Legislative Analyst evaluated each of the six alternatives above for consideration by the Board of Supervisors. Each alternative was evaluated based on its: likely effectiveness in reducing collisions; implementation costs in terms of one-time capital improvements and staff time advocating for State legislative changes, and ongoing enforcement costs.

Environmental costs were not included since, as discussed above, they depend on driver behavior, vehicle type, road condition and type of traffic calming treatment which would require an environmental analysis.

Alternative 1: Enhance enforcement of current speed limits using additional police officers

The Board of Supervisors could consider increasing enforcement of existing speed laws since driving at a speed higher than the posted speed limit is a common occurrence in San Francisco, according to SFMTA data, and research studies cited above have found that lower speeds are correlated with lower rates of collisions and collision severity. As shown in Exhibit 10 below, over 21 percent of drivers exceed the speed limit by five mph or more on numerous streets, or segments of streets, as indicated by the red lines in Exhibit 10.

Exhibit 10: Speed Limit Compliance in San Francisco, 2004 - 2009



Source: San Francisco Metropolitan Transportation Agency 2004 to 2009

According to State law and discussed above, unless otherwise posted, the prima facie speed limit for residential and commercial streets in San Francisco is 25 mph. However, according to SFMTA staff and surveys, the average actual speed driven on such streets Citywide is between 27 and 33 mph. Since these are the average speeds, some drivers are driving at speeds in excess of 33 mph on 25 mph streets, presenting an even greater safety risk. Since the probability of more serious injuries being sustained in a collision increases with vehicle speed, a driver exceeding the posted speed limit of 25 mph and driving at 30 mph or 40 mph, poses a greater risk than a driver adhering to the 25 mph speed limit.

Police enforcement should be a deterrent to speeding; however, patrols must be visible and frequent according to research conducted by the Transportation Research Board.[65] A study from the U.K.'s Transport Research Laboratory found that with increased

[65] Managing Speed: Review of Current Practice for Setting and Enforcing Speed Limits (1998) Transportation Research Board. Washington, D.C. Available online at: http://onlinepubs.trb.org/onlinepubs/sr/sr254.pdf [Accessed December 2014].

enforcement, cities achieved a three mph reduction in average speed in addition to what was achieved by lowering the speed limit.[66] In Graz, Austria, for example, vehicle speeds decreased in the first 12 months after reducing the City's speed limits when enforcement efforts were enhanced; however, speeds began to increase again 18 months after reducing the speed limit when enforcement efforts waned.[67]

Current Speed Limit Enforcement Efforts in San Francisco

The San Francisco Police Department is the primary traffic law enforcement agency in San Francisco, though there are four other law enforcement agencies that are active in enforcing traffic laws in the City.[68] Currently SFPD assigns 41 officers, six sergeants and two lieutenants full-time to the Department's Traffic Enforcement Unit. The Traffic Enforcement Unit enforces all traffic laws and issues citations for violations including exceeding the speed limit, running a red light, making an illegal turn, and blocking an intersection after the light has changed, to name a few. The Traffic Enforcement Unit focuses their speed limit enforcement efforts on corridors and intersections where speed has been identified as the primary cause of traffic collisions. In addition, police officers that are on patrol but not part of the Traffic Enforcement Unit are also expected to issue citations it they witness a traffic violation, according to SFPD.

In calendar year 2014,SFPD issued 129,638 traffic violation citations which was 97 percent more than the 65,653 traffic violation citations SFPD issued in 2013 indicating that traffic enforcement efforts have significantly increased compared to the last year. Of the total traffic violation citations issued in 2014, 7,454 were for speeding, or six percent, as shown in Exhibit 11 below.

[66] A. Mackie. (1998) Urban Speed Management Methods. Transportation Research Laboratory. Accessed online at: http://www.20splentyforus.org.uk/UsefulReports/TRLREports/trl363AMackie.pdf [Accessed November 2014].
[67] Toy S. (2012) Delivering soft measures to support signs-only 20mph limits: Report on research findings. Bristol Social Marketing Centre.
[68] Other agencies that enforce traffic laws in certain jurisdictions within San Francisco include the U.C.S.F. Police Department, San Francisco State University Police Department, City College of San Francisco Police Department and the California Highway Patrol.

Exhibit 11: Traffic Violations Issued by SFPD in 2014

Traffic Violation	Number of Citations	Percentage of Total Traffic Violations
Running a Red Light	5,501	4%
Not Stopping at a Stop Sign	13,061	10%
Not Yielding to Pedestrians at Crosswalk	4,415	3%
Speeding	7,454	6%
Failure to Yield when Turning	390	0%
Talking on a Cell Phone	5,514	4%
Unlicensed Driver	2,177	2%
Suspended License	2,820	2%
Pedestrian Offenses[1]	5,969	5%
Bicycle Offenses[2]	1,591	1%
Other Offenses[3]	80,746	62%
Total	**129,638**	

Source: San Francisco Police Department Staff

[1] This refers to all violations given to pedestrians including jaywalking and crossing against a red light.

[2] This refers to all violations given to bicyclists including running a red light or stop sign or right of-way violations.

[3] This refers to hundreds of other violations including "fix-it" violations, expired registration, failure to obey a posted sign, and impeding the flow of traffic.

The 2014 speeding citations amounted to approximately 621 tickets per month, or approximately 20 tickets per day. Given driver compliance rates and the average speed of drivers on 25 mph streets, it is reasonable to assume that more than 20 drivers a day are driving faster than the posted speed limits and are not receiving speeding citations. However, as shown in Exhibit 11 above, SFPD police officers are also issuing citations for other traffic violations that contribute to vehicle collisions such as running red lights and not yielding to pedestrians at crosswalks, in addition to issuing speeding citations.

The SFPD is currently in year three of its six year hiring plan to hire 960 sworn officers to reach 1,971 full duty sworn officers as mandated by San Francisco Charter Section 4.127.[69] As of January 2015, SFPD has hired 452 sworn officers, or 47 percent of the number of officers in its six-year hiring plan.

SFPD reports that it will be increasing the number of officers assigned to the Traffic Enforcement Unit by 25 percent over the next two years. The 25 percent increase is in support of the City's Visions Zero policy which seeks to eliminate all traffic deaths in San Francisco by 2024 and SFPD's Focus on Five program which focuses enforcement efforts on the City's top five collision factors: 1) driving at unsafe speeds, 2) red light signal violations, 3) failure of drivers to yield to pedestrians at a crosswalk, 4) failure of drivers to yield while making a left or U-turn, and 5) failure to stop at a stop sign limit line.

If the Board of Supervisors would like to increase enforcement above what the hiring plan currently entails which includes a planned 25 percent increase in the Traffic Enforcement Unit, it would cost approximately $5 million for each additional 50 person Academy class,[70] according to SFPD budget staff. The estimated $5 million cost includes, background checks, salaries and benefits, uniforms, and training. Annually thereafter it would cost between $108,000 and $200,000 per officer to provide salary and benefits, equipment and any other additional training that may be needed.

Officers in the Traffic Enforcement Unit are typically senior officers; therefore, it would be unlikely for the 50 new officers that graduate from the Academy to be assigned to this unit, although they would still be expected to issue traffic violations, as noted above. The 50 new officers could also enable more senior officers to transition to the Traffic Enforcement Unit with their current deployments replaced by the new officers.

Increasing enforcement of existing speed limits with additional police officers would not incur implementation costs associated with the other alternative approaches suggested in this report as there would be no capital improvement costs or costs incurred to advocate for State legislative changes.

Alternative 2: Advocate for amendments to State law to allow for enhanced enforcement through Automated Speed Enforcement (ASE) technology.

An alternative way to increase enforcement would be implementing an Automated Speed Enforcement (ASE) program, more generally referred to as speed cameras. A 1998 study commissioned by the United Kingdom's Department of the Environment, Transport and

[69] San Francisco Police Department FY 2014-15 Budget Presentation given by Chief Gregory P. Suhr on February 3, 2014.
[70] SFPD typically hires in groups, or Academies, so that all of the newly hired officers attend State mandated training courses at the same time.

the Regions reviewed vehicle speeds in multiple jurisdictions that employed different speed reduction measures and found that speed cameras reduce average speed by 6 mph which is relatively effective compared to all other speed reduction measures except traffic calming as shown in Exhibit 12 below.

Exhibit 12: Effectiveness of Speed Reducing Measures on Streets with Treatments

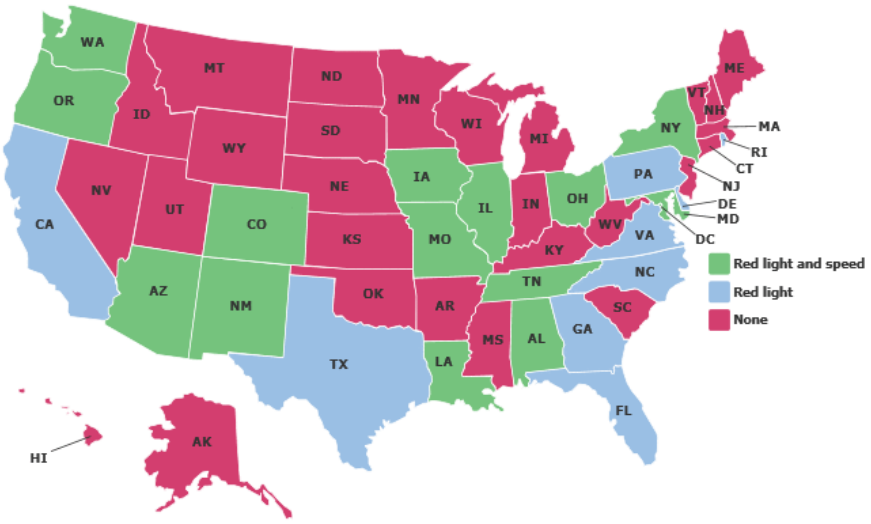
Speed Reduction Measure	Effect on Average Speed (mph)
Traffic Calming	-9.3
Speed Cameras	-6.0
Vehicle -Activated Signs	-4.2
Flashing Signs	-3.8
Static Signs	-2.2

Source: Urban Speed Management Methods. Transport Research Laboratory. A. Mackie. 1998

In the United States, there are currently 136 jurisdictions in 15 states that have ASE programs. The states in which these jurisdictions are located are colored in green in Exhibit 13 below. Although red light cameras are legal and used in San Francisco, speed cameras are not allowed in California according to State law.[71] In order to implement an Automated Speed Enforcement program, the California Vehicle Code would need to be amended. Over the last 10 years, five bills have been considered by the California State Legislature to authorize some form of automated traffic enforcement, largely pilot programs administered by local jurisdictions, but the bills were either vetoed or did not make it to the Assembly or Senate for a vote.

[71] California Department of Motor Vehicles, Cal. Vehicle Code 21455.6

Exhibit 13: States with Speed and Red Light Cameras, January 2015



Source: Insurance Institute for Highway Safety, www.iihs.org, June 2015

There are several concerns about ASE that could make enabling legislation difficult including, but not limited to: 1) infringing on drivers' privacy as photographs are taken or video footage is recorded, 2) vendors that may be contracted to operate the program may be incentivized to cite drivers because they may be paid based on citation volume, 3) citations are issued to the registered owner and not the driver who may have been a different person than the owner.[72] These concerns should be addressed in designing an ASE program if the Board of Supervisors is interested in pursuing this alternative.

Implementation costs for creating an ASE program would include City staff time, and possibly, outside counsel and advocate costs as State legislation would need to be developed, proposed, advocated for and approved by the California State Legislature. Capital and personnel costs are largely contingent on the scope of the ASE program, how it is administered and by which City department, and the extent to which a third-party vendor is used. Capital costs would include leasing or purchasing equipment such as static speed cameras or mobile speed cameras similar to the speed cameras in the marked police vans used in Portland and ongoing maintenance costs. Personnel costs would depend on who is operating the cameras: the City's Police Department, a department such as SFMTA, or a third-party vendor that reviews the violations. Although the implementation costs may be high depending on the scope of the ASE program, literature

[72] Phillips C and Kronenberg, C. Review of Automated Speed Enforcement. Presentation given by the Controller's Office, City Performance Unit.

reviewed by the Budget and Legislative Analyst shows that this approach is effective at reducing vehicle speeds and requires less law enforcement personnel to issue the same level of citations.

Unlike Alternative #1, enhanced enforcement with additional police officers, an ASE program would allow for a higher level of enforcement that would supplement the existing and any additional police officers that will be hired as part of SFPD's six- year hiring plan that could allow for the assignment of more resources to the Traffic Enforcement Unit. Supplementing SFPD's existing enforcement efforts with ASE should lead to a more efficient program as ASE can detect more speeding drivers than a single police officer.

As of 2014, the City of Portland uses two-full time sworn City police officers to operate and monitor the speed cameras and they contract out with a third-party vendor to download the images captured by the cameras. The vendor reviews the images for violations, requests registration information from the DMV, sends the violations to the Portland Police Department for a second review, and, once signed off by the Police Department, mails the citations. The cost of the vendor contract for five years is $7 million or approximately $1.4 million per year. The City of Portland issued 22,241 citations in 2010 through its ASE program.

According to staff from the Seattle Police Department, their city contracts with a third-party vendor to install, maintain and mail citations at a cost of $80,750 per month, or $969,000 a year, for 17 cameras in nine school zones. The program is supported by City staff including a program manager, two patrol police officers and a Seattle Department of Transportation employee whose labor costs are not included in the $969,000 a year figure.

To offset the cost of this alternative, the additional revenue generated from citations could be used to pay for the program and could be investing into other speed reduction strategies if there are additional revenues.

Enforcement personnel costs, defined in this report as police officer labor, would be moderate as it would likely require the time of several existing police officers or City staff to support the ASE programs' administration and citation review.

Alternative 3: Advocate for changes in State law to City speed limits below 25 mph and to eliminate the requirement that speed limits be set at actual speed of most drivers.

As previously described, State law requires speed limits to be set or changed (if currently a prima facie speed limit) by local jurisdictions based on an Engineering and Traffic Survey

(E&TS). However, if an E&TS supports a 20 mph speed limit on a street that is not in a school zone or is not an alleyway or blind intersection, a local jurisdiction such as the City and County of San Francisco cannot reduce the speed limit to 20 mph as the minimum speed limit for all other streets is 25 mph according to the California Vehicle Code. For the City to establish a 20 mph speed limit on a street that is not already identified as an exception to the 25 mph minimum in State law, the City would have to request that the State Legislature amend the California Vehicle Code to allow additional exceptions or reduce the minimum speed limit to 20 mph.

If a local jurisdiction desires to reduce the speed limit on certain streets, or all city streets if a citywide speed limit reduction is preferred, to a speed that is not supported by an E&TS the California Vehicle Code would also need to be amended to eliminate the E&TS requirement. An example of this would be reducing the speed limit on certain sections of Fulton Street from 35 mph to 25 mph when 35 mph is the speed limit recommended by the E&TS.

According to research and case studies, simply reducing the speed limit by installing new speed limit signs and markings may have some impact but, without enhanced enforcement or traffic calming devices, it is not the most effective speed reduction strategy as drivers will continue to drive at a speed in which they feel comfortable based on lane width, visibility, clearance, traffic volumes, turning activity and amount of pedestrian and cyclist activity, regardless of the posted speed limit. [73]

A study prepared for the Institute of Transportation Economics, a Brussels-based non-profit association advocating sustainable mobility, asserts that if the speed limit is changed, the change in the average actual speed of traffic will amount to 25 percent of the change in the speed limit. [74] For example, if the speed limit on Guerrero Street was reduced by 10 mph from 25 mph to 15 mph, but the average speed of traffic was actually 27 mph, then one could expect a 2.5 mph decrease in the average actual speed of traffic (25 percent x the 10 mph reduction in speed limit = a 2.5 mph reduction in speed), resulting in a new average actual speed of 24.5 mph, or 2.5 mph less than the previous actual speed of 27 mph.

There are several negative impacts that should be considered if the California Vehicle Code were amended to allow a minimum 20 mph speed limit or a speed limit that is not supported by an E&TS and the 85th percentile speed.. First, if an E&TS shows that the appropriate speed limit on a street is 40 mph given prevailing vehicle speeds and road

[73] Victoria Transportation Policy Institute. (2014) Speed Reduction Strategies that Reduce Traffic Speeds. Available online at: http://www.vtpi.org/tdm/tdm105.htm. [Accessed December 2014].
[74] R. Elvik, P. Christensen, and A. Amundsen, (2004). Speed and Road Accidents: An Evaluation of the Power Model. The Institute of Transport Economics

design, under current law, the City cannot reduce the speed limit on that street to 25 mph. As previously explained, if a street is designed to carry vehicles safely at 40 mph (i.e. the street is flat, the lanes are wide, there are multiple traffic lanes, there is an absence of cyclists and pedestrians) reducing the speed limit to 25 mph when traffic can move safely at a higher speed is believed by traffic engineers to increase the risk of collisions as it creates a speed variance.[75]

Secondly, according to Caltrans's California Manual for Setting Speed Limits, to maintain the confidence of the public and legal system, a rational and defensible procedure should be in place to determine speed limits, which Caltrans considers the E&TS process to be. The E&TS provides a standardized approach for hundreds of local jurisdictions across the state to objectively determine speed limits. If the City amends the California Vehicle Code to reduce speed limits to levels not consistent with the 85th percentile speed or other factors included in the E&TS, the speed limit determination process could lose credibility and respect from the public.

Implementation costs for the City advocating for changes to State law to allow for lower speed limits in San Francisco would include City staff time and possible costs for outside counsel and consultants as State legislation would need to be developed, proposed and approved by the California State Legislature.

Once adopted, the City's costs would depend on the number of streets on which speed limits would be changed. Installing one new speed limit sign costs approximately $200, a painted speed limit marking on the street costs $400 and a more advanced radar speed feedback sign would cost approximately $30,000 to purchase and install according to SFMTA staff. Also, if speed limits are changed on streets that are included in a signalized corridor, traffic signals would need to be recalibrated pursuant to an engineering study. According to SFMTA staff, recalibrating traffic signals costs approximately $2,000 per signal, not including labor, to design and review the signal changes.

Alternative 4: Advocate for changes in State law to allow City speed limits below 25 mph and to eliminate requirement that speed limits be set at actual speed of most drivers and enhance enforcement of new speed limits

Alternative 4 would incur similar implementation costs as enhanced enforcement Alternatives 1 or 2 (or both if enforcement were enhanced through increased law enforcement *and* an automated safety enforcement program), and all of the

[75] European Road Safety Observatory. (n.d.) Speed and Accident Risk. Available online at:http://ec.europa.eu/transport/wcm/road_safety/erso/knowledge/Content/20_speed/speed_and_accident_risk.htm. [Accessed October 2014].

implementation costs of Alternative 3 associated with advocating for amendments to State law, as discussed above.

The costs associated with this Alternative 4 would include infrastructure costs to change speed limit signs, labor and consultant costs associated with legislative changes and enhanced enforcement costs. However, the combination of reducing the speed limit and increased enforcement should result in greater average speed reductions. Again using the example of Guerrero Street provided above, a 10 mph reduction in the speed limit would likely result in a 2.5 mph reduction in actual speeds driven based on the formula cited above that the average speed will decrease by 25 percent of the change in the speed limit. However, by pairing a reduction in speed limit with increased enforcement, the U.K.'s Transport Research Laboratory study suggests that the average speed would decrease by an additional 3 mph due to increased enforcement, thus amounting to a total average speed reduction of 5.5 mph (2.5 mph from the 10 mph reduction in speed limit + 3 mph due to increased enforcement = 5.5 mph reduction).[76]

Applying the formula of a five percent reduction in collisions for every one mph reduction in speed cited above, a reduction in average speeds of 5.5 mph in 2011 would have resulted in a reduction of 856 of the 3,111 non-fatal collisions reported that year (5.5 mph speed reduction x 5% = 27.5 percent reduction in non-fatal collisions x 3,111 non-fatal collisions in 2011 = 856 fewer non-fatal collisions).

Alternative 5: Implement or enhance City traffic calming measures

Vehicle speeds could be reduced by installing more traffic calming measures such as speed bumps and chicanes or other treatments that prevent or make it difficult for vehicles to drive unsafe speeds. SFMTA's existing Traffic Calming Program currently allows residents to apply for street bumps or other traffic calming treatments on certain streets if they are concerned about speeds travelled on those streets. SFMTA is also making safety improvements on certain arterials and commercial corridors selected by SFMTA staff to reduce vehicle speeds and make it safer for pedestrians. The Board of Supervisors could advocate for reallocated resources within SFMTA or enhanced funding for SFMTA's Traffic Calming Program so it could be expanded to include larger geographical areas with more residential and/or arterial streets.

As shown in Exhibit 12 above, one research study by the Transport Research Laboratory of the U.K. found that traffic calming treatments are the most effective strategy for reducing speed relative to other speed reduction measures. Traffic calming is almost four times

[76] A. Mackie. (1998) Urban Speed Management Methods. Transportation Research Laboratory. Accessed online at: http://www.20splentyforus.org.uk/UsefulReports/TRLREports/trl363AMackie.pdf [Accessed November 2014].

more effective than installing a stationary speed limit sign, according to the study. According to the research, traffic calming treatments reduce a driver's speed from an average of 30 mph to approximately 20 mph which, in the event of a pedestrian collision, reduces the risk of the pedestrian's death by 40 percent. The benefits of traffic calming are substantial; however, they are highly localized to the streets with treatments.

Traffic calming treatments could be initially costly depending on which and how many treatments are installed. Exhibit 14 shows examples of the unit costs of different types of traffic calming measures according to the San Francisco Municipal Transportation Agency. As can be seen, the unit costs range from $10,100 for one speed bump to $67,500 for an individual bulb-out. To put this in perspective, NYCDOT installed nine speed bumps in the Claremont Neighborhood Slow Zone for approximately $90,900 which covered 4.1 road miles.

Exhibit 14: Traffic Calming Costs by Type of Treatment

Traffic Calming Measure	Cost per Unit
Speed bumps/cushions	$10,100
Islands	$24,300
Chicanes	$24,300
Traffic Circles	$35,000
Bulb Outs	$67,500

Source: San Francisco Municipal Transportation Agency

Traffic calming treatments could be installed in individual areas or as part of redesigning an entire corridor such as the Masonic Avenue Streetscape Improvement Project between Geary Boulevard and Fell Street in San Francisco. The Masonic Avenue Streetscape Improvement Project is intended to increase pedestrian and bicyclist safety by reducing traffic speed with medians and cycle tracks. These treatments will reduce the number of vehicle lanes (known as a road diet) and limit traffic speeds to those driven by the fastest driver as fewer lanes make it difficult for a driver to change lanes to access a faster lane. These treatments will also narrow the lanes which tend to make drivers feel less comfortable driving at faster speeds as there is less room to maneuver. Other treatments such as bus bulb-outs and landscape features will also be included. The total estimated cost for the entire Masonic Avenue Streetscape Improvement Project, including planning and environmental review is $18.5 million, according to SFMTA staff.

The most effective type of traffic calming treatment depends on the design of the roadway and its purpose. There are four different street categories that serve different functions: 1) local streets, 2) collector streets, 3) urban arterials and 4) freeways.[77] [78]

The function of the street should be considered when considering what type of traffic calming treatment to install or whether the treatment should be installed at all. For example, speed bumps on certain arterials could impede emergency vehicle, transit vehicle and driver mobility. A study conducted in Oregon by the City of Portland Bureaus of Fire and Traffic Management found that 14-foot wide speed bumps delayed a fire vehicles' response time by 1 to 9.4 seconds, a 22-foot wide bump caused a delays of up to 9.2 seconds and traffic circles caused a of 1.3 to 10.7 second delay in response time.[79]

Many jurisdictions have found that implementation of traffic calming treatments benefit from community engagement to be successful. SFMTA's current traffic calming program calls for residents concerned about speeding on their street to submit an application and petition to the SFMTA with at least 20 residents' signatures from separate households who live on the street for which the traffic calming treatment is being requested. The applications are evaluated by SFMTA based on certain criteria including whether the street is a local-access residential street, whether there is a measurable speeding problem, and whether the street is located near a school zone, a community or senior center, or a park or playground. SFMTA staff ranks the applications and determines which locations will receive funding given available funds. SFMTA determines the appropriate traffic calming measure for selected streets and informs residents on the accepted blocks of the proposed treatment. The residents are asked to vote on whether or not they want the treatment. If 50 percent of the vote is in favor of the treatment the proposed designs will be vetted through the official SFMTA public hearing process and then installed.

Enforcement costs would be low for this alternative as physical traffic calming measures are self-enforcing as the measures make it difficult for drivers to drive unsafe speeds. Costs are mostly one-time upfront costs for installation of the treatment(s), with some fairly minimal ongoing maintenance costs required.

[77] Presentation given by David Vega-Barachowitz, Designing Cities Initiative, NACTO, May 13, 2014.
[78] Local streets provide access to residential properties or other land uses and should not be used for through-traffic, and offer the lowest capacity in terms of traffic volume. Collector streets connect local streets to larger arterial streets within neighborhoods and can sustain a higher capacity of traffic than local streets. Arterial streets can typically hold more capacity than collector streets and are used to move people and goods efficiently within and through neighborhoods and the City. Freeways have the highest capacity and their primary function is to carry intercity traffic.
[79] Brunte L. (2000) Traffic Calming Programs and Emergency Response: A Competition of Two Public Goods. University of Texas at Austin. Available online at: http://nacto.org/docs/usdg/traffic_calming_programs_and_emergency_response_bunte.pdf. [Accessed December 2014].

Alternative 6: Implement traffic calming measures, advocate for changes in State law to allow City speed limits below 25 mph and to eliminate requirement that speed limits be set at actual speed of most drivers, and enhance enforcement of new speed limits

Alternative 6 would be the most expensive but most effective speed reduction strategy to implement as it combines Alternatives 4 and 5 and would include advocating for State law changes to allow speed limit reductions, increased enforcement of lower speed limits and installation of traffic calming measures. As noted in Alternative 5 above, traffic calming measures have been shown to be more effective than other speed reduction measures; however, due to the installation costs of traffic calming treatments, the City may be limited to how many can be installed Citywide.

To supplement traffic calming measures, the City could advocate for amendments to the California Vehicle Code by the State Legislature and/or draft legislation to allow the City and County of San Francisco to reduce the minimum speed limit on certain streets to 20 mph or below. In addition, the City could draft legislation to amend the California Vehicle Code to reduce the speed limit to an authorized speed, between 25 mph and 65 mph, without a supporting Engineering and Traffic Survey.

The consequences of the City reducing the speed limit without a supporting Engineering and Traffic Survey (a higher risk of collisions due to variable driver speeds and a loss of confidence in the speed limit setting process) should be considered if this alternative is selected. Finally, the City could also enhance enforcement, which should increase the effectiveness of both a reduction in the speed limit and traffic calming measures. If the Board of Supervisors elects to purse this alternative, all of the aforementioned infrastructure, labor and enforcement costs would be incurred as explained in Alternatives 4 and 5.

Comparison of Alternatives

Exhibit 15 below provides a comparison of the six alternatives presented based on the likelihood of reducing vehicle speeds and collisions, unit implementation costs for: a) capital improvements such as speed bumps and Automated Speed Enforcement equipment, and b) advocating for State legislative changes, including the costs of labor, outside counsel and consultants required to develop legislation and the time and effort needed to obtain approval by the California State Legislature. Unit enforcement personnel costs refer to costs associated with one unit of enforcement personnel such as an additional sworn police officer and related support costs.

Exhibit 15: Speed Reduction Option Comparison Table

Speed Limit Program	Effectiveness in Reducing Vehicle Speed	Implementation Costs			Total Cost
		One-time Capital Improvement Unit Cost	One-time Legislative Advocacy Costs	Ongoing Enforcement Personnel Unit Cost	
Alternative 1: Enhance Enforcement with Police Dept. labor	Low - Moderate	-	-	$$	$$
Alternative 2: Advocate for legislative change to allow enhanced enforcement with Automated Speed Enforcement cameras	Moderate	$	$	$$	$$$$
Alternative 3: Advocate for changes to State law to allow speed limit reductions not based on current actual speeds	Low		$	-	$
Alternative 4: Advocate for changes to State law to allow speed limit reductions not based on current actual speeds; enhance enforcement of new speed limits	Moderate		$	$$	$$$
Alternative 5: Implement/enhance traffic calming treatments	Moderate - High	$	-	-	$
Alternative 6: Advocate for changes to State law to allow speed limit reductions not based on current actual speeds; enhance enforcement; implement/enhance traffic calming	High	$$	$	$$	$$$$$

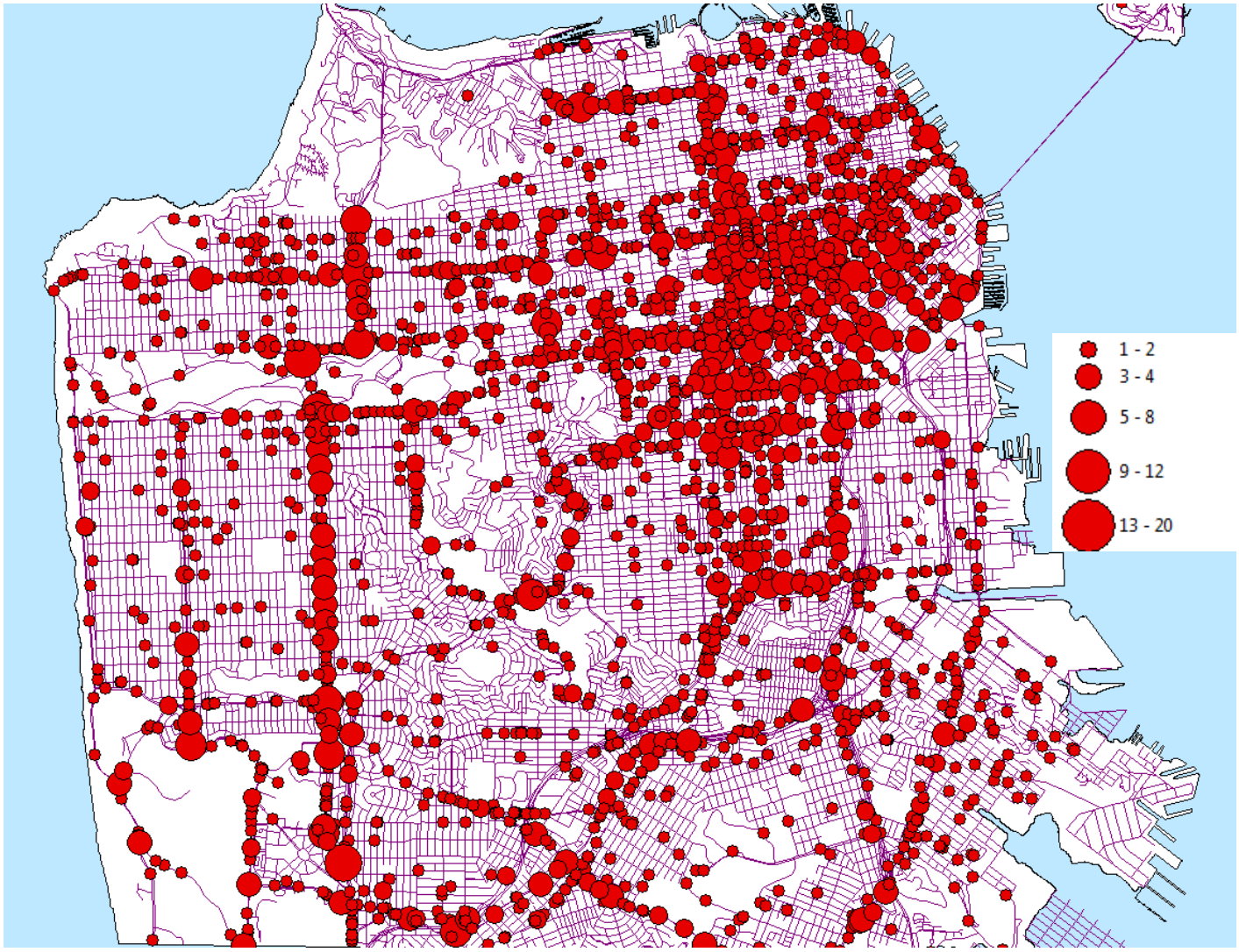
Alternative 3, reducing current speed limits through amendments to State law, could be implemented at the lowest cost as there would be no increase in enforcement costs beyond what is currently provided; however, it would have the lowest impact on reducing vehicle speeds, collisions and injury rates. Alternatives 5 and 6, both of which include installation of traffic calming measures is likely to have the most impact on reducing collision and injury rates for streets where the traffic calming measures are installed as drivers would be forced to slow down to speeds of 20 mph or slower or risk vehicle damage. Alternatives 1 and 2 would likely reduce vehicle speed to closer to the posted speed limit, however, without legislative changes to allow the City and County of San Francisco to reduce its speed limits, the posted speed limits could be no lower than 25 mph, with the risks associated with higher speeds still in place.

Alternative 4 is the second most costly alternative but would be relatively more effective as speed limits could be reduced to levels that would not cause as many serious injuries or deaths in the event of a collision and drivers would be more likely to adhere to lower speed limits due to enhanced enforcement. However, even with enhanced enforcement, speed cameras and police officers cannot be present on every street all of the time which limits the effectiveness of this alternative.

Alternative 6 would require the most resources but would most effectively reduce vehicle speeds, collisions and fatalities as it would reduce speeds on streets that are appropriate for traffic calming measures and on all other streets through lowered speed limits to speeds that are less dangerous for pedestrians and bicyclists with the support of enhanced enforcement.

Appendix A

Collisions Caused by Speeding in San Franicosco, 2008-2013

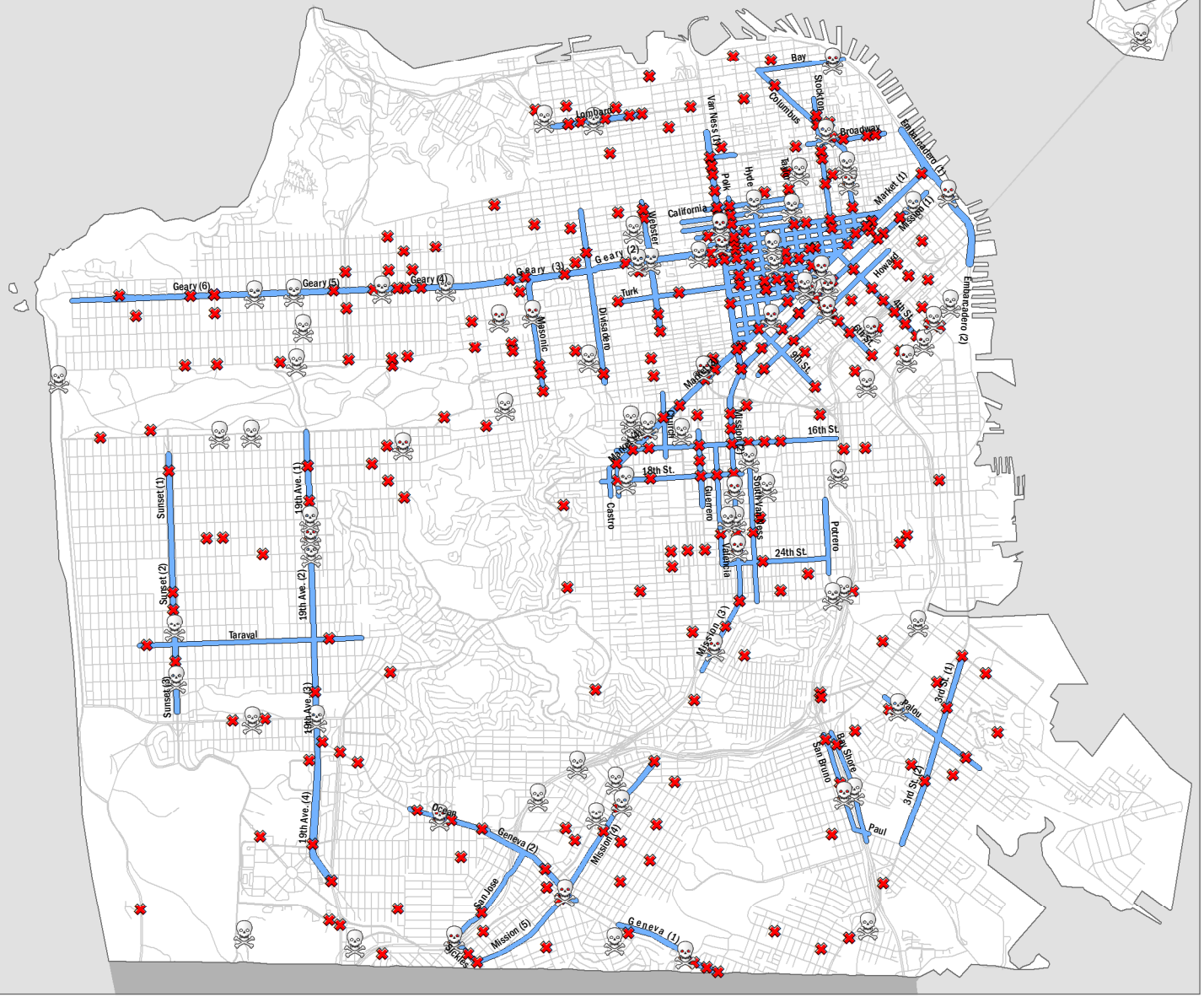


Source : SFMTA Traffic Egineering

Pedestrian High Injury Corridors: San Francisco, California

Vehicle-Pedestrian Injuries (2007-2011)

High Injury Corridors represent 6% (69 miles) of San Francisco's street miles, where 60% of severe and fatal vehicle-pedestrian injuries occurred in 2007-2011.



Pedestrians Killed

Pedestrians Severely Injured

Pedestrian High Injury Corridor

0 0.5 1 2

Miles

Source: SFDPH 2013; Statewide Integrated Traffic Records System (SWITRS) 2007-2011

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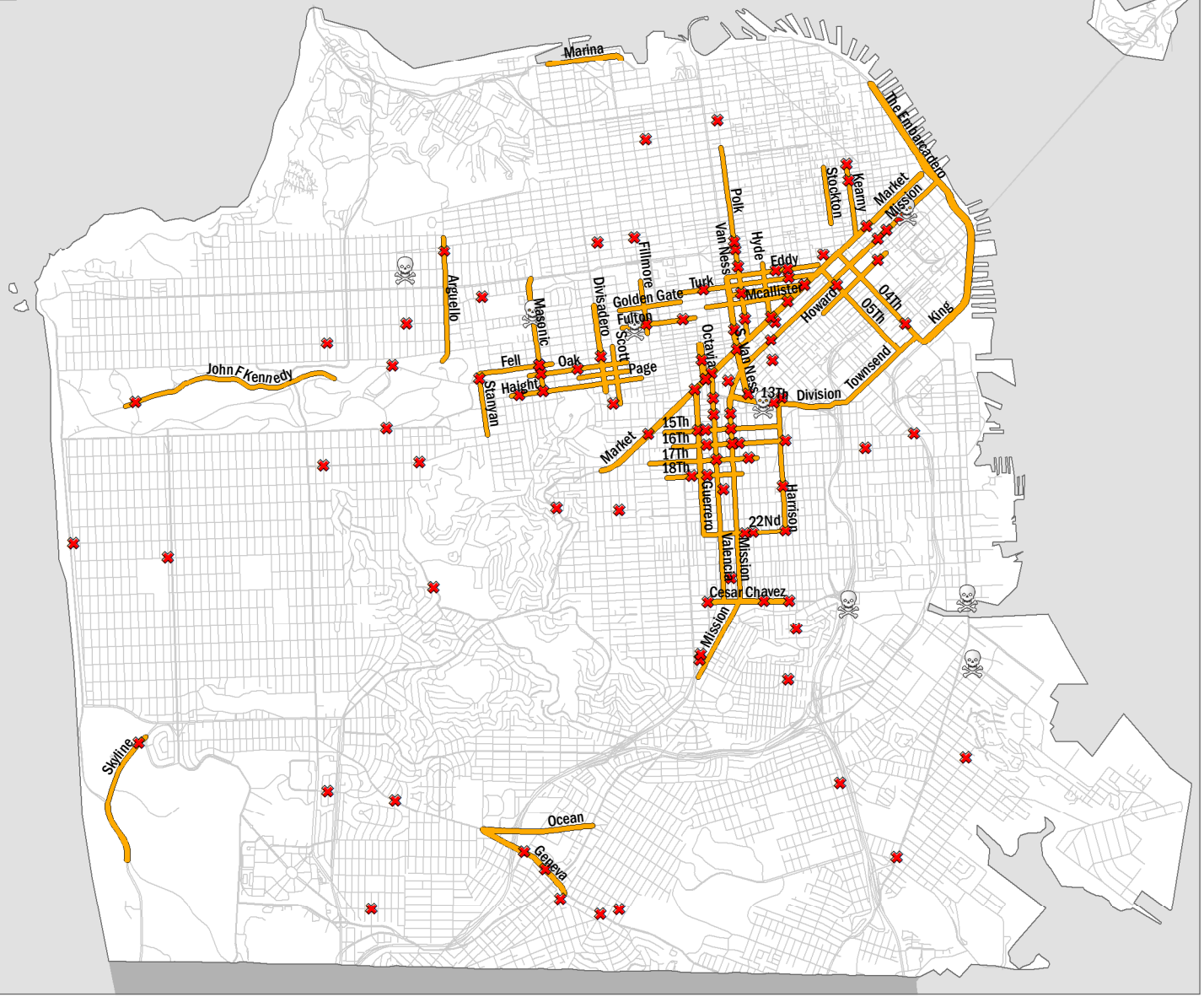
Cyclist High Injury Corridors: San Francisco, California

Vehicle-Cyclist Injuries (2007-2011)

Cyclist high injury corridors represent 4% of San Francisco's street miles where approximately 60% of severe and fatal cyclist injuries and over 50% of total cyclist injuries occurred in 2007-2011.



Cyclist Killed

Cyclist Severely Injured

Cyclist High Injury Corridor (42 Miles)

0 0.5 1 2

Miles

Source: SFDPH 2014; Statewide Integrated Traffic Records System (SWITRS) 2007-2011

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