Mass Transit Health Impact Assessment:

Potential health impacts of the Governor's Proposed Redirection of California State Transportation Spillover Funds

Health Impact Assessment Project
UCLA School of Public Health
June 2008

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Report available at:
http://www.ph.ucla.edu/hs/health-impact

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Mass Transit HIA: Potential health impacts of the Governor's Proposed Redirection of California State Transportation Spillover Funds

Legislative Update

On August 21, 2007 the California State Legislature approved a budget for fiscal year 2007 that included the Governor's proposed re-direction of $1.3 billion in transportation "spillover" funds to the State's General Funds. Although the fate of this particular bill has already been decided, allocation of public funds for transit in California continues to be a high priority issue. Local government officials will need to decide how to respond to the loss of these state funds and undoubtedly the State Legislature will continue to revisit the issue in considerations of future State budgets. We believe that the information contained in this health impact assessment will continue to be salient and will provide a foundation for other analyses of potential health impacts of future transit funding proposals at the state and local level.

Even though re-direction of transportation funds has already been approved by the State Legislature, it will be referred to as a proposed re-allocation for the purposes of this health impact assessment.

I. Executive Summary

Aims of this Health Impact Assessment

The aims of this health impact assessment (HIA) are two-fold. First, in order to inform pending transportation funding decisions in California, it aims to synthesize and communicate research evidence on how proposed cuts in state funding of mass transit may impact the public's health. Secondly, and more generally, it aims to identify potential opportunities for public policies outside the traditional purview of public health, such as transportation policy, to contribute to efforts to promote public health, particularly towards stemming the rising tide of childhood obesity and sedentary lifestyle—the goal of the California Endowment's Healthy Eating Active Living Initiative of which this project is part.

Legislative background

The Governor's proposed budget for fiscal 2007/2008 contained provisions for reallocating approximately $1.3 billion in gasoline sales tax sales tax revenue (aka "spillover funds") that had been set aside for funding transit programs throughout the state for other purposes (Governor's Budget Office, 2007). Since these funds are distributed to local transit authorities, which vary in how they use state transit funds, their other sources of revenue, and their likely responses to potential cuts in State funding, considerable uncertainty exists as to the exact, on-the-ground manifestations of potential budget cuts. That said, $1.3 billion is a significant sum of money, even in a state as large as California with a population of 36 million people and combined state, federal and local government outlays of $20 billion per year for transportation (LAO, 2007b). Funding cuts of this magnitude would certainly have some effects on transit service and eventually some downstream effects on health. While we cannot precisely predict the magnitude or distribution of these effects, we can describe the pathways through which transportation in general, and transit availability and utilization in particular, affect the public's health. Beyond the particular policy question at hand, the information synthesized in this HIA can help guide policy assessments of potential health effects of other policy decisions affecting transit service, including analyses of local transportation proposals where more detailed information is available about specific alternatives for transit operations and projects.

Selection and scoping process

Selection of this policy as the focus of an HIA was guided by the California Endowment HIA Working Group, an advisory committee made up of various public health experts and community

health advocates from around California who are active in other aspects of the California Endowment's Healthy Eating Active Communities (HEAC) Initiative to prevent childhood obesity. This particular issue was selected among a number of others because the working group felt that it best met the following criteria:

1. Utility, including:
    a. Nexus between the proposed policy and childhood obesity;
    b. Political salience/timeliness/potential for policy change;
    c. Potential relevance (e.g. down-scaling) for HEAC Community Grantees (in 6 low income communities around the state);
2. Technical feasibility/data availability.

From the outset project staff and working group members recognized that the limited state of research on the relevant pathways would preclude quantitative estimation of most health impacts, but a decision was made to go forward because of interest in the topic and perceived value for policy-making.

After reviewing state budget documents, claims of transit advocacy groups and the research nascent literature on transportation and health, project staff identified major pathways through which transit and state transit funding in particular might impact health. These pathways, including impacts on a range of social, economic and physical determinants of health, are outlined in a logic framework (see Figure ES-1). As a result of discussion with working group members and a transportation researcher at UCLA, some linkages were added to the logic framework. While logic frameworks such as this one may over-simplify the complex causal

interactions that affect health, they are useful for guiding and organizing HIA analysis and communicating results.

Besides uncertainty about how individual transit agencies might respond to the proposed cuts, we are also uncertain about potential effects stemming from corresponding increases in funding for other programs. Funds that are not allocated for transit are allocated for other programs or redistributed to taxpayers. The health effects and their distribution is highly variable and a full assessment of any budget cuts needs to consider not only the effects arising from the cuts to one program but also increases in funding to another program. While investment of public resources in transit yields many public benefits, including improved health, the health benefits would almost certainly be larger from an investment of equal magnitude in health care for uninsured children. A corresponding investment to expand state prisons or an across the board reduction in state income taxes totaling the same amount would probably not yield the same health benefit as investment in transit.

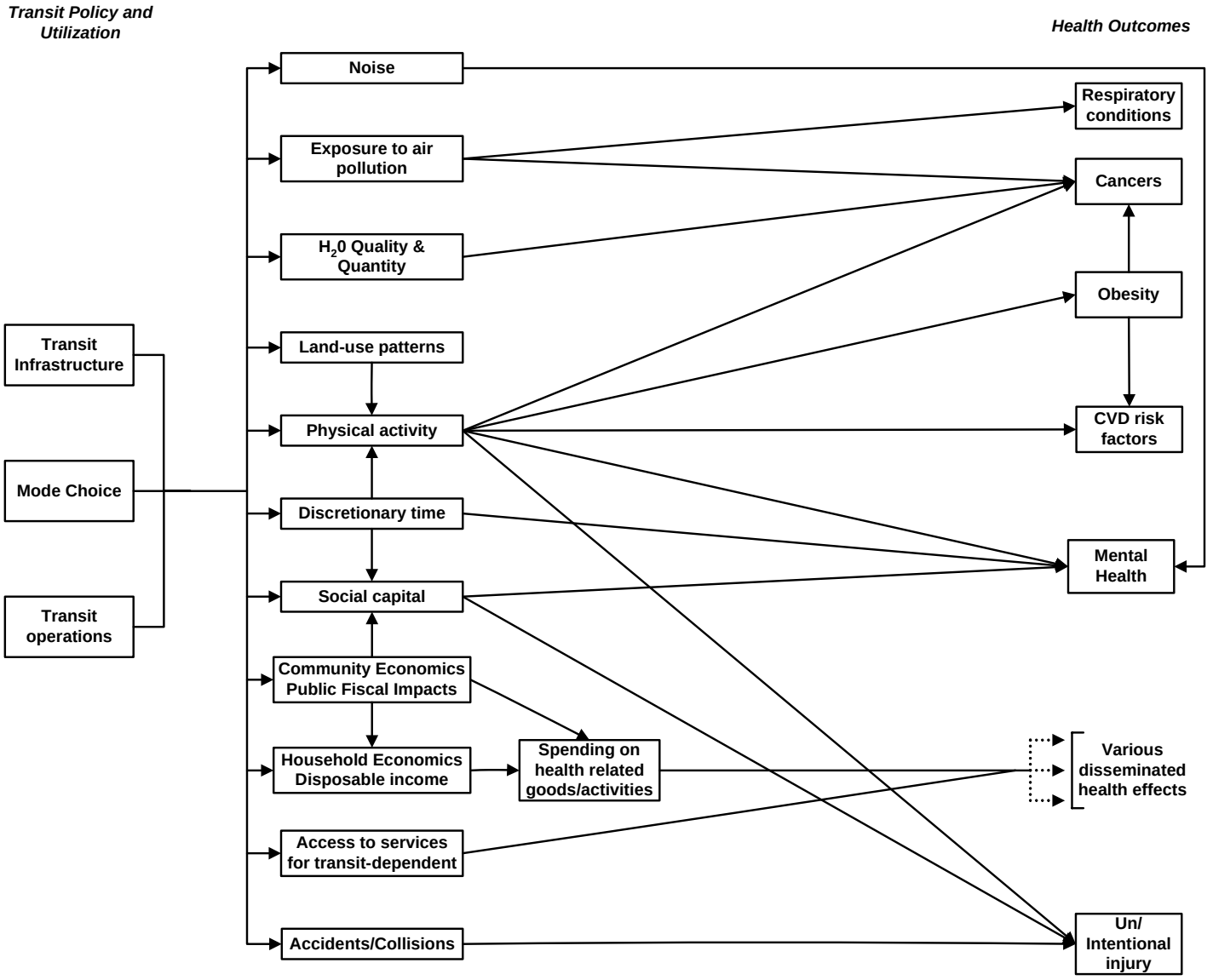


Figure ES-1: Logic Framework for the health impact assessment of state transit funding

Pathways

Through review of the research literature, consultation with experts in the transportation field, and based on our team's experience working on HIAs of other policies, we identified the following pathways as potentially significant mechanisms through which the proposed cuts to transit funding might impact public health: air, water and noise pollution; economics, land-use, physical activity, discretionary time and social capital.

1. Air pollution

Pollutants such as carbon monoxide, ozone, particulate matter, and sulfur dioxide emitted from motor vehicles contribute greatly to poor air quality and have been found to cause significant health impacts, including lung cancer, cardiovascular disease, asthma and other respiratory problems linked to impaired quality of life and premature mortality (U.S. EPA, 2001). By reducing the number of automobile trips and reducing congestion for automobiles that remain on the road, better mass transit systems could reduce air pollution levels. Nationally, transit in the U.S. is estimated to reduce annual emissions of volatile organic compounds by more than 70,000 tons, nitrogen oxides by 27,000 tons, and carbon monoxide by 745,000 tons. Transit utilization also helps reduce carbon dioxide (CO_2) emissions by an estimated 7.4 million tons per year (Zimmerman, 2005). Although CO_2 is not considered an air pollutant in terms of human health risk, it is linked to global climate change.

Air pollution and its attendant health risks are not evenly distributed across the population. Children, the elderly, those living in proximity to high traffic volumes, and minority populations are all disproportionately affected. A study measuring the number of toxic air compounds at

different locations along the Los Angeles Basin found that residents living along highways with heavy traffic, particularly those in Huntington Park, Pico Rivera, Los Angeles, and Burbank (the core areas surrounding Downtown Los Angeles) were exposed to greater levels of toxic particulates and subsequently were at increased risk for cancer than those living elsewhere along the basin (South Coast AQMD, 2000). The Surface Transportation Policy Project has estimated that transportation-related public health costs from air pollution in the Los Angeles/Riverside/San Bernardino area alone total more than $2 billion per year (Ernst, Corless & Greene-Roesel, 2003).

California has been a national and world leader in reducing air pollution from both mobile and fixed sources. While the State has improved air quality by 27 percent over the last several decades while the population has nearly doubled, there are still a significant number of people in various regions living with poor air quality making this a severe threat to public health.

2. Water pollution;

Just as motor vehicle travel negatively effects air quality, it has also been shown to indirectly take a toll on water quality due to its association with land use patterns. Sprawl increases driving which in turn increases the number of pollutants affecting water supply through run-off; the process by whichwater from rain, snowmelt or irrigation flowing over land surface and is not absorbed into the ground, instead it flows into streams or other surface waters or land depressions. Chemicals added to gasoline such as MTBE have been known to contaminate ground water through leaks from underground storage tanks. In addition, the cancer causing

compounds found in exhaust have also been shown to contaminate water, and are found in high concentration in areas with increased traffic volume (Frank, Kavage & Litman, 2006).

In 1989 South San Francisco Bay was declared an impaired water body by the California State Water Resources Control Board. Since that time, thirteen cities and Santa Clara County have acquired permits that require the development and implementation of an identification program locating sources of heavy metal and executing control measures to prevent pollution at its source. The five categories that were identified as sources of heavy metals include: 1) air pollution, 2) automotive, 3) industrial, 4) residential, and 5) water supply. Of the five categories, it was discovered that automotive sources were among the most significant, including vehicle exhaust, tire wear, and brake pad wear (Armstrong, 1994).

3. Noise pollution;

A major source of urban noise is mass transit as well as other transportation modes. A study in New York City found mean noise levels varied at different transit locations: 93.5, 94.9, and 84.1 dBAs at subways platforms, subway cars, and bus stops respectively (Gershon, Neitzel et al., 2006). Noise from motor vehicles is also considerable; noise is generated from engine acceleration, tire/road contract, horns, and alarms (Frank, Kavage & Litman, 2006). Typical noise levels at 100 feet are 50, 70, and 90 dBAs for light auto traffic, free traffic, and city traffic, respectively (USEPA, 1999).

Exposure to excessive noise levels can induce hearing loss and negatively impact mental and cardiovascular health. The Environmental Protection Agency and World Health Organization

recommend that individuals' exposure to noise not exceed 75 dBA over an 8 hour daily average to prevent hearing loss (USEPA, 1999). Noise-induced hearing loss is a significant problem in urban settings among industrialized nations (Gerson, Neitzel et al., 2006). Hearing loss has negative effects on interpersonal communication, quality of life, and work as it disrupts speech and sleep, increases stresses, and reduces productivity in the workplace and in school (Frank, Kavage & Litman, 2006). Excessive exposure to noise is often associated with adverse effects on mental health (arousal of cortisol and catecholamine) and the cardiovascular system. Noise can also adversely affect short and long-term memory and sleep patterns, disturbing productivity in the workplace and school.

4. Physical activity

The built environment of most U.S. communities is not conducive to physical activity. Most residential communities built since World War II were designed for automobiles, not pedestrians (Ewing, Schmid et al., 2003; Giles-Corti & Donovan, 2003; Saelens, Sallis & Frank, 2003). In these post-war communities, residential areas tend to be located far from employment, shopping, restaurants, and entertainment. Going out to buy a couple of grocery items or a cup of coffee entails getting in the car and driving a mile or more, not a walk down the street. Longer commutes to work leave less time for leisure activities that might entail some physical activity, such as gardening, taking a walk or taking one's children to the park.

Spending more time in automobiles and more time commuting to work are associated with physical inactivity (French, Story & Jeffery, 2001), less walking and increased likelihood of obesity (Frank, Andresen & Schmid, 2004). According to the U.S. Census, commuting to work

takes California workers an average of 27 minutes one-way (2005 American Community Survey), with one-way commute times exceeding an hour for nearly 8 percent of California workers, and over 15 percent of workers in Contra Costa, Riverside and San Bernardino Counties. In Los Angeles, commuters lose an estimated 100 hours per year due to traffic congestion (Pisarski, 2006, Commuting in America III). Recreational physical activity, leisure time walking, and physical activity incurred in the conduct of routine household activity are just a few of the things people forego as people spend more and more time in their cars.

Among different transportation modes, walking and bicycling provide the most physical activity, however due to such barriers as distance, traffic safety, climate, and inadequate support facilities (e.g., lack of showers and lockers at work), walking or cycling to work is not a viable option for many people (Wener & Evans, 2007). Public transit, however, fills in the gap as it has the added benefit of being associated with greater physical activity compared to automobile use (Nestle & Jacobson, 2000; Wener & Evans, 2007).

In a study of transit users in the U.S., those who rode the bus and train reported a median of 19 minutes of walking per day as part of their commute (Besser & Dannenberg, 2005). This level of walking may have clinical significance given relatively small changes in physical activity can translate into potentially large outcomes in weight trends at the population level (Morabia & Costanza, 2004). Physical activity affects a number of health outcomes: mortality, cardiovascular disease, diabetes mellitus, cancer (colon and breast), obesity, hypertension, bone and joint diseases (osteoporosis and osteoarthritis), and mental health (U.S. Department of Health and Human Services, 1996). Furthermore, physical activities that are incorporated into daily life

or have an inherent meaning, or lifestyle activities, rather than structured exercise regimens, are potentially a better strategy for increasing physical activity (Frank, Engelke & Schmid, 2003). For example, walking a mile or more to and from a transit station can be an easier habit to make rather than going to the gym after work. Lifestyle activities are especially significant for people who dislike vigorous structured activity, do not have access to facilities, or do not have enough time for structured activities (Frank & Engelke, 2001).

Few people in California get enough overall physical activity in their daily lives. In California, close to 26 percent of all adults report no physical activity in a typical week (CHIS, 2005). Across the state, this level varies: in highly dense and urban San Francisco County, about 17 percent of the population is physically inactive, however, in more sprawling Los Angeles County; this value is about 26 percent. Close to 90 percent of adults in San Francisco County and about 79 percent of adults in Los Angeles County report having walked in the last week for transportation, recreation, or exercise.

5. Discretionary Time

Modern American life is highly time-constrained with attendant costs to physical and mental well-being. Large portions of the American public report that they are too busy to get enough sleep, cook a meal at home, sit down to eat with their families, exercise or take a vacation (Robinson & Godbey, 2005), all activities that are associated with good health (Harrison & Horne, 1995; Eisenberg, Olson et al., 2004; Gump & Matthews, 2000; U.S. Department of Health and Human Services, 1996). As more and more time of each day is spent traveling,

especially traveling by car, less time is available for individuals to engage in those things that they enjoy and that can make them healthier.

Increases in commuting distances and traffic congestion have contributed to an 18 percent increase in commuting time from 1980 to 2000 (Evans & Wener, 2006). Non-work travel trips and time—shopping, personal business, recreation, and leisure—have increased even more than work travel (Zhang, 2005). According to data from the 2001 National Household Travel Survey, Californians spent an average of 80 minutes per day traveling, with 85 percent of their travel time spent in privately operated vehicles.[1]

According to a detailed analysis of commuting times and modes of transportation of California workers conducted by the Public Policy Institute of California (Barbour, 2006), total time spent in transit has increased dramatically in the past decades in California. This is largely been due to the increase in the share of total commute going to the suburbs. Because of the decentralized nature of most large cities in California, the commute to the suburbs is longer on average than other commutes. The trips are made largely by single-occupant motor vehicles. In 2004, the average commute time for Californian workers was 27.1 minutes. The increase in the number of commuters with trips over 45 minutes long has largely driven increased commute duration over time. The average commute to work in both San Francisco and Los Angeles Counties in 2004 was about 29 minutes. The longest commute times in the state are in Riverside and San Bernardino Counties, both rapidly growing suburban regions.

[1] Analysis conducted 8/10/07 by the lead author using the NHTS on-line analysis tool at http://nhts.ornl.org.

In general, individuals using public transit typically spend more time traveling to work than those who travel by automobile, however this also varies by distance, region, and the directness of transit connections. Even in New York City, transit commuters spend 15-20 minutes longer traveling to work than automobile commuters, but they also travel much greater distances (Institute of Transportation Studies, 2006).

While in certain situations time spent in public transit may be greater than time spent in the car, time in these two settings is not qualitatively equivalent. Although some individuals may value their time driving, traveling by transit allows riders to read, sleep, or just relax (Litman, 2006). Studies have also shown that automobile commuting is associated with self-reports of stress and physiological indicators of stress (Koslowsky, Kluger & Reich, 1995; Novaco, Kleiner & Broquet, 1991; Schaeffer, Street et al., 1988). In a study of rail and car commuters who lived in New Jersey and worked in New York City, train commuters had significantly lower levels of stress than their counterparts who drove to work (Evans & Wener, 2006).

Given the extent to which the time efficiency of different travel modes is contingent on local circumstances, and that people differ in what they can and are interested in doing while traveling and how they value that time, it would be imprudent to make a blanket statement about the relative benefit of one transportation mode over another to individuals. Clearly, however, having multiple options permits selection of what works best for different people at different times. While the face of transit in California may not be transformed by decisions on the pending State budget, in some locales, loss of these state funds could constrain the already limited choices Californians have for getting around.

6. Social Capital

Social capital is defined as the degree of citizen involvement in a community; the degree to which people know and trust their neighborhoods, and the social interactions that people have (Frank, Kavage & Litman, 2006). Studies indicate that friendly interactions directly improve health. Public transportation encourages community cohesion as well as increases personal security and provides more opportunities to walk and partake in social activities.

Social capital reduces unhealthy activities such as crime, drug use, and alcoholism (Frank, Kavage & Litman, 2006). The presence of mass transit is associated with social capital as well as mental health, since shorter commute times encourage community connectedness. Studies on this topic have shown that short commute times prevent and mitigate poor mental health outcomes through community connectedness (Evans & Wener, 1996; Evans, Wener & Phillips, 2002). Residents with less auto-traveled stress are more likely to know their neighbors and experience greater social capital as commute times and predictability of commutes are inversely related to stress. Traffic and congestion negatively affects social capital. Evans and Wener (2006) found that longer commute times were significantly associated with elevated salivary cortisol levels which measure stress, poor proofreading performance, and high levels of perceived community stress. Another study demonstrated that individuals on direct, non-transfer train rides had significantly lower stress levels compared to those who had to transfer train lines; this association was significantly stronger for working mothers (Wener, Evans & Lutin, 2006; Wener, Evans et al., 2003). In addition, auto commuters had significantly higher stress, more

negative mood, and indicated the trip was significantly more effort and less predictable compared to rail commuters.

The continuing decentralization of population due to affordable housing has exacerbated the isolation of many low-income families who lack reliable auto access (Blumenberg & Waller, 2003). Lack of affordable housing forces many residents to move further away from the city central, increasing commute time and congestion, both of which negatively affect social capital. This differentially impacts low-income families and communities, since working families who earn less than 80 percent of the median area income travel a longer distance to job opportunities (Institute for Transportation Studies, 2006) due to constraints of affordable housing near employment centers.

Cuts in transit funding could contribute to an erosion of social capital since lack of affordable housing near central cities prompts working families relocate to neighborhoods further away from their jobs, which increases commute time as well as congestion in surrounding communities (Lipman, 2006). While housing and regional planning policy need to be addressed in order to rein in upward trends in housing prices, sprawl and outward migration of lower income families, financial support for transit can help provide options to workers who seek to maximize earnings while minimizing travel expenses and travel time.

Operational funds to support bus systems is particularly important to children, the elderly and disabled who are more likely to depend on transit for access to medical and social services, shopping and entertainment. Reducing transit service is likely to decrease their access to

services (Bailey, 2003; CTWO, PUEBLO & TALC, 2002) and increase levels of social isolation experienced by these groups (STPP, TALC & LIF, 2003).

7. Accidents/collisions – Unintentional injury

The predominant mode of travel in the U.S., the automobile, is by nearly every measure far riskier than transit (i.e. bus and train). Increased use of transit has the potential to reduce injury and death from transportation-related accidents. Expanded mass transit service can affect individuals' risk of accidental injury in three ways:

1. By changing the mode of travel, usually from automobile to another mode for which the risk of injury is greater or less than travel by automobile;
2. By changing the potential risk of vehicular collision for other vehicles and pedestrians;
3. By providing transportation alternatives to people with impairments that put them at high risk of injury.

Changing to a safer mode of travel

Expanded mass transit service and utilization can result in a decrease in traffic-related injury by shifting a portion of daily trips from a more dangerous mode (e.g. automobile travel) to a safer mode of travel (e.g. bus or train). According to national transportation and injury statistics, the risk of fatal injury per person-trip by bus in the U.S. is 23 times less than by car (0.4 versus 9.2 fatalities per 100 million person-trips) and the risk of non-fatal injury is five times less for bus trips compared to automobile trips (161 versus 803 per 100 million person-trips) (Beck, Dellinger & O'Neill, 2007). Thus, a shift from automobile travel to travel by transit will probably lead to an overall reduction of injury risk.

Since every transit trip is also a pedestrian trip, some of the potential decrease in injuries resulting from a shift from automobile to transit trips may be eroded by increase in injuries incurred in the walking portion of trips. In order to minimize such risks, it is essential to implement pedestrian and bicycle safety measures along routes utilized by transit riders accessing the transit system.

Change in collision risk for other vehicles and pedestrians

Mass transit infrastructure can also affect injury rates by changing the potential interface between different types of traffic—trains, buses, trucks, cars, bicyclists and pedestrians. Traffic collision risks are particularly high where there is a mismatch between the type, size and speed of vehicles and pedestrians using common roadways. Such risks can be greatly reduced by grade separation that eliminates this interface between different kinds of traffic. When expanded mass transit results creates interfaces for disparate types of traffic, such as at unprotected railroad crossings, then collisions and injuries may be expected to increase. However, if infrastructure is put in place that separates traffic, such as pedestrian overpasses, separate bus lanes and subways, then the likelihood of traffic collisions and injuries are likely to decrease.

Transportation alternatives for impaired travelers

A third way in which expanded transit can affect injury rates is by providing a transportation alternative to drivers whose impairments or frailty put them at increased risk of traffic-related injuries. Although per capita injury rates for the elderly are similar to those of younger persons, per mile driven, both collisions and injury rates are higher for older drivers. For each mile

driven the traffic fatality rate is nine times higher for drivers who are 85 or older than for drivers aged 25 to 69 (Bailey, 2003). Most of this excess injury is explained by increased frailty among older drivers (Li, Braver & Chen, 2003).

Beyond the elements necessary for an effective transit system in general, several supplemental elements are necessary in order to provide a safe and effective transportation alternative for people with impaired mobility and physical frailties:

1. Transport (e.g. on-demand "paratransit" services) between home and transit stations;
2. Physically accessible transit stations and transfer points;
3. System designs that are physically and cognitively easy for users to navigate.
4. Outreach campaigns to inform potential users of services and help novice riders become familiar with the transit system.

8. Household and community economics

Transit proponents have long asserted that improved transit can stimulate economic development (Taylor & Samples, 2002; Vuchic, 1999). Secondarily, improved economic conditions can have downstream health benefits. A substantial body of research has linked the household and community economic conditions with health status (Adler & Newman, 2002). Although the relationship is not linear and is often mediated by other factors, more wealth is generally associated with improved health.

At the level of individual households, a well functioning transit system has the potential to increase income by improving access to jobs and reducing household expenditures on

transportation. Transportation costs comprise a substantial share of Americans' household expenses—on average 20 percent of household expenses. Only housing comprises a larger share of household expenses. Much of this expense is related to the high cost of owning, maintaining and operating automobiles (Bureau of Labor Statistics, Consumer Expenditure Survey Data from Surface Transportation Policy Project, 2003). According to the 2001 American Household Survey, American households spent an average of $7,233 each year to own and operate their cars and trucks, including costs of vehicle purchase, maintenance, fuel, motor oil, and insurance (Surface Transportation Policy Project, 2003). While not having any car saves the greatest amount, this is not a viable alternative for most families. Still, owning fewer vehicles, driving them less and using transit more can still yield considerable savings.

At the level of the community and region, improved transit systems have the potential to produce economic efficiencies, stimulate economic growth and make an area more attractive for other economic investments. Economic growth is driven by the creation of jobs, bringing an influx of public funds that ripple through the economy and stimulating economic activity by lowering transportation costs (Taylor & Samples, 2002).

Using an economic model developed by the Southern California Association of Governments (SCAG), Taylor and Samples (2002) estimated that approximately 639 jobs would be created for each $10 million invested in transit operations. For transit capital investments, job creation would be substantially less, approximately 196 jobs for each $10 million invested, chiefly due to leakage of invested dollars to contractors in other countries. The relative advantage of investment in transit operations as compared to transit capital projects for job creation is

especially pertinent to the cuts proposed by Governor Schwarzenegger since they affect one of the few state funding streams available for funding transit operations, while Proposition 1B bond monies that could supposedly offset these costs are restricted for use on capital projects.

Public funding for transit always involves a redistribution of resources—redistributing revenues from various taxes and other sources to transit operators and their contractors, then to passengers in terms of subsidized service, and finally to other affected groups who might benefit from less congested roads, better economic environments, and cleaner air. Decisions to allocate these funds—to different communities, regions and operators, to bus versus rail, to new construction or existing operations—are shaped by various social and political goals. Just as a change to existing taxes or tax credits will affect household incomes, so will different allocation decisions affect household resources.

9. Land Use

As well-developed transit systems stimulate economic development and investment, they also affect patterns of land use, encouraging commercial development and increasing land use mix when coupled with good land use policies. Transit-Oriented Development (TOD) offers an example of how transportation can affect land use patterns. TODs are developments of residential and commercial areas around a public transit station that are specifically designed to maximize access to transit. TOD aims to create compact, mixed-use, walkable communities within a walking distance of a transit stop. TOD encourages walk to transit and transit use. Studies suggest that TOD can reduce per capita automobile travel (Lund, Cervero & Wilson, 2004; Kuzmyak & Pratt, 2003; Cervero, Murphy et al., 2004). However, these effects are

probably only realized when transit systems reach sufficient coverage and efficiency so as to provide an attractive alternative to automobile travel (Lund, Wilson & Cervero, 2006)

In California, TOD has been identified as a strategy to help mitigate the potential adverse effects of increases in population predicted for the next few decades (California Department of Transportation, 2002). Thus, there have been a number of TOD developments throughout the state. The leaders in TOD within California are San Francisco and San Diego. The Bay Area Rapid Transit (BART) in San Francisco and the Metropolitan Transit Development Board (MTDB) in San Diego have partnered with other city and regional agencies to promote TOD.

Conclusion

Getting people out of their cars and into mass transit has the potential to benefit health in a number of ways—possibly reducing air pollution, increasing physical activity, improving mental health and boosting community social capital. In addition, having a well-functioning mass transit system in place can serve a number of other functions, including providing mobility to people with limited or no access to private vehicles, improving land-use and stimulating economic development. We don't know, however, how the Governor's proposed cuts (or re-allocation) of $1.3 billion over two years will affect transit systems throughout the state. Considerable uncertainty exists as to the exact, on-the-ground manifestations of potential budget cuts. State funds comprise only a small part of the total revenue stream for most major transit agencies, some agencies might not receive any state funds, while for others, state funds may comprise a large and critical share of their revenue sources. Even when state funds make up only a small portion of a transit agency's revenue stream, these funds can be critical to continued

operations. These funds may be critical for making up budget short-falls in the face of escalating costs and cuts in other revenue sources. The state transit funds that are the subject of these proposed cuts are one of the few non-local sources that can be used for transit operations in metropolitan areas over 200,000 people. Capital projects, such as building rail lines, can look to a number of different federal and state programs for funding, especially over the next several years with the availability of Proposition 1B bond revenue. Bus service operations, however, are much more limited in where they can obtain non-local funding. It is bus service, not rail, that serves the preponderance of transit passengers in California, and bus passengers are much more likely to be poor and from disadvantaged ethnic groups.

While the proposed funding cuts will not lead to a wholesale shutdown of transit service in the state, there are vulnerable agencies and populations that these cuts are likely to impact: (1) smaller transit agencies for whom state funds make up a critical portion of revenue and which have limited ability to raise replacement revenue from other sources (e.g. fare increases), and (2) transit-dependent populations served by these transit providers, including the poor, children, seniors and mobility impaired who depend on transit for access to jobs, school, shopping, health care and social services.

II. Focus and Aim of the HIA

2.1. Impetus and goals for the HIA

The aim of this health impact assessment (HIA) (see Box A) is two-fold. First, as part of the California Endowment's Healthy Eating Active Living (HEAC) Initiative (see Box B), it aims to illustrate how policies outside the public health and health care sectors affect the public's health, highlighting in particular those policy alternatives that can help stem the rising tide of childhood obesity and sedentary lifestyle. Second, it aims to synthesize existing information on the links between transportation and health in order to inform policy makers considering a specific policy decision – the California State Legislature's pending approval of Governor Schwarzenegger's proposed 2007/2008 budget that includes a diversion of $1.3 billion that had been targeted for transit operations, maintenance and capital projects throughout the state.

Towards this second aim, we will briefly outline transit funding mechanisms in California. Since funds are distributed to local transit authorities, which vary in how they use state transit funds, their other sources of revenue, and how they might respond to funding cuts, considerable uncertainty exists as to the exact, on-the-ground manifestations of potential budget cuts. That said, $1.3 billion is a significant sum of money, even in a state as large as California. Funding cuts of this magnitude would certainly have some effects on transit service and eventually some downstream effects on health. While we cannot predict the magnitude or distribution of these effects, we can describe the pathways through which transportation in general, and transit availability and utilization in particular, affect the public's health. Beyond the particular policy question at hand, the information synthesized in this HIA can help guide policy assessments of

potential health effects of other policy decisions affecting transit service, including analyses of local transportation proposals where more detailed information is available about specific alternatives for transit operations and projects.

Box A: Health Impact Assessment (HIA) and the UCLA HIA Group

(Excerpted from Cole and Fielding, 2007 (Annual Review of Public Health)

Among the numerous definitions of HIA, a particularly useful one is provided by researchers at the Northern and York Public Health Observatory in Great Britain:

> *"A multidisciplinary process within which a range of evidence about the health effects of a proposal is considered in a structured framework, …based on a broad model of health which proposes that economic, political, social, psychological, and environmental factors determine population health."*
>
> (Northern and York, 2004).

This definition incorporates five generally accepted key characteristics of HIA:

1. Focus on specific policy or project proposals,
2. Comprehensive consideration of potential health impacts,
3. Broad, population-based perspective that incorporates multiple determinants and dimensions of health,
4. Multidisciplinary systems-based analytical approach, and

Process that is highly structured but maintains flexibility.

The general tenet underlying HIA is that by bringing consideration of health issues into decision-making in other sectors whose actions affect population health, HIA can provide a practical means for facilitating intersectoral action for health promotion (World Health Organization, 1999). Its greatest value lies in its ability to identify and communicate potentially significant health impacts that are under-recognized or unexpected, addressing, for example, the potential health effects of policies such as agricultural subsidies, wage laws, education programs, and urban redevelopment projects.

HIA has taken on a wide variety of forms depending on the socio-political environment of the different countries where it is conducted, the characteristics of the particular policy questions to which it is applied, the disciplinary backgrounds of practitioners, and the expectations of stakeholders who use its results.

Since 2001 the UCLA Health Impact Assessment Group (UCLA-HIAG) has been at the forefront of advancing HIA methods and practice in the U.S. With funding from the Robert Wood Johnson Foundation and the California Endowment, UCLA-HIAG has completed HIAs of policies and projects from many sectors including labor policy, education, agriculture, and community planning. UCLA-HIAG staff have conducted trainings on HIA methods for public agencies and non-profits throughout California and nationally. More information about their work and HIA is available on their website at http://www.ph.ucla.edu/hs/health-impact.

2.2. Aims of CA Endowment's Healthy Eating, Active Communities

Box B: The California Endowment's Healthy Eating, Active Communities (HEAC) Initiative

(Excerpted from http://www.calendow.org/heac/reports/HEAC.pdf)

Healthy Eating, Active Communities (HEAC), is The California Endowment's $26.2 million, four-year strategic initiative launched in 2005 to reduce disparities in obesity and diabetes by improving food and physical activity environments for school-age children. The most prominent feature of HEAC is a community demonstration component that provides grants to highly-motivated schools, community organizations, and local public health departments in six communities across the state. The primary goals of the community demonstration component of HEAC are to implement and evaluate strategies to improve environments for healthy eating and physical activity and to create momentum for widespread changes in policy and practice that will ultimately lead to preventing obesity. Efforts in six demonstration communities engage youth, families, community leaders, health professionals, and others, targeting changes in schools, after school programs, neighborhoods, media and advertising, and health care. Bolstering the efforts of grantee collaboratives in demonstration communities is a statewide network of public health experts and organizations working to share promising strategies, increase visibility and advocacy for potential policy measures, and build momentum for changes in practice that will strengthen community-based public health.

III. Policy Background

3.1 Description of Proposed Policy

The Governor's proposed budget for fiscal 2007/2008 contains provisions for reallocating approximately $1.3 billion in gasoline sales tax sales tax revenue (aka "spillover funds") that had been set aside for funding transit programs throughout the state for other purposes (Governor's Budget Office, 2007). Whether or not this amounts to a cutback is a matter of debate, since the governor's budget includes funds from a one-time sale of general obligation bonds approved by voters with passage of Proposition 1B in 2006. Others would argue that the intent of the Proposition was to increase funding for maintaining and improving California's strained transportation infrastructure, not to merely maintain transportation funding at current levels so funds that had been earmarked for transportation purposes could be diverted to other uses.

Since passage of Proposition 13 in 1978, which significantly restricted the ability of the state and local governments to impose new taxes and increase rates for existing taxes, it has been difficult to approve tax increases—both in the legislature and through the voter initiative process. Nonetheless, the legislature and voters have approved a steady series of tax and bond measures to support improved transportation infrastructure (see Box C). Many of these measures have contained provisions for targeting increased funding for building or improving transit infrastructure, such as railroads and busways. Twenty percent of the bond funds authorized by Proposition 1B are earmarked for transit capital projects. Additional Proposition 1B funds in other categories, such as congestion reduction, may also be used for transit projects (see Table 1).

Box C: California Legislation and Voter Initiatives Affecting Transportation Revenue Generation and Allocation

Proposition 1A (2006) aims to limit the ability of the Governor and Legislature from diverting the sales taxes on gasoline to non-transportation purposes.

Proposition 1B (2006) allows the state to sell $20 billion in general obligation bonds to fund transportation projects to relieve congestion, improve air quality, and enhance safety and security of the state's transportation system. Bond funds are one-time, but may be spent over multiple years.

Proposition 42 (2002) requires that the funds from the state's portion of the gasoline sales tax (5 percent tax rate) be used exclusively for transportation purposes instead of being transferred to the state's General Fund. Under fiscal emergencies this requirement may be waived. Due to concern about repeated use of this waiver leading to on-going diversion of these funds for non-transportation purposes, voters approved Proposition 1A in 2006, which significantly limits the diversion of these funds. Beginning in FY 2008/09, 20 percent Proposition 42 funds will be allocated to the PTA (i.e. transit), 40 percent will be allocated to the STIP, and 40 percent will be allocated for improvements to local streets and roads.

Proposition 111 (1990) increased the excise tax on gasoline from $0.09/gallon to $0.18/gallon.

Table 1: Allocation of bond funds authorized by Proposition 1B (2006)
(from California State Legislative Analyst's Office (2007). "California Travels." Available online at http://www.lao.ca.gov/2007/ca_travels/ca_travels_012607.pdf)

Use	millions $	percent
Improvements on highways and local roads to reduce congestion (including projects to increase transit capacity, and grants to locally funded transportation projects)	11,250	56.5 percent
Capital projects to improve transit	4,000	20.1 percent
Reducing emissions and improving goods movement on highways, rail, and in ports	3,200	16.1 percent
Safety and security (including seismic retrofitting, disaster response planning, rail crossing security)	1,475	7.4 percent
Total	19,925	100.0 percent

3.2 Transportation funding mechanisms in California

While the state's transportation systems have benefited from voters' support for increased investment of public funds in transportation, this patchwork of legislation and voter-approved measures has resulted in a highly complex system for raising and distributing funds for transportation. This system is outlined in Figure 1 with an explanation of the different transportation accounts and programs provided in Boxes A and B. Readers interested in understanding these funding mechanisms are also encouraged to refer to the report "California Travels" produced by the state's Legislative Analyst's Office (available at http://www.lao.ca.gov/2007/ca_travels/ca_travels_012607.pdf) and the Transportation Funding Primer provided on the website of Transportation California (http://www.transportationca.com).

State transportation funding

In fiscal 2005/2006 the State of California raised approximately $6.1 billion in transportation funds from on-going sources, (i.e. excluding funds raised by the sale of Proposition 1B bonds). These funds, generated from a variety of sources (mostly various excise and sales taxes on vehicle fuels), were supplemented with an estimated $4.6 billion from the Federal government (from federal fuel taxes) and $9.4 billion in local revenues (mostly from sales and property taxes) for a total of $20.1 billion dollars of revenue for transportation purposes. Depending on their source, state funds are funneled into a variety of accounts and programs, each with limits on how the funds can be used. For instance, a portion of the state's 5 percent sales tax on gasoline goes into the Public Transportation Account (PTA) where it can be used to fund local transit capital

projects and operations, but another portion of the 5 percent of sales tax on gasoline goes into the State Transportation Improvement Program (STIP) that funds both road and railway capital projects. While STIP funds cannot be used to fund transit operations, certain other sales tax-derived in the PTA can be used to fund transit operations. A separate $0.09/gallon sales tax goes only into the PTA and can be used only for transit. Overall, eighty-five percent of the state's transportation revenue goes towards supporting highways and local roads, with about 10 percent going towards support of transit infrastructure and operations (see Table 2).

Table 2: Expenditures of state transportation funds with detail for transit expenditures (fiscal 2005-2006)

	Totals (millions of dollars)		
	Sub-category	Category	Percent of total
Highways		4,500	68.2 percent
Local streets and roads		1,100	16.7 percent
Transit			
Transit capital improvements	377		
State transit assistance	199		
Support for intercity passenger rail	103		
Transit planning/administrative support	7		
subtotal for transit	686 →	686	10.4 percent
Planning, Administration, Other		314	4.8 percent
Total		6,600	100.0 percent

3.3 Explanation of Spillover Account

The "spillover" account, which is the focus of Governor's proposed reallocation, is a peculiar transportation funding source that is separate from other sources of transportation funding. Even though it is derived from gasoline sales tax revenue, it is not part of the $0.09 per gallon or 5 percent sales taxes that go into other funds. The spillover account is the product of legislation

passed in 1971 that extended the state sales tax to gasoline while reducing the overall sales tax rate. The legislation, which was intended to be revenue neutral, included a formula for transferring any "excess" revenue to the Public Transportation Account (from CaliforniaCityFinance.com, 2007). The spillover is calculated annually as the difference between a 4.75 percent sales tax on items subject to the sales tax *including gasoline* and a 5 percent tax rate on taxable items *excluding gasoline*.

Obviously, the amount of the revenue generated by the spillover mechanism is highly variable. For 15 of the 17 years from 1985 through 2002 there was no spillover (LAO, 2007a). Accrual of spillover revenue is generally greatest when sales of other items are relatively low, such as during periods of low or negative economic growth and simultaneously gasoline sales are high (due either to high sales volume or high prices). If gasoline sales are relatively low or are merely keeping pace with the rest of the economy, spillover revenue will be small or nonexistent. Under current economic conditions with a relatively slow economy and high gas prices coupled with strong demand for gasoline, the spillover is relatively large (LAO, 2007a). A spillover of $617 million is forecast for this year (Governor's Budget Office, ebudget.ca.gov)

All spillover revenue goes to the Public Transportation Account (PTA) where it can be dispersed throughout the state to support various transit projects and operations. Under existing law, half of half of this revenue is allocated for state transit projects and planning, and half goes into the State Transit Assistance Program to be distributed to regional transportation planning agencies for operations, planning, and capital acquisition. The STA is one of the few sources of state

transportation funding that can be used to support local transit operations; most other funding sources are limited to use for capital projects (building or maintaining fixed infrastructure).

The Governor's proposed budget would use $1.3 billion of spillover-derived PTA funds to pay for expenditures which would normally paid from the General Fund, including $340 million for debt service on transportation bonds, $627 million on home-to-school transportation (diesel-to-natural gas) and $144 million on regional transportation centers.

3.4 Revenue sources for local transit agencies

An influx of revenue from the sale of Proposition 1B bonds has created a substantial foundation for funding transit infrastructure. The funding situation for transit operations; however, is more problematic. In metropolitan areas with populations greater than 200,000, federal transportation funds can only be used for capital projects. Local transit agencies vary greatly in their dependence on state transportation funds to support transit operations. Other revenue sources include, passenger fares, transportation funds from federal government, and allocations from local government, as well as other state funds, such as state education funds to support transportation of students from home to school, and developmental services funds to support paratransit operations to transport mobility impaired individuals. As shown in Table IV, statewide, passenger fares provide an average of 25 percent of local transit agency operating revenue, (which includes employee wages and benefits, vehicle maintenance and fuel expenses), another 37 percent comes from local sources (e.g. local sales and property taxes), 11 percent from the federal government and 11 percent from state transportation funds. Only 9 percent of transit agencies' revenue for capital projects comes from the state, with 47 percent derived from

local sources and 41 percent from the federal government. The proportion of transit agency revenue from state funds is lower for many of the state's largest transit agencies, however for some smaller agencies it can make up more than 50 percent of operating revenue.

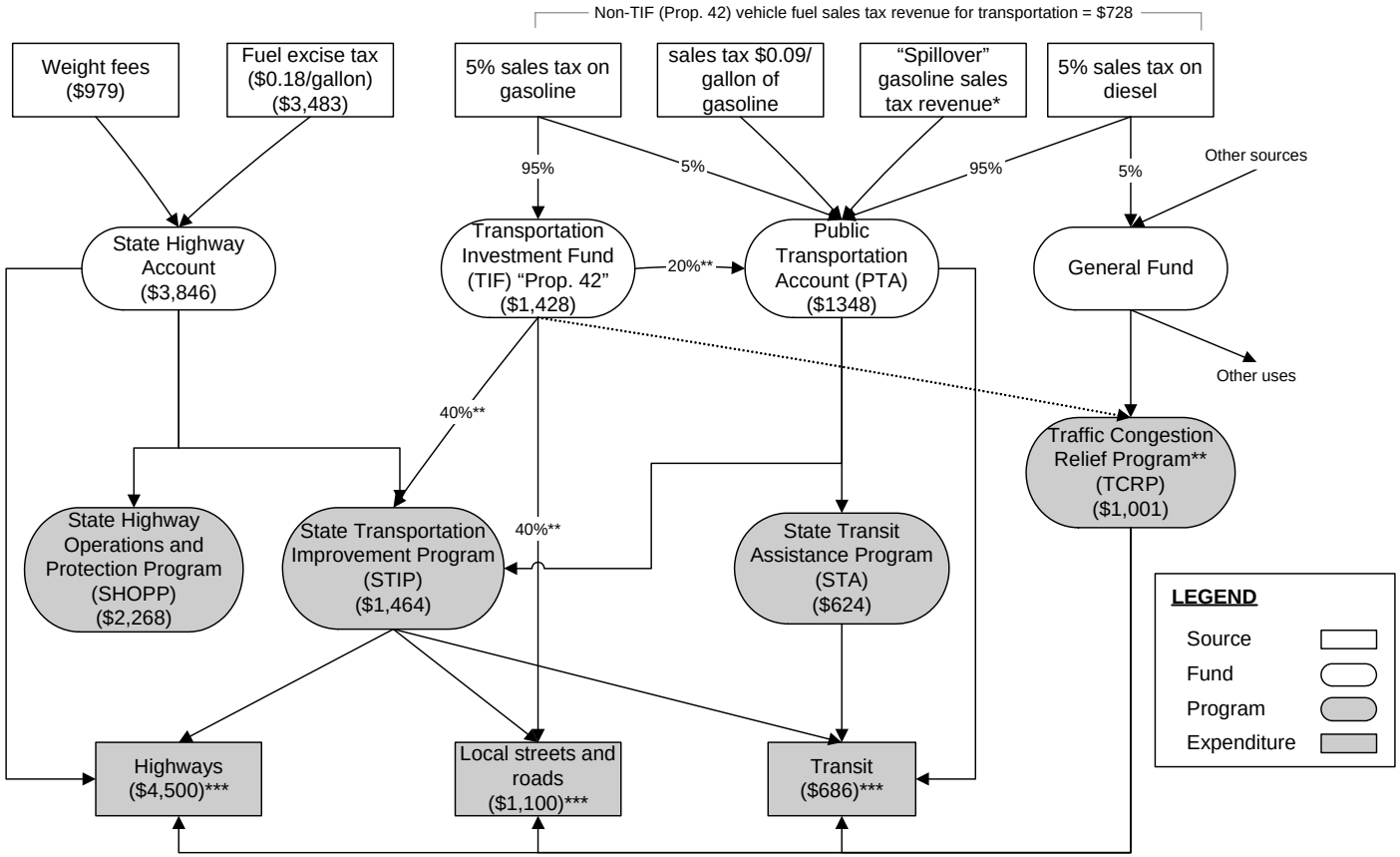
While STA funds comprise only a small percentage of overall operating revenue, it is a key, relatively dependable source of funding (LAO, 2001), becoming all the more important since transit agencies in large urban areas are generally no longer eligible for federal transportation funds to support their operating expenses (Brown, 2005) and in the face of resistance to increases in passenger fares and local taxes.

Recent economic slowdowns and upward trends of gasoline prices have contributed to a growth in spillover funds destined for the STA and eventual dispersal to local transit agencies. While some local transit agencies may count on receiving spillover-derived STA funds to bridge funding shortfalls, the source of revenue is highly uncertain even without the Governor's proposed changes. The Legislative Analyst's Office has referred to the spillover funding mechanism as "anachronistic and arcane," and has suggested a number of measures to stabilize funding for transit under the STA (LAO, 2007a, p. 4). Analysis of the merits of the LAO's proposals is beyond the scope of this HIA, however it is worth noting that the LAO projects an increase in STA funding above the recent historical average due to an influx of sales tax revenue as mandated by Proposition 42, suggesting that the drop in STA funding resulting from the Governor's proposal is only temporary. While this may indeed be the case, recent history suggests that diversion of transit funds for other uses is not a one-time occurrence. Over the last five years $1.36 billion in PTA funds have been diverted to other uses (Odyssey, 2007).

Correspondingly, we believe it is reasonable to assume that on-going state funding of transit (i.e. funding other than revenue from Proposition 1B bond sales) will be static at best, if not subject to further reductions.

Table 3: Public Transportation Account Expenditures: 2006-07 Versus 2007-08 Budget Proposal (in Millions) *from LAO, 2007a*

	2006-07	2007-08	Change
State Transit Assistance	$623.70	$184.60	-$439.10
Department of Transportation			
• Support/intercity rail	133.3	142.5	9.2
• Transit capital improvements	571	69.3	-501.7
High-Speed Rail Authority	14.3	1.2	-13.1
Other agency support	5.4	5.5	0.1
Debt service	—	340.0[a]	340
Home-to-School transportation	—	626.8	626.8
Regional center transportation	—	144	144
Totals	**$1,347.70**	**$1,173.90**	$166.20



Notes:

FY 2006/2007 totals are from the Governor's Budget Office (http://www.ebudget.ca.gov) and the Legislative Analyst's Office (http:/www.lao.ca.gov).

* "Spillover" refers to any net positive revenue from 4.75% sales tax on gasoline in excess of 0.25% sales tax on other goods.
** After 2007/08 Proposition 42 TIF funds will allocated according to percentages shown. Although TCRP will not receive any new TIF funds, it is expected to continue being funded through repayment of loans made to the general fund.
*** Estimated total state expenditures for highways, local streets/roads, and transit are for fiscal year 2004/2005 (from LAO, 2007, "California Travels").

Figure 1: Sources and uses on on-going state transportation revenue in California (millions $, FY 2006/07 figures). Excludes revenue from the sales of Proposition 1B bonds.

Box D: Key State Transportation Funding Accounts
(from Legislative Analyst's Office (2007). "California Travels." Available online at http://www.lao.ca.gov/2007/ca_travels/ca_travels_012607.pdf)

State Highway Account (SHA)

- *Revenues*—state gas (excise) tax and weight fees.

Expenditures—generally used for highway maintenance and operation, highway rehabilitation and reconstruction, and Caltrans administration. Can also be used for capital improvements (highways and certain transit facilities). State gas excise tax revenues cannot be used for transit maintenance, operations, or to purchase trains, buses, or ferries.

Transportation Investment Fund (TIF)

- *Revenues*—state sales tax on gasoline.

Expenditures—provides funds directly for local road improvements, as well as for capital projects (highway and transit) selected by regionals and Caltrans in the State Transportation Improvement Program. Also funds traffic congestion relief projects and transit indirectly through transfers to the TCRF and PTA (see below).

Traffic Congestion Relief Fund (TCRF)

- *Revenues*—state sales tax on gasoline (from TIF) and the state's General Fund.
- *Expenditures*—provides funds for 141 statutorily specified transportation projects.

Enacted in 2000, this fund was to distribute $4.9 billion to designated transportation programs throughout the state over a six-year period. Although the program was set to expire in fiscal 2007/2008, it continues to be funded through repayment of loans made to the General Fund for other programs.

Public Transportation Account (PTA)

- *Revenues*—state sales tax on diesel, and a portion of state sales tax on gasoline including:
  - Sales tax on 9 cents per gallon of gasoline (referred to as Proposition 111 revenue).
  - Net revenue from 4.75 percent sales tax on gasoline in excess of 0.25 percent sales tax on all other goods, over and above the Proposition 111 revenues (referred to as spillover).
  - A portion of state gasoline sales tax revenue from TIF.
- *Expenditures*—provides funds for transit capital improvement, as well as operating assistance for local transit systems. Also funds capital improvement and ongoing support of the state's intercity rail program. Funds are restricted to expenditures for transit and planning only. Traditionally half of PTA funds went to the State Transit Assistance (STA) Program. Unlike many other state and federal transportation funding sources, STA funds can be used to support local transit operations.

Figure 1(cont'd): Sources and uses on on-going state transportation revenue in California (millions $, fiscal 2006/07 figures). Excludes revenue from the sales of Proposition 1B bonds.

Box D: State Transportation Funding Accounts and Programs

Major State Transportation Capital Spending Programs

(from California State Legislative Analyst's Office (2007). "California Travels." Available online at http://www.lao.ca.gov/2007/ca_travels/ca_travels_012607.pdf)

- ***The State Transportation Improvement Program (STIP)*** funds new construction projects that add capacity to the transportation system. These projects include capital improvements to highways, streets and roads, and transit systems. Funding comes from a mix of the state gas tax and sales tax on motor fuels, as well as federal funds. This program is ongoing.

- ***The State Highway Operations and Protection Program (SHOPP)*** funds capital projects to improve existing highways. Projects include pavement rehabilitation (reconstruction), as well as projects to enhance highway safety and operations. Funding comes from state gas tax, truck weight fees, and federal funds. This program is ongoing.

- ***The Traffic Congestion Relief Program (TCRP)*** funds 141 capital projects specified in the traffic Congestion Relief Act of 2000 (AB 2928, Torlakson). The TCRP includes mainly highway and transit projects located in urban areas. Funding comes primarily from gasoline sales tax revenues provided each year through 2007-08. However, TCRP will likely receive revenues into the next decade from repayment of loans it made to the General Fund in past years. Loan of TCRP funds to the state's General Fund has delayed project delivery.

- ***State Transit Assistance Program (STA) distributes funds to local transportation authorities to*** fund transit operations, maintenance and capital projects. Under current law half of the Public Transportation Account Funds should flow to the STA. Estimated current funding for FY 2007/2008 is $596 million, but under the Governor's proposed budget this would be cut to $185 million; however, the proposed budget would add $600 million of Proposition 1B bond funds to the STA.

- ***Proposition 1B Bond Program*** funds projects to relieve congestion, facilitate goods movement, improve air quality, and enhance the safety and security of the transportation system. Specific projects have yet to be selected, but will include projects that add capacity to highways and transit systems, improve major trade infrastructure (including highways with high truck volumes, ports, and freight rail lines), as well as enhance the safety of existing transportation infrastructure. These projects are to be funded by almost $20 billion in general obligation bonds sold by the state.

Table 4: 2005 Expenditures, Revenue Sources and Service Delivery for Selected Transit Agencies* California

Agency*		Expenditures (millions)	Revenue Sources (percent)**				Annual Service***		
			Fares	Local	State	Federal	Mode	Passenger miles (millions)	Unlinked trips (millions)
Metropolitan Transit Authority - Los Angeles County (LACMTA)	Operations	1135	24	54	1	19	Bus:	1407	377
							Hvy rail:	174	36
							Lt rail:	269	38
	Cap. projects	567	--	55	6	39	Total:	1850	451
San Francisco Bay Area Rapid Transit (BART)	Operations	521	45	45	0	0	Bus:	--	--
							Hvy rail:	1256	99
							Lt rail:	--	--
	Cap. projects	115	--	56	13	31	Total:	1256	99
San Francisco MUNI	Operations	476	26	53	14	5	Bus:	301	163
							Hvy rail:	--	--
							Lt rail:	121	47
	Cap. projects	124	--	64	2	34	Total:	430	217
Sacramento Regional Transit	Operations	130	17	61	0	20	Bus:	62	19
							Hvy rail:	--	--
							Lt rail:	61	12
	Cap. projects	63	--	9	8	83	Total:	125	31
Metropolitan Transit System - San Diego (MTS)	Operations	76	28	47	5	19	Bus:	94	24
							Hvy rail:	--	--
							Lt rail:	--	--
	Cap. projects	0	--	--	--	--	Total:	94	24
San Diego Trolley (MTS)	Operations	46	56	40	0	4	Bus:	--	--
							Hvy rail:	--	--
							Lt rail:	188	29
	Cap. projects	0	--	--	--	--	Total:	188	29
Orange County Transportation Authority (OCTA)	Operations	215	22	14	43	9	Bus:	283	67
							Hvy rail:	--	--
							Lt rail:	--	--
	Cap. projects	35	--	0	0	72	Total:	294	69

Agency*		Expenditures (millions)	Revenue Sources (percent)**				Annual Service***		
			Fares	Local	State	Federal	Mode	Passenger miles (millions)	Unlinked trips (millions)
Santa Clara Valley Transit Authority – San Jose (VTA)	Operations	297	12	45	25	12	Bus:	127	31
							Hvy rail:	--	--
	Cap. projects	254	--	87	7	6	Lt rail:	32	7
							Total:	167	38
Alameda/Contra Costa Transit District (AC Transit)	Operations	250	18	61	4	14	Bus:	200	65
							Hvy rail:	--	--
	Cap. projects	33	--	46	37	17	Lt rail:	--	--
							Total:	200	65
Merced County Transit (The Bus)	Operations	5	14	0	56	26	Bus:	2	1
							Hvy rail:	--	--
	Cap. projects	1	--	0	68	32	Lt rail:	--	--
							Total:	3	2
National City Transit (NCT)	Operations	3	45	0	55	0	Bus:	4	2
							Hvy rail:	--	--
	Cap. projects	0	--	--	--	--	Lt rail:	--	--
							Total:	4	2
City of Santa Rosa (Santa Rosa CityBus)	Operations	8	20	0	50	30	Bus:	9	3
							Hvy rail:	--	--
	Cap. projects	3	--	0	35	65	Lt rail:	--	--
							Total:	9	3
State Total	Operations	4591	25	37	11	11	Bus:	3673	968
							Hvy rail:	1429	136
	Cap. projects	1597	--	47	9	41	Lt rail:	671	133
							Total:	4553	1158

Data from the National Transit Database (http://www.ntdprogram.gov/ntdprogram/). Numbers are rounded to the nearest million, except numbers less than 1 million are rounded up to 1 million. Percentages rounded to the nearest whole percent.

* Of the 12 agencies shown, 9 were selected to represent the largest transit agencies and metropolitan areas in California, 3 other agencies (shaded) were selected to represent smaller transit agencies with a high share of revenue from state sources.

** "Other" sources (e.g.) of revenue not shown.

*** Annual miles and trips for demand-response/paratransit not shown, but they are represented in totals.

IV. Mass Transit HIA Pathways

After reviewing state budget documents, claims of transit advocacy groups and the research nascent literature on transportation and health, project staff identified major pathways through which transit and state transit funding in particular might impact health. These pathways, including impacts on a range of social, economic and physical determinants of health, are outlined in a logic framework (see Figure 2). As a result of discussion with working group members and a transportation researcher at UCLA, some linkages were added to the logic framework. While logic frameworks such as this one may over-simplify the complex causal interactions that affect health, they are useful for guiding and organizing HIA analysis and communicating results.

Among the health impacts mediated by changes in the physical environment we examine air, water and noise pollution. The other impact pathways addressed in this report involve changes to behavior and the social and economic environments, including physical activity, individuals' discretionary time, household and community economic conditions, and patterns of land-use. Not all impacts along these pathways necessarily rise to the level of significance; this depends in large part on the response of local agencies to state budget decisions, but in certain locales they could be significant, if not as a result of these funding decisions, then at least cumulatively over time as a result of multiple transit policy decisions.

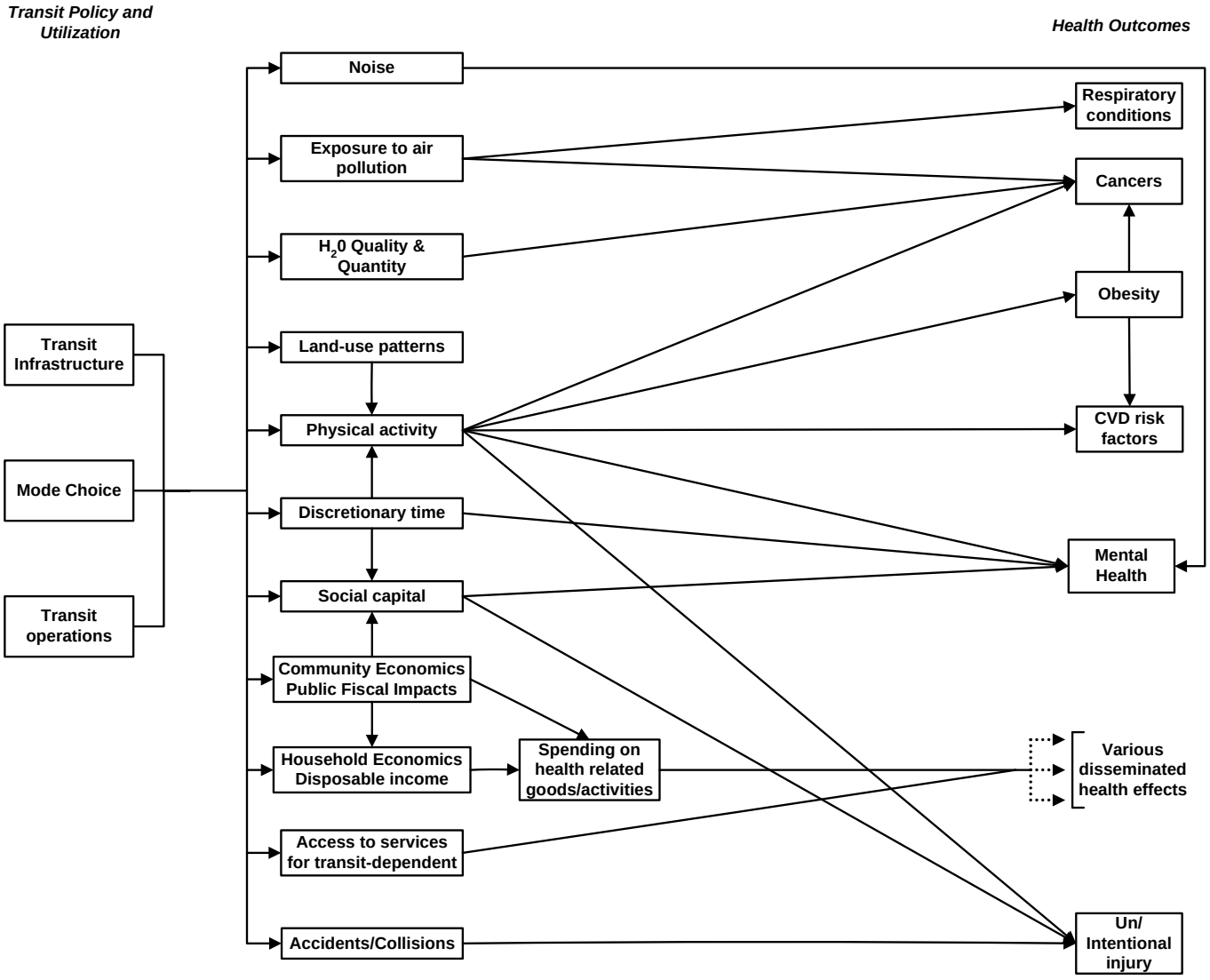


Figure 2: Logic framework for the health impact assessment of state transit funding.

Section 4.1: Air Pollution

The end of the 20th century marked considerable changes in development patterns, demographics, and market changes within the US that ultimately lead to increases in vehicle travel, congestion, and compromised air quality (U.S. EPA, 2001). For instance, over the last three decades, the number of motor vehicles increased at an annual rate of about one and a half times that of the total number of licensed drivers. Additionally, the percentage of households owning three or more vehicles grew from 19 percent in 1995 to 23 percent in 2001 (NHTS, 2001). Likewise, the average distance for commuting to work continues to increase, now placing commuting as the largest contributor to overall vehicle travel, surpassing social and recreational trips that once lead in 1995 (NHTS, 2001). Today people are not only driving further, but they are also traveling more often. As a result of these significant changes, pollutants such as carbon monoxide, ozone, particulate matter, and sulfur dioxide emitted from motor vehicles contribute greatly to poor air quality and have been found to cause significant health impacts as described in Table 5 (U.S. EPA, 2001):

Table 5: Health Impacts of Motor-Vehicle Related Pollutants

Pollutant	Health Impacts
Carbon Monoxide (CO)	Interferes with the absorption of oxygen by hemoglobin in the blood. A lack of oxygen impairs the cardiovascular and nervous system. In addition it also affects fetal growth and tissue development. Results in mortality at extremely high concentrations

Ozone	Short-tem exposure may cause temporary lung and minor eye irritation; coughing, and pain upon inhalation. Long-term exposure to ambient ozone may cause structural lung damage leading to chronic lung disease, lung cancer, and increased susceptibility to respiratory infections. Also exacerbates allergies.
Particulate Matter	Effects on breathing and respiratory symptoms, aggravation of existing respiratory and cardiovascular disease, alterations in the body's defense systems, damage to lung tissue, carcinogenesis.
Sulfar Dioxide (SO_2)	Constricts bronchial passages and alters the lungs' defenses. Those with pre-existing lung and heart conditions are at increased risk of acute illness or premature death
Lead	Causes impairment of children's mental functioning; as well as neurological impairments.

Associated Health Outcomes

The negative health effects attributed to air pollution (Table 5) have long been documented in scientific and medical journals for several years; recent studies now offer supporting evidence associating transportation-related air pollution, specifically ozone and particulate matter from cars to severe asthma exacerbation in both adults and children. The most persuasive evidence demonstrating the correlation between motor vehicle related air pollution and asthma comes from a study performed in Atlanta that monitored the impact of changes in transportation and commuting behaviors during the 1996 Summer Olympic Games on air quality and childhood asthma. Researchers found that efforts taken to reduce downtown traffic congestion during peak travel hours resulted in decreased traffic density, a reduction in ozone pollution, and significantly lower rates of childhood asthma events; namely, an 11.1 percent decline in pediatric hospital emergency room visits (Friedman, Powell et al., 2001).

Studies also show that compromised air quality increases the risk of heart disease and some cancers. Carcinogens like Benzene exist in gasoline and are emitted in the air when gas evaporates or passes through the engine as unburned fuel. According to health and air-quality models, The Environmental Protection Agency (EPA) estimates that mobile sources (such as cars, trucks, and buses) emit air toxics that account for approximately half of all cancers attributed to outdoor sources (US EPA, 1994). Additionally, the estimated individual risk of developing cancer due to a lifetime exposure to hazardous air pollutants from cars and vehicles is about 215 cases per 1,000,000 residents (Ernst, Corless & Greene-Roesel, 2003).

Present Conditions in California: Air quality

Children, the elderly, those living in proximity to high traffic volumes, and minority populations are all disproportionately affected by these and other negative health effects such as stroke, high blood pressure, birth defects, brain damage and premature death. A study measuring the number of toxic air compounds at different locations along the Los Angeles Basin found that residents living along highways with heavy traffic, particularly those in Huntington Park, Pico Rivera, Los Angeles, and Burbank (the core areas surrounding Downtown Los Angeles) were exposed to greater levels of toxic particulates and subsequently were at increased risk for cancer than those living elsewhere along the basin (South Coast AQMD, 2000). Researchers at Johns Hopkins School of Public Health discovered that for every ten micrograms per cubic meter increase in coarse particulate matter, there was a one percent increase in the number of hospital admissions for cardiovascular disease (Ernst, Corless & Greene-Roesel, 2003).

Analyses done on the costs of motor vehicle travel reveal that transportation-related air pollution not only impacts public health, but also bears significant economic costs. Estimations on the public health costs of automobile and vehicle travel have been projected to be between $40 billion and $64 billion per year with premature death accounting for approximately 77 percent of the costs while non-fatal illnesses make up the difference. Approximations published by the Surface Transportation Policy Project propose that transportation-related public health costs from air pollution in six urbanized areas in California total over $3,434,942,001, more specifically; the breakdown per area is as follows (Ernst, Corless & Greene-Roesel, 2003):

- Los Angeles $1,807,866,900
- Riverside-San Bernardino $217,794,588
- Sacramento $185,595,200
- San Diego $417,448,675
- San Francisco $556,357,638
- San Jose $249,879,000

There have been significant strides made to improve air quality since the passing of the Clean Air Act in 1970, however, close to half of all Americans still reside in locations that are noncompliant with federal standards for air pollution. The EPA publishes an annual survey listing the number of days that air quality in various regions exceeds 100, (the standard measure for unhealthy air among vulnerable populations), also known as "Code Orange" levels. According to the 2000 to 2002 data, of the top ten regions with the highest total number of days of poor air quality, five metropolitan areas in California ranked the highest in the country (Ernst,

Corless & Greene-Roesel, 2003). While the State has taken full advantage of federal funding to improve air quality by 27 percent; there are still a significant number of people in various regions living with poor air quality making this a severe threat to public health.

Data and Estimates of Impacts

Mass transit describes modes of transportation services offered to the general public at generally fixed prices along a defined route. The benefits of mass transit include lower emissions of air pollutants, energy conservation, speed and safety (Zimmerman, 2005). In 2002 transportation other than transit accounted for 82 percent of total emissions of carbon monoxide, 56 percent of nitrogen oxides, 42 percent of volatile organic compounds and 12 percent of lead (Zimmerman, 2005). In general, these pollutants are not directly emitted from mass transit operated by electrical power. Substituting car trips with transit trips has been estimated to reduce annual emissions of volatile organic compounds in the U.S. by more than 70,000 tons, nitrogen oxides by 27,000 tons, and carbon monoxide by 745,000 tons. In addition, carbon dioxide reduction is estimated at 7.4 million tons per year (Zimmerman, 2005). This translates to cleaner air and better health outcomes.

While society in general may place a high value on mass transit, data shows that individuals may not. In 2002, according to US Department of Transportation, approximately 9 billion mass transit trips were made daily with ridership concentrated primarily in New York and California (Ernst, Corless & Greene-Roesel, 2003). Therefore, other ways to reduce harmful emissions should be examined. For instance, studies done to determine whether policies shaping the built environment could ultimately reduce vehicle travel found that land-use policies maximizing

opportunities to drive less actually lead to less driving. Increasing development and accessibility to retail and commercial institutions among residential property, and maximizing street connectivity are just a few examples of ways to shape the built environment in a manner that reduces vehicle travel (Handy, Mokhtarian & Buehler, 2004).

Studies have also been performed to determine if transportation pricing has an effect on vehicle travel. An analysis done in four metropolitan areas in California determined that transportation pricing measures (i.e., congestion pricing, parking fees, fuel tax increases, vehicle miles of travel fees, and emission fees) could effectively relieve congestion, lower emissions, reduce energy use, and raise revenues; thereby making transportation pricing a viable strategy in improving air quality (Deakin & Harvey, 1996). Other potential strategies include ride-sharing, the promotion of cleaner vehicles and fuels, developing safer biking and walking infrastructure, and the development of mix-used communities.

Section 4.2: Water Pollution

Just as vehicle travel negatively effects air quality, it has also been shown to indirectly take a toll on water quality due to its association with land use patterns. Sprawl increases driving which in turn increases the number of pollutants affecting water supply through run-off; the process by whichwater from rain, snowmelt or irrigation flowing over land surface and is not absorbed into the ground, instead it flows into streams or other surface waters or land depressions.

In urban areas, parking lots and wide streets account for the majority of water pollution because these large impervious surfaces prevent adequate absorption of rainfall; whereas in the suburban areas, non-point sources account for the majority of pollution as rainfall or snowmelt passes through the ground collecting contaminants such as fertilizer, herbicides and debris and deposits them into lakes, rivers, wetlands and groundwater (Frumkin, 2002).

Associated Health Outcomes

Chemicals added to gasoline such as MTBE have been known to contaminate ground water through leaks from underground storage tanks. In addition, the cancer causing compounds found in exhaust have also been shown to contaminate water, and are found in high concentration in areas with increased traffic volume (Frank, Kavage & Litman, 2006).

Present Conditions in California: Water quality

In 1989 the South San Francisco Bay was listed as an impaired water body by the California Water Resources Control Board. Since that time, 13 cities and Santa Clara County have

acquired permits that require the development and implementation of an identification program locating sources of heavy metal and executing control measures to prevent pollution at its source. The five categories that were identified as sources of heavy metals include: 1) air pollution, 2) automotive, 3) industrial, 4) residential, and 5) water supply. Of the five categories, it was discovered that vehicle exhaust, dry/wet deposition, tire wear, and brake pad wear were the most significant sources of heavy metal (Armstrong, 1994).

Areas of improvement for preserving watershed and improving water quality include: decreasing street width, utilizing mandatory watershed buffers, substituting asphalt for pervious pavers, replacing traditional curb and gutter systems, and constructing buildings with green roofs (South Coast AQMD). In addition, urban water quality could be improved by increasing vegetated surfaces within urban limits (Frank, Kavage & Litman, 2006).

Section 4.3: Noise Pollution

Excessive noise exposure is cited as a serious global health problem affecting millions of people. A major source of urban noise is attributed to mass transit as well as other transportation modes. Noise from motor vehicles includes engine acceleration, tire/road contract, horns, and alarms (Frank, Kavage & Litman, 2006). Therefore, strategies to decrease noise are being considered to improve the quality of life among urban dwellers.

Data and Estimates of Impacts

Mass transit contributes to urban noise, but there are measures that can be taken to reduce noise. Although mass transit contributes to urban noise, there are measures that can be taken to reduce noise. Streetscape features including plants can provide sound barriers. Similarly, buildings designed with noise reduction features such as double-pan windows and improved bus design and maintenance practices can all reduce noise (Frank, Kavage & Litman, 2006). Other traffic calming measures can actually increase noise such as speed bumps. Placentia and Riverside California are among six California cities with a designated quiet zone, meaning train engineers will not use the horns when passing through the city. In Placentia, trains will pass through the city without using the horn. In order to eliminate the need for the horn, eight crosses that have been upgraded with additional gates, new sidewalks, synchronized traffic signals and other measures to blocks cars and pedestrians from entering the right-of-way (Reyes, 2007). This shows that there are measures to mitigate noise from urban transit without cutting mass transit services.

Noise levels are measured using decibel-A weighting (dBA), a method commonly used to quantify environmental sounds involves evaluating all of the frequencies of a sound according to a weighting system which reflects that human hearing is less sensitive at low frequencies and extremely high frequencies than at the mid-range frequencies. The decibel scale is a logarithmic scale in which 0 dBA approximates the threshold of hearing in the mid-frequencies in which the threshold of discomfort is between 85 and 95 dBA and the threshold for pain is between 120 and 140 dBA (National Institute for Occupational Safety and Health, 1996). Typical noise levels at 100 feet are 50, 70, and 90 dBAs for light auto traffic, free traffic, and city traffic respectively (USEPA, 1999). In 1980, the United States Environmental Protection Agency (USEPA, 1999) reported that 37 percent of the U.S. population is exposed to over 55dBA, a level great enough to cause annoyance. The Environmental Protection Agency and World Health Organization recommend that individuals do not exceed 75 dBA over an 8 hour daily average to prevent hearing loss in exposed individuals (USEPA, 1999). A study in New York City found mean dBAs were 93.5, 94.9, and 84.1 for subways platforms, subway cars, and bus stops respectively (Gershon, Neitzel et al., 2006).

Associated Health Outcomes

The associated health outcomes from noise are considerable. Noise-induced hearing loss is a significant problem in urban settings among industrialized nations (Gerson, Neitzel et al., 2006). In addition to auditory damage, increasing attention is being paid to the non-auditory health effects of noise (Evans, Lercher et al., 2001). Hearing loss has negative effects on interpersonal communication, quality of life, and work-life as it disrupts speech and sleep, increases stresses,

and reduces productivity in the workplace and in school (Frank, Kavage & Litman, 2006). Excessive exposure to noise is often associated with adverse effects on mental health (arousal of cortisol and catecholamine) and the cardiovascular system.

Noise adversely affects short and long-term memory and sleep patterns, affecting productivity in the workplace and school. The Centre for Sustainable Transportation (February, 2004) reported that low-level but chronic noise of moderate traffic can stress children and raise their blood pressure, heart rates and levels of stress hormones. In addition, Evans and colleagues (2001) examined the two comparable groups of children living in noise conditions under 50 dBA or above 60 dBA in which the major sources of noise were local roads and rail traffic. Children in the noisier neighborhoods had elevated resting systolic blood pressure and an elevated heart rate reactivity while taking a reading test and had higher self-reported perceived stress scores in comparison to those in less noisy neighborhood. Further, girls displayed diminished motivation in standardized behavioral protocols (Evans, Lercher et al., 2001).

Present Conditions in California: Noise pollution

Los Angeles and San Francisco have the greatest traffic congestion burden index in the nation (Surface Transportation Policy Project, 2001). With this traffic come significant levels of noise pollution. The California population residing urban areas, primarily in the greater Los Angeles and San Francisco Bay areas, comprises almost 36 percent or 12.8 million of the population in California. Noise exposure from transportation would most significantly affect these 12.8 million urban residents. While reductions in mass transit funding might encourage some to walk, those most likely to rely on public transportation are working families (Institute for

Transportation Studies, 2006) who are forced to live further away due to housing affordability issues and other low-income and vulnerable populations that live in transit-dependent areas (Environmental and Energy Study Institute, 2006). Thus, cutbacks in mass transit can have probable adverse health and mental health effects due to additional noise, particularly in urban areas which are estimated to already be at 90 dBA of a noise, a level deemed as "discomfort" by the U.S. Occupational Safety and Health Administration. Cutbacks in mass transit can encourage more people to drive, creating additional congestion or can extend the length of rush hour and commute time, all of which will adversely affect noise pollution.

Section 4.4: Physical Activity

The built environment – namely, suburban sprawl and automobile reliance – has received a great deal of recent attention as an important contributor to sedentary behavior. Interest in this area has primarily stemmed from a need for population-level interventions to combat obesity that can be implemented through policies (Transportation Research Board, 2005). Broadly defined, the built environment includes land use patterns, the transportation system, and design features that together provide opportunities for travel and physical activity (Transportation Research Board, 2005). Land use patterns refer to the distribution, including location and density, of activities across space; these activities are grouped into relatively broad categories, such as residential, commercial, and industrial (Handy, Boarnet et al., 2002). The transportation system is made up of the physical infrastructure, for example roads, sidewalks, bike paths, as well as the level of service provided, often ascertained by traffic levels and public transit, such as bus or train frequencies (Handy, Boarnet et al., 2002). Lastly, urban design refers to the design of space, be it a city or other entity, and the physical elements within it, including their arrangement and appearance; design is mainly concerned with the function and appeal of spaces (Handy, Boarnet et al., 2002).

In general, the built environment of most U.S. communities today are not conducive to physical activity; in fact, residential communities built since World War II were designed specifically for the automobile rather than the pedestrian (Ewing, Schmid et al., 2003; Giles-Corti & Donovan, 2003; Saelens, Sallis, Frank et al., 2003). Residential communities are often located far from commercial centers where most people work, resulting in longer commutes to work that leave

individuals spending a large proportion of their days in automobiles rather than on-foot. Thus, the built environment is implicated in contributing to the overall reduction in physical activity seen among U.S. adults since a car is required for almost all trips (Frumkin, Frank, & Jackson, 2004; Muller, 1995). In fact, environmental design has been shown to be significantly associated with the number of people actually walking to work (Craig, Brownson et al., 2002).

In a recent nation-wide study, Ewing et al (2003) compared 448 U.S. counties on the basis of a sprawl index to the health characteristics of more than 200,000 individuals living in these counties (Ewing, Schmid et al., 2003). The "sprawl index" was developed using principal component analysis of data from the U.S. Census Bureau and other federal sources on: residential density, land use mix, strength of centers of activity and downtowns, and street network connectivity. Low housing density, low land-use mix, no strong centers of activity, and poor connectivity characterized high degree of sprawl. Counties with a higher degree of sprawl received lower values on the index, with county sprawl index scores ranging from 63 for the most sprawling county (Geauga County, Ohio) to 352 for the least sprawling county (New York County, New York). Controlling for age, gender, race and ethnicity, the study found that people living in sprawling counties walked less, had higher BMIs, and higher obesity and hypertension prevalence than people living in more dense urban neighborhoods. It was estimated that residents of a county one standard deviation above the mean county index would be expected to walk for leisure 14 minutes more each month compared to residents of a county one standard deviation below the mean. In other words, residents of New York County, the least sprawling county, would be expected to walk for leisure 79 minutes more each month than residents of Geauga County, the highest sprawling county. Sprawling communities typically have poor

public transit infrastructure since the large distances between residential and commercial centers are more conducive for automobile travel.

The total amount of vehicle miles driven per year and driving to work is associated with physical inactivity (French, Story & Jeffery, 2001). Increased time spent in a car and decreased walking are also thus associated with obesity (Frank, Andresen & Schmid, 2004). According to the U.S. Census, commuting to work takes California workers an average of 27 minutes one-way (U.S. Census, 2005), with one-way commute times exceeding an hour for nearly 8 percent of California workers, and over 15 percent of workers in Contra Costa, Riverside and San Bernardino Counties. In Los Angeles, commuters lose an estimated 100 hours per year due to traffic congestion (Pisarski, 2006, Commuting in America III). Recreational physical activity, leisure time walking, and physical activity incurred in the conduct of routine household activity are just a few of the things people forego as people spend more and more time in their cars.

However, due to barriers related to "distance, traffic safety, climate, or inadequate support facilities (e.g., lack of showers and lockers at work)" walking or cycling to work may not be a viable option for many people (Wener & Evans, 2007). Public transit, however, fills in the gap as it has the added benefit of being associated with greater physical activity compared to automobile use. Studies suggest that mass transit may be the solution to increase walking and thus physical activity of populations (Nestle & Jacobson, 2000; Wener & Evans, 2007).

In a study of transit users in the U.S., those who rode the bus and train reported a median of 19 minutes of walking per day as part of their commute (Besser & Dannenberg, 2005). This level

of walking may have clinical significance given relatively small changes in physical activity can translate into potentially large outcomes in weight trends at the population level (Morabia & Costanza, 2004).

Associated Health Outcomes

Reviews of physical activity interventions suggest that people may be more willing and able to adopt moderate physical activities, once such activities are set in motion they are more inclined to maintain them over time, as compared with other types of vigorous physical activity (Frank & Engelke, 2001). Research has shown that there can be considerable resistance among non-exercisers, especially among middle-aged and older persons, to commencing high-intensity and program-centered activities (Laitakari, Vuori & Oja, 1996); in contrast, there is less resistance to adopting moderate physical activity regimens, such as active-transport or walking to destinations. Physical activities that are incorporated into daily life or have an inherent meaning, or lifestyle activities, rather than structured exercise regimens, are potentially a better strategy for increasing physical activity (Frank, Engelke & Schmid, 2003). For example, walking a mile or more to and from a transit station can be an easier habit to make rather than going to the gym after work. Lifestyle activities are especially significant for people who dislike vigorous structured activity, do not have access to facilities, or do not have enough time for structured activities (Frank & Engelke, 2001).

Commissioned as a response to the rising levels of obesity in the U.S., in 1996 the U.S. Department of Health and Human Services Surgeon General's report on physical activity and obesity was the first to bring to the forefront the health consequences of physical activity (U.S.

Department of Health and Human Services, 1996). Based on this and a number of other comprehensive reviews of the literature, it is clear that physical activity affects a number of health outcomes: mortality, cardiovascular disease, diabetes mellitus, cancer (colon and breast), obesity, hypertension, bone and joint diseases (osteoporosis and osteoarthritis), and mental health (U.S. Department of Health and Human Services, 1996; Warburton, Nicol & Bredin, 2006; Blair & Brodney, 1999; American College of Sports Medicine,1998; McAuley,1994; Taylor, Brown et al., 2004; Blair, Cheng & Holder et al., 2001; Warburton, Gledhill & Quinney, 2001a; Warburton, Gledhill & Quinney, 2001b).

Present conditions in California: Physical activity

Few people get enough overall physical activity in their daily lives. In California, close to 26 percent - of all adults report no physical activity in a typical week (CHIS, 2005). Across the state, this level varies: in highly dense and urban San Francisco County, about 17 percent of the population is physically inactive, however, in more sprawling Los Angeles County; this value is about 26 percent. Close to 90 percent of adults in San Francisco County and about 79 percent of adults in Los Angeles County report having walked in the last week for transportation, recreation, or exercise.

Walking for transportation is the act of walking purposefully to a certain destination and this may include walking to a transit spot such as a bus stop or a train station. In a recent study of commuting and physical activity in New York City, train commuters were found to have walked an average of 30 percent more steps per day and for a period of 10 minutes longer than car commuters (Wener & Evans, 2007).

The National Household Travel Survey (NHTS), U.S. Department of Transportation telephone-based survey that collects travel-related information about the noninstitutionalized U.S. population, can be used to determine physical activity levels obtained by walking to and from public transit. From the most recent NHTS data available from 2001, approximately 3 percent of adults walked to and from transit on a given day (Besser & Dannenberg, 2005). This translated into a mean of 24 minutes of walking and a median of 19 minutes of walking. The purpose of each trip was also reported; the two most commonly reported uses were for commuting to work (39 percent) and for shopping (14 percent).

Due to small sample size, the NHTS data cannot be used for travel statistics specific to California. In a small study comparing two different San Francisco Bay area communities, Rockridge, with compact, mixed-use and transit oriented development and Lafayatte, with mostly residential and automobile oriented development (Cervero & Radisch, 1996). Rockridge residents were more likely than those in Lafayatte to make walking or bicycling trips to and from transit and more likely to walk or bike to a non-work destination. The number of minutes accumulated per day for this travel, however, was not calculated in the study.

Data and Estimates of Impacts

Studies have assessed the impact of active commuting on health outcomes. In one small study of workers, active commuting to work for one hour a day for a period of 10 weeks significantly improved measures of fitness and cholesterol (Vuori, Oja & Paronen, 1994). In a similar study

conducted in China, active commuting to work reduced cardiovascular risk factors (Hu, Pekkarinen et al., 2002).

It is increasingly being recognized that even relatively small changes in physical activity can translate into potentially large changes in weight trends at the population level (Morabia & Costanza, 2004). It is estimated that 60 minutes of slow walking and 30 minutes of moderate or brisk walking expends 100 calories for average adults (Morabia & Costanza, 2004). The general consensus is that a total of 30 minutes of moderate to vigorous physical activity, which can be achieved via brisk walking or cycling, on most days of the week, reduces the risk of cardiovascular diseases, diabetes and hypertension, and helps to control blood lipids and body weight (Pate, Pratt et al., 1995). These benefits are conferred even if the activities are done in short ten- to fifteen-minute episodes. Thus, physical activity recommendations for adults call for at least 30 minutes of moderate to vigorous activity per day for health benefits. While the benefits of physical activity increase with the intensity and frequency of physical activity, the greatest come when people who have been sedentary engage in some form of physical activity. Moderate physical activity is a realistic target to achieve for most individuals. Active commuting, walking or cycling to destinations is an example of moderate to vigorous physical activity that can be easily integrated into daily living. Environmental design has been shown to be significantly associated with the number of people actually walking to destinations (Craig, Brownson et al., 2002). Improving the use of public transit rather than automobiles may significantly improve overall levels of physical activity, and thus health outcomes, in communities as a whole (Wener & Evans, 2007).

Section 4.5: Discretionary Time

Fundamental to both work and non-work purposes, transportation has seen marked increases in the past few decades in the time needed to get from one place to another. Increases in the average duration of the commute to and from work, which increased 18 percent between 1980 and 2000, have been attributed to greater commuting distances and traffic congestion (Evans & Wener, 2006). Similarly, there has been an increase in the share and time spent in travel for non-work purposes, such as shopping, personal business, recreation, and leisure (Zhang, 2005). In total, individuals spend an average of over 10 hours per week in transportation (Sturm, 2004).

Time spent in transit is largely dependent on travel mode. In general, commuting by public transit typically takes longer than the automobile, however this also depends on region. For example, in New York City traveling to work using public transit results in a 15–20 minute longer commute (Institute for Transportation Studies, 2006). However, in the Greater Los Angeles area, working families who use public transit have a shorter commute by five minute compared to those who use cars for work travel (Institute for Transportation Studies, 2006).

Present conditions in California: Discretionary time

According to a detailed analysis of commuting times and modes of transportation of California workers conducted by the Public Policy Institute of California (Barbour, 2006), total time spend in transit has increased dramatically in the past decades in California. This is largely been due to the increase in the share of total commute going to the suburbs. Because of the decentralized nature of most large cities in California, the commute to the suburbs is longer on average than

other commutes. The trips are made largely by single-occupant motor vehicles. In 2004, the average commute time for Californian workers was 27.1 minutes. The increase in the number of commuters with trips over 45 minutes long has largely driven increased commute duration over time. The average commute time in both San Francisco and Los Angeles Counties in 2004 was about 29 minutes long. The longest commute times in the state are in Riverside and San Bernardino Counties, both rapidly growing surburban regions.

Associated Health Outcomes

Modern American life is highly time-constrained with attendant costs to physical and mental well-being. Large portions of the American public report that they are too busy to get enough sleep, cook a meal at home, sit down to eat with their families, exercise or take a vacation (Robinson & Godbey, 2005), all activities that are associated with good health (Harrison & Horne, 1995; Eisenberg, Olson et al., 2004; Gump & Matthews, 2000; U.S. Department of Health and Human Services, 1996). As more and more time of each day is spent traveling, especially traveling by car, less time is available for individuals to engage in those things that they enjoy and that can make them healthier.

An economic and time-budget model, the SLOTH model, categorizes the day into five domains: Sleep, Leisure, Occupation, Transportation, and Home (Pratt, Macera et al, 2004). Apart from the sleep domain, each of these domains includes the opportunity to be physically active. Pratt et al (2004) argue that the choice of whether or not to be physically active in each of these time periods is affected by economics and in particular transportation choices and further that public investment in transportation infrastructure also affects choices. By and large, choices are

determined by individual, social, and environmental factors as well as economic forces. Furthermore, increased time in one domain puts a strain on the time available to spend in other domains. Because the automobile infrastructure has been developed a great deal since World War II, many people who can afford to have cars, have opted to drive to destinations; as such, there has been marked increases in the time spent in the car, which largely comes at the expense of time spent on household chores or physical activity in the home (Sturm, 2004). Thus, transportation choices affect not only the time spent in travel, but also have repercussions on the time available for other activities.

While in certain situations time spent in public transit may be greater than time spent in the car, it is important to consider that these two are not necessarily equivalent. In particular, the time spent in the automobile in congestion and other high stress situations has been shown to be very different from the time spent during a ride that permits activities such as reading, sleeping, or working (Litman, 2006). This time can be spent on activities that would not be allowed if driving a car and should be placed in the context of the entire day.

Studies have also shown that automobile commuting is associated with self-reports of stress and physiological indicators of stress ((Koslowsky, Kluger & Reich, 1995; Novaco, Kleiner & Broquet, 1991; Schaeffer, Street et al., 1988). In a study of rail and car commuters who lived in New Jersey and worked in New York City, rail commuters had significantly lower levels of stress than their counterparts who drove to work (Evans & Wener, 2006). Specifically, compared with the rail passengers the drivers reported higher levels of stress, more negative mood, the sense that the trip required more effort, and the feeling that the trip was much less

predictable than the train trip. However, there were no differences in the perceived levels of control and sense of well-being between the two types of commuters.

Section 4.6: Social Capital and related issues of mental health, housing and mobility

Social capital represents the social connectedness found in a community. Among the key elements of social capital are community members' involvement in community affairs, knowledge and trust of neighbors, and the extent of community members' interactions with each other (Frank, Kavage & Litman, 2006). In addition to reducing unhealthy activities such as crime, drug use, and alcoholism (Frank, Kavage & Litman, 2006; Sampson, Raudenbusch & Earls, 1997), social capital is also associated with higher levels of physical and mental well-being (Berkman, Glass et al., 2000; Kawachi & Berkman, 2001; Kawachi, Kennedy & Glass, 1999; Yen & Kaplan, 1999). Public transportation can help build social capital by encouraging community cohesion and providing opportunities to walk and participate in social activities. Since the relationship between transportation and social capital is intertwined with access to affordable housing, land-use and mobility for transit-dependent populations, these issues will also be addressed in this section.

Associated Health Outcomes

Social capital, experienced as living in a connected and supportive community, can affect health through a number of different pathways, especially by providing social support and promoting healthier behaviors (Berkman, Glass et al., 2000). Especially relevant to transportation issues is the role of social support in helping prevent and mitigate the impact of mental health disorders (Kawachi and Berkman, 2001).

Mental health is measurably impacted by how workers commute between home and work, along with the ease and duration of that commute. Longer, less predictable commutes are both associated with increased stress. Spending time in congested traffic, isolated in the metal and plastic cocoon of an automobile is probably the antithesis of experiencing a healthy psychosocial environment with high levels of social capital. Long commutes reduce opportunities for social interaction and recreational activity that could relieve stress. Studies have shown that short commute times prevent and mitigate poor mental health outcomes by allowing participation in a connected community (Evans & Wener, 1996; Evans, Wener & Phillips, 2002). Secondly, the commute itself can create stress. Evans and Wener (2006) found that longer commute times were significantly associated with elevated salivary cortisol levels which measure stress, poor proofreading performance, and high levels of perceived community stress. Another study demonstrated that individuals on direct, non-transfer train rides had significantly lower stress levels compared to those who had to transfer train lines; an affect that was particularly strong for working mothers (Wener, Evans & Lutin, 2006; Wener, Evans et al., 2003). These studies have also shown that auto commuters had significantly higher stress, more negative mood, and indicated their trips required more effort and were less predictable compared to rail commuters.

Affordable Housing

Poorly functioning transportation systems that result in increased commute times are likely to particularly impact low-income populations. These populations are more likely to be transit dependent and are less able to afford housing close to work. Since they often cannot afford to

live near where they work, low-income earners spend more time commuting (Institute for Transportation Studies, 2006). Working families who earn less than 80 percent of the median area income travel a longer distance to job opportunities than families with higher incomes (Institute for Transportation Studies, 2006) due to constraints of affordable housing near employment centers. The continuing decentralization of population due to affordable housing has exacerbated the isolation of many low-income families who lack reliable auto access (Blumenberg & Waller, 2003).

By forcing workers to spend more time in their cars and less time in their communities, a lack of affordable housing can erode social capital. In California, the average commute time to work each way exceeds 27 minutes and it is estimated that almost 6.6 million residents spend over 45 minutes commuting to work each way (Barbour, 2006). As housing becomes less affordable, lower income workers are forced into longer commutes. In Los Angeles, for example, among workers with above-average transportation costs as a percentage of their income, 16 percent fewer worked in the communities where they lived in 2000 compared to 1990 (Haas, Makarewicz et al., 2006).

Patterns of land use

Patterns of land use can exacerbate the separation of affordable housing and places of employment with consequent increases in commuting times and erosion of social capital and well being. A number of studies have shown that single-use, low-density patterns of land use with disconnected street networks have higher levels of automobile dependence (Frank, Sallis et al., 2006), since the distances between where people work, live and play are too far to walk.

Handy and colleagues (2004) propose that multi-use land development can be successful in decreasing commute time. Correspondingly, researchers have found significantly greater sense of community in residential neighborhoods with mixed-use patterns of development compared to single-use residential neighborhoods (Frank, Sallis et al., 2006; World Health Organization Regional Office for Europe, 2006). While a well functioning transit system probably cannot fully compensate for poor land-use planning, it can facilitate opportunities for social interaction that can further build the social capital well planned communities.

Mobility and Access to Services

Cutbacks in transit options can reduce access to health and other services and further increase disparities for many who rely on public transportation, particularly among low-income individuals, elderly, and children who cannot drive or cannot afford an automobile.

Paradoxically, the same heavy reliance on automobiles in the U.S. that enables such high levels of mobility for many, restricts mobility for some population groups. With few alternatives to driving, those who don't own a car or have only one car in a household, along those who are unable to drive or restricted in their driving capabilities, have severely restricted mobility (Environmental and Energy Study Institute, 2006). Transit plays a crucial role in connecting these individuals with essential services, integrating them into the social life of their communities and providing a sense of independence.

Approximately 21 percent of Americans age 65 or older do not drive and more than 50 percent of non-drivers stay at home partially because they lack transportation options decreasing their

ability to participant in the community. They make 15 percent fewer trips to doctor, 59 percent fewer shopping trips and visits to restaurants, and 65 percent fewer trips for social, family and religious activities (Bailey, 2004). The low-density layout often has few amenities for both elderly and children, lacking sidewalks, crosswalks and bike lanes. For Californian children this has been intensified by cutbacks in school bus service, explaining why California has the lowest school bus ridership rate in the nation (STPP, TALC & LIF, 2003). When school bus service is unallowable, parents are left with no alternative but to drive their children to school, reducing social capital as parents and children both spend more time in the care and less time pursuing more rewarding activities (STPP, TALC & LIF, 2003).

The Roadblocks to Health Report (2002) demonstrated that that the Bay Area in Northern California faces significant transportation barriers to health activities. For example, in Alameda County only 28 percent of residents from disadvantaged areas have access to a hospital, leaving 72 percent without transit access. Similarly, in Contra Costa County individuals living in lower-income areas have low transit access to many services: only 20 percent having transit access to a hospital, 33 percent have transit access to a community clinic, and 39 percent have walking access to a supermarket.

Growth in populations with challenges to mobility

The transit dependent population in California is likely to grow in absolute numbers and as a proportion of the total population. Adults over 65 and children comprise 10 percent and 19 percent of California's population. The population over 65 is predicted to increase by 112

percent during the period from 1990 to 2020, and by 2030 one in every five Californians will be 65 or older (California Department of Aging, 2007).

Previous research suggests that travel behavior among immigrants for their first five to ten years in the U.S. is different than U.S.-born residents (Tal & Handy, 2005), with a much heavier reliance on public transportation. The California Department of Finance estimates the total population is expected to almost double, growing by over 20 million from 1990 to 2040, mainly a result of immigration. Low-income individuals who earn income below the federal poverty line, comprise 15 percent of California's urban population or almost 2 million people. Poor and non-White households are less likely to own a vehicle and more likely to be transit-dependent. The likelihood of a household in California not owning a vehicle is 1.6 times higher among Latino households and 2.6 times higher among Black households, compared to White households.[2] Consequently, African Americans and Latinos are twice as likely as Whites to take transit to get to work. Workers with household incomes in the lowest quartile are 1.6 times more likely to use transit to get to work, compared to workers with household incomes in the top two quartiles (Barbour, 2006).

Of course, improved transit systems by themselves cannot remedy problems created by poor land use, housing and economic policies, but they clearly need to be part of a comprehensive reform. Transit can provide the connections that facilitate opportunities for social interaction for all segments of society. That said, expanded transit services are unlikely to significantly improve

[2] Analysis conducted by the lead author on 8/14/07 using American Factfinder on-line custom tables feature and data from the 2005 American Community Survey at (http://factfinder.census.gov).

social capital in rural areas with low population densities. In such areas transit may provide a crucial service to those who do not own an automobile or cannot drive, but the effect is unlikely to be of sufficient magnitude to affect the level of social capital in the entire community.

Section 4.7: Accidents/ Collisions: Unintentional injury

The predominant mode of travel in the U.S., the automobile, is by nearly every measure far riskier than transit (i.e. bus and train). Increased use of transit has the potential to reduce injury and death from transportation-related accidents. Expanded mass transit service can affect individuals' risk of accidental injury in three ways:

1. By changing the mode of travel, usually from automobile to another mode for which the risk of injury is greater or less than travel by automobile;
2. By changing the potential risk of vehicular collision for other vehicles and pedestrians;
3. By providing transportation alternatives to people with impairments that put them at high risk of injury.

Simply providing more transit service; however, may not reduce transportation injuries. In fact, injury rates may sometimes be increased as a result of transit expansions. Whether potential reductions in injury rates are realized will depend on implementation of various mitigation measures and other adjuncts to support safe travel for transit users and others.

Changing to a safer mode of travel

Expanded mass transit service and utilization can result in a decrease in traffic-related injury by shifting a portion of daily trips from a more dangerous mode (e.g. automobile travel) to a safer mode of travel (e.g. bus or train). Understanding the relative safety of different modes of travel is complicated; however, by the fact that trip distance and duration, both of which affect risk exposure, also vary greatly by mode of travel. For instance, because of its longer duration, a half-mile walking trip that takes 20 minutes will have more potential exposure to injury than the

same half-mile trip in an automobile that takes only two minutes. Simply comparing injury rates per unit of population is an especially biased measure since so many people in the U.S. spend so much more of their time traveling by automobile than by any other mode of travel.

Probably the least biased measure for comparing injury rates across different modes of travel is injuries per person-trip (Beck, Dellinger & O'Neill, 2007). By this measure, mass transit provides one of the safest modes of travel. According to national transportation and injury statistics, the risk of fatal injury per person-trip by bus in the U.S. is 23 times less than by car (0.4 versus 9.2 fatalities per 100 million person-trips) and the risk of non-fatal injury is five times less for bus trips compared to automobile trips (161 versus 803 per 100 million person-trips) (Beck, Dellinger & O'Neill, 2007). Thus, a shift from automobile travel to travel by transit will probably lead to an overall reduction of injury risk. Unfortunately, risk of fatal injury for pedestrians is about 50 percent higher per person trip than for persons traveling by automobile (13.7 versus 9.2 fatalities per 100 million person-trips) and about two times higher for bicycle trips (18.5 versus 9.2 fatalities per 100 million person-trips) (Beck, Dellinger & O'Neill, 2007). Since every transit trip is also a pedestrian trip, some of the potential decrease in injuries resulting from a shift from automobile to transit trips may be eroded by increase in injuries incurred in the walking portion of trips. In order to minimize such risks, it is essential to implement pedestrian and bicycle safety measures along routes utilized by transit riders accessing the transit system.

Change in collision risk for other vehicles and pedestrians

Mass transit infrastructure can also affect injury rates by changing the potential interface between different types of traffic—trains, buses, trucks, cars, bicyclists and pedestrians. Traffic collision risks are particularly high where there is a mismatch between the type, size and speed of vehicles and pedestrians using common roadways. Pedestrian traffic accidents are exceedingly rare when pedestrian and vehicular traffic are completely separated. Train accidents are far more likely to occur where there is potential interface with other vehicles and pedestrians, such as at railroad crossings. Such risks can be greatly reduced by grade separation that eliminates this interface between different kinds of traffic.

In the event of a collision, risk of injury is also greater when there is a mismatch in vehicle size. William Haddon's (Haddon, 1970) conceptualization of traffic collisions and subsequent injury in terms of energy transfer has provided great insight into traffic injury prevention. Larger vehicles in motion have more momentum than smaller vehicles traveling the same speed. When a collision occurs, the kinetic energy of the colliding objects is transferred from one to another. If one of the colliding objects is smaller than the other, the instantaneous acceleration (i.e. impact) of the smaller object will be greater than for the larger object. In a collision between a large vehicle and a small vehicle, what may be experienced as a small bump for occupants in the large vehicle may be experienced as a catastrophic impact for occupants in the smaller vehicle.

When expanded mass transit results creates interfaces for disparate types of traffic, such as at unprotected railroad crossings, then collisions and injuries may be expected to increase. However, if infrastructure is put in place that separates traffic, such as pedestrian overpasses,

separate bus lanes and subways, then the likelihood of traffic collisions and injuries are likely to decrease.

Transportation alternatives for impaired travelers

A third way in which expanded transit can affect injury rates is by providing a transportation alternative to drivers whose impairments or frailty put them at increased risk of traffic-related injuries. Although per capita injury rates for the elderly are similar to those of younger persons, per mile driven, both collisions and injury rates are higher for older drivers. For each mile driven the traffic fatality rate is nine times higher for drivers who are 85 or older than for drivers aged 25 to 69 (Bailey, 2003). Most of this excess injury is explained by increased frailty among older drivers (Li, Braver & Chen, 2003).

Beyond the elements necessary for an effective transit system in general, several supplemental elements are necessary in order to provide a safe and effective transportation alternative for people with impaired mobility and physical frailties:

1. Transport (e.g. on-demand "paratransit" services) between home and transit stations;
2. Physically accessible transit stations and transfer points;
3. System designs that are physically and cognitively easy for users to navigate.
4. Outreach campaigns to inform potential users of services and help novice riders become familiar with the transit system.

Even with these supplements many individuals with limited mobility and frailties will either not be able to use or will choose not to use transit. In rural areas with low population densities, it is

unlikely that transit will provide a significant alternative to automobiles or on-demand paratransit services.

Section 4.8: Community and Personal Economics

Transit proponents have long asserted that improved transit can stimulate economic development (Taylor & Samples, 2002; Vuchic, 1999). If realized, improved economic conditions can improve health. A substantial body of research has linked the economic well-being of individuals and their communities to improved health status (Adler & Newman, 2002). Although the relationship is not linear and is often mediated by other factors, more wealth is associated with improved health.

At the level of individual households, a well functioning transit system has the potential to increase income by improving access to jobs and reducing household expenditures on transportation. At the level of the community and region, improved transit systems have the potential to produce economic efficiencies, stimulate economic growth and make an area more attractive for other economic investments. These potential effects and the evidence pertaining to each will be discussed below. Also discussed are issues of equity, since uneven distribution of the costs and benefits of improved transit systems can perpetuate or even exacerbate existing social and economic inequalities with resulting detriments to health.

Associated Health Outcomes

The health status of individuals is clearly associated with income and socio-economic status (Adler and Newman, 2002). Poorer people die sooner (Rogot, Sorlie & Johnson 1992; Backlund, Sorlie & Johnson, 1999; Wood, Sallar et al., 1999); have higher rates of morbidity

associated with biomedical diseases such as asthma (Weitzman, Gortmaker et al., 1992), have higher rates of depressive symptoms, and have poorer self-rated health status (Ettner, 1996). The mechanism and components of economic status that explain these effects are still, however, the matter of much debate (Adler & Newman, 2002).

Current hypotheses about the association between income and health fall into two general schools—the "absolute income hypothesis" and the "income inequality hypothesis," with some hypotheses blending elements of both. Since the generally suggested effects of transit on household budgets are more closely tied to changes in disposable income, not income inequality, we will focus our discussion of the literature on the former. The absolute income hypothesis posits that an individual's income facilitates access to health-related resources, for instance allowing the purchase of better health care, nutrition, housing and education. It also implies that there is some level of income above which additional income probably yields only marginal returns, since basic needs are already met. Evidence for this is provided by Backlund, Sorlie and Johnson's (1999) analysis of data from the National Longitudinal Mortality Study that found that income had a substantially higher effect on mortality of individuals with incomes below the U.S. median income than those who had higher incomes at baseline. Other evidence for the absolute income hypothesis comes from Ettner (1996) whose data demonstrated a positive effect of income on self-rated health, and Fisella and Franks (1997) who found a strong income effect on self-rated health, morbidity and mortality after controlling for income inequality. A variant of the absolute income hypothesis suggests that it is income volatility, not income per se, that is detrimental to health (McDonough, 1997). Rather than acting on health through the acquisition

of health promoting resources, its mechanism of action would presumably be psychosocial (i.e. increased stress).

Some labor economists critique the absolute income hypothesis, arguing that the direction of causality is actually reversed – that poor health causes a decline in earnings, not the other way around. Longitudinal studies and statistical techniques to control for this "reverse causality" indicate that this effect does occur; however, the dominant effect is in the other direction, that is, income affects health (Ettner, 1996). Another line of criticism suggests that the association between income and health is actually spurious. For instance, Muller's (2002) research shows that education leads to both higher incomes and better health status. Likewise, behavioral patterns, such as risk-taking and delayed gratification could also affect both income and health, however the Whitehall studies in Britain controlled for health-related habits and still found an association between social class and coronary heart disease (Marmot et al, 1987; Marmot et al, 1997).

The effects of transit utilization on household economics

Transit proponents suggest that a well functioning transit system has the potential to benefit household budgets in two ways—increasing earnings by providing better access to a broader choice of jobs (Taylor & Samples, 2002) and reducing the burden of automobile-related expenditures (Surface Transportation Policy Project, 2003). The evidence supporting these suppositions is mixed and is likely to be affected by local conditions.

Transportation costs comprise a substantial share of Americans' household expenses—on average 20 percent of household expenses. Only housing comprises a larger share of household expenses. Much of this expense is related to the high cost of owning, maintaining and operating automobiles (Bureau of Labor Statistics, Consumer Expenditure Survey Data from Surface Transportation Policy Project, 2003).

According to the 2001 American Household Survey, American households spent an average of $7,233 each year to own and operate their cars and trucks, including costs of vehicle purchase, maintenance, fuel, motor oil, and insurance (Surface Transportation Policy Project, 2003). While not having any car saves the greatest amount, this is not a viable alternative for most families. Still, owning fewer vehicles, driving them less and using transit more can still yield considerable savings. Households that own at least two vehicles and rarely use transit spend 19 percent of their income on transportation. Households that own one vehicle or less and do not use transit spend 16 percent of their income on transportation. But, households who own one vehicle or less and have above average transit use spend on average only 10 percent of their incomes on transportation (Center for Neighborhood Technology & the Surface Transportation Policy Project, 2005). Considering only the marginal costs of commuting to work (i.e. extra fuel, maintenance and parking costs, excluding vehicle purchase and basic automobile insurance costs), workers commuting by private vehicle spent an average of $1,280 in 1999, compared to workers using public transit who spent an average of $765 (U.S. Bureau of Labor Statistics, 2003).

The burden of transportation costs hits the poor especially hard. The poorest 20 percent of American households, those earning less than $13,908 per year after taxes, spend 40.2 percent of their income on transportation (Bureau of Labor Statistics, Consumer Expenditure Survey Data reported by Surface Transportation Policy Project, 2003). And, the proportion of their incomes going towards transportation expenses is growing. Between 1992 and 2000, transportation expenses increased 36.5 percent for households with incomes of less than $20,000, 57 percent for households with incomes between $5,000 and $9,999, but only 16 percent for households with incomes of $70,000 and above (Sanchez, Stolz & Ma, 2003).

Present Conditions in California: Effects of transportation expenses on household budgets

In an era of rising fuel prices, increases in transportation costs are likely to outpace increases in both other living expenses and wages. Nationally, annual household expenditures for gasoline have increased from $1291 in 2000 to $2013 in 2005 (U.S. BLS, Consumer Expenditure Survey). Rising gasoline prices forced Californians to spend on average an additional $361 per household ($4.28 billion statewide) in 2004 than in 2003 (Center for Neighborhood Technology & the Surface Transportation Policy Project, 2005). Based on same-week 2005 versus 2006 gasoline prices, a sharp surge in gasoline prices in May 2006 cost Californians an additional $1.3 billion for gasoline for the three month period from May through July 2006 (California Energy Commission, 2006). Transit has the potential to mitigate these impacts on household budgets, but only when there is a well-developed network of transit that provides needed connections between home, work, school, shopping and recreation without excessively long travel times.

Probably the best developed regional transit system in California is found in the San Francisco Bay Area. For many residents, this system provides a realistic and economical alternative to their cars. During the spike in gas prices in 2004, (which was followed by a much larger price hike in 2006), households in the San Francisco metropolitan statistical area (MSA) saw their annual gasoline and motor oil expenses go up an average of about $100, while in the Los Angeles MSA, where the transit system is much more fragmented, the average annual household expenditure went up by $400 for the same time period (California Energy Commission, 2006). San Francisco's better developed transit system may have helped reduce the impact of rising gasoline prices on household budgets in two ways. First, households utilizing transit, which comprise a greater share of households in San Francisco than in Los Angeles, would have been somewhat insulated against the gasoline price increases. Second, the broader coverage of the coverage of the transit system in San Francisco would have provided a more competitive alternative for more automobile drivers wishing to escape the burden of higher gasoline prices than in Los Angeles.

Data and Estimates of Impacts

Decreased household transportation expenditures resulting from increased transit usage can free up household resources for other uses. Conversely, households that are automobile-dependent are likely to see an increasing proportion of their income going to transportation expenses. For middle and upper income households this might mean decreases on discretionary items and savings and greater constraints on housing choices. For lower income households these costs are likely to lead to reductions in spending on essential products and services, and in some cases

when they are no longer able to afford commuting costs they will suffer some loss of employment (California Energy Commission, 2006).

The high cost of housing, the only single household expense greater than transportation, is a major factor driving transportation costs. Combined housing and transportation costs comprise an average of 52 percent of Americans' household expenses (Surface Transportation Policy Project, 2003). In order to make ends meet, families are often forced into choosing between paying more for housing and less for transportation or more for transportation and less for transportation (Surface Transportation Policy Project, 2003; Lipman, 2006). Car ownership might enable a family to live in less expensive housing in a distant, less accessible place but they end up paying more in terms of commuting time and transportation costs (not to mention higher environmental externalities such as air pollution and loss of agricultural land).

Housing costs can also accelerate trends towards more sprawling, periurban development. In their search for lower cost housing, people look further and further out from established commercial and residential centers, trading housing costs for transportation costs (Lipman, 2006). At the same time, this outward push stimulates demand for new low cost housing that leads to sprawl. This suggests that the relationship between transportation and housing expenses is strongly mediated by patterns of development.

Access to employment opportunities

> "The inadequate and costly public transportation currently existing throughout the Los Angeles area seriously restricts the residents of the disadvantaged areas such as south central Los Angeles. This lack of adequate transportation handicaps them in seeking and holding jobs, attending schools, shopping, and fulfilling other needs."
>
> *Governor's Commission on the Los Angeles Riots, 1965, p. 65*

Whether transit improves access to employment opportunities, depends on patterns of land-use, economic conditions, the service patterns of the transit system, and the population in question. Even large transit systems with extensive rail and bus routes will not improve access to employment, if they do not connect employment centers with the neighborhoods where people live, especially lower income workers who have the fewest job opportunities and few transportation alternatives. Waller (2005) and others assert that, except in urban core areas, transit often does not connect workers with employment opportunities. In Atlanta and Portland, Oregon, access to bus transit was found to be associated with increased employment for all races (Sanchez, 1999). In Dade County, Florida, however, Thompson did not find a strong relationship between public transportation access to employment locations and rates of employment of minorities (Thompson, 1997). Studies of the effects of transit access on employment of welfare recipients show only a small effect or no effect on rates of employment (Waller, 2005). Even when transit connects centers of employment and residential neighborhoods, long travel times can deter usage (Ellwood, 1986).

It may be unrealistic to expect transportation to solve problems that are fundamentally about regional economic planning and community land-use planning. A number of trends are leading to increasing distances between workers' residences and employment locations, and a flow entry-level, low-skill jobs to the urban fringe while managerial and information processing jobs remain in downtown areas (Sanchez, Stolz & Ma, 2003). In concert with other efforts, improved transit can improve access to employment opportunities but it is unlikely to accomplish this goal by itself.

Researchers using multi-level modeling techniques to disaggregate individual- and community-level effects have shown that independent of an individual's economic status, neighborhood and community economic conditions influence a wide range of physical and mental health conditions (Cubbin, LeClere & Smith, 2000; Diez-Roux, Nieto et al., 1997; Driessen, Gunther & Van Os, 1998; Lee & Cubbin, 2002; O'Campo, Rao et al., 2000; Pickett & Pearl, 2001). In addition to average levels of income, employment and other measures of economic status, higher levels of income inequality have also been shown to be associated with poorer health status (Yen & Kaplan, 1999; Lochner et al, 2001). Researchers suggest that these neighborhood- and community-level indicators of economic deprivation are markers for societal under-investment in public goods and welfare (Yen & Kaplan, 1999), as well as low levels of social cohesion which in turn affect quality-of-life and the allocation of public resources (Kawachi & Kennedy, 1997).

Proponents of transit suggest that improved transit can improve community and regional economic conditions by creating jobs, bringing an influx of public funds that ripple through the economy and stimulating economic activity by lowering transportation costs (Taylor & Samples, 2002). As shown in Table 6, these are differentiated into expenditure and transportation effects. Expenditure effects include additional employment and purchases generated directly from transit projects and operations. Such effects might be generated by any similar investment of public or private monies, such as building roads, bringing in a manufacturing plant, or starting a new university. Transportation effects stem from having a better functioning transportation system in place. These effects are generated by lowering congestion and other costs related to having a poorly functioning transportation system. These savings then lead to improved economic

efficiencies and ultimately attract additional business activity and economic investment (Taylor & Samples, 2002).

Table 6: Economic benefits of transportation expenditure (adapted from Taylor and Samples, 2002)

Expenditure Effects	Transportation Effects
• Includes effects associated with the expenditure of operating or capital subsidy dollars ("leakage" may occur when purchases are not made locally) • Purchases made by the recipient agency and its suppliers • Multiplier effects of purchases throughout the economy	• Stimulus of economic activity by lowering transportation costs • Time and monetary savings to travelers that are then translated into productivity gains • Encouraging development of new business and employment around transportation centers and routes; • Attracting customers and users to new business hubs around transportation centers and routes.

On the expenditure side, a 1999 study commissioned by the American Public Transit Association (APTA) estimated that 314 jobs are created for each $10 million invested in transit capital projects, and another 570 jobs are created for each $10 million invested in transit operations. As money spent by these workers ripples through the regional economy, business sales would increase by approximately $30 million for each $10 million invested in transit operations or capital projects (Cambridge Systematics, 1999).

Using an economic model developed by the Southern California Association of Governments (SCAG), Taylor and Samples (2002) estimate that the number of jobs created would be substantially less for transit capital investments, approximately 196 jobs for each $10 million invested, chiefly due to leakage of invested dollars to contractors in other countries. On the other hand, they estimate somewhat higher levels of job creation from investment in transit operations, approximately 639 jobs per $10 million invested. The relative advantage of investment in transit

operations as compared to transit capital projects for job creation is especially pertinent to the cuts proposed by Governor Schwarzenegger since they affect one of the few state funding streams available for funding transit operations, while Proposition 1B bond monies that could supposedly offset these costs are restricted for use on capital projects.

The APTA/Cambridge Systematics study also estimated the economic stimulus effects of improved transit systems. Their report suggests that by reducing operating costs, fuel costs and congestion costs, each $10 million invested in transit systems would save highway and transit users an estimated $15 million. Economic efficiencies resulting from these savings would generate increasing levels output over a 20-year time horizon, with additional business output increasing from $2 million in the first year to $31 million after 20 years, and personal income increasing from $0.8 million in the first year to $18 million after 20 years. These estimated economic impacts do not include economic benefits related to indirect effects related to reduced environmental externalities (e.g. reduced air pollution and carbon dioxide emissions) and reduced demand for public services.

Equity: Distribution of costs and benefits

> "Does public transit exist to get people who don't own cars from point A to point B, or to get commuters out of their cars so they aren't clogging the freeways and polluting the air? Actually, an effective transit system must do both."
>
> *Editorial in the Los Angeles Times, June 7, 2007*

Public funding for transit always involves a redistribution of resources—redistributing revenues from various taxes and other sources to transit operators and their contractors, then to passengers in terms of subsidized service, and finally to other affected groups who might benefit from less congested roads, better economic environments, and cleaner air. Decisions to allocate these

funds—to different communities, regions and operators, to bus versus rail, to new construction or existing operations—are shaped by various social and political goals. Just as a change to existing taxes or tax credits will affect household incomes, so will different allocation decisions affect household resources.

As suggested by the quote above, transit systems have multiple goals that represent potentially competing expectations and constituencies. On the one hand, transit aims to provide mobility for those people who cannot drive or afford a car and thus promote social goals favoring vertical equity (i.e. distribution of public resources by level of need). On the other hand, transit development promises to reduce congestion and pollution, priorities expressed by middle- and upper-class voters who want to see the taxes they pay improve their quality of life. Both of these goals have arisen in response to a long-standing, pervasive emphasis on automobile travel and automobile-oriented patterns of land-use in public funding and planning. Competition for scarce public resources for transit, compounded by existing social inequalities and tensions helps set up these different goals to be at odds with one another (Grengs, 2004).

Iseki and Taylor (2001) assert that while transit subsidies generally result in a net transfer of resources from higher income taxpayers to lower income transit users, among transit users, the distribution of resources is actually regressive, that is middle-income rail passengers traveling longer distances get a larger share of subsidies than lower income bus riders traveling shorter distances. They suggest a cost-based fare structure (charging different fares for different times of day and distance traveled) for making the distribution of transit subsidies both more equitable and more efficient. What is most pertinent to the analysis of the Governor's proposed budget cuts is that these cuts would eliminate one of the few state funding streams available to support

transit operations, which includes bus service. Potential replacement funds from Proposition 1B bond sales would go towards new capital projects that support the more affluent rail passengers who Iseki and Taylor found are already receiving a disproportionate amount of transit dollars.

Section 4.9: Land Use

Transportation and land use are intricately related; most studies on the associations between the two focus on the influence of land use on transportation (Handy, 2005). Land use most often refers to the relative proximity of different land uses, typically commercial and residential, within a specified area (Handy, Boarnet et al., 2002). Public transit infrastructure tends to be well developed in areas with highly mixed land uses and high population density since the short distances between residences and employment or commercial centers and the large numbers of potential riders is conducive to public transportation (Handy, 2005). Studies have shown that with increased accessibility to transit at both the origin and destination of the trip there is an increase in use of transit along with a decrease in automobile use (Handy, 2005). Accessibility, a key element of which is the distance between origin and destinations; has been shown to increase number of non-motorized trips, especially for shopping and school trips (Cervero & Duncan, 2003; Handy, Clifton, & Fisher, 1998; Kitamura, Mokhtarian & Laidet, 1997; McCormack Rutherford & Wilkinson, 2001). Furthermore, residents of neighborhoods with a mix of land uses and pedestrian-friendly designs have been found to travel less by car and use more non-motorized travel, such as walking and cycling (Cervero & Radisch, 1996; Friedman, Gordon & Peers, 1994).

Less well studied is the effect of transportation on land use. Public transit is an important contributor to economic development and investments in public transportation generate economic benefits (American Public Transportation Association, 2006). A simulation study of the U.S. national transportation infrastructure shows that every $10 million in capital investment

in public transportation increases business sales by $30 million (Cambridge Systematics, 1999). Such economic stimulus will affect land use by encouraging commercial development and increasing land use mix. Conversely, transportation policies and investments that encourage dispersed, low density land use patterns can have a range of negative economic impacts (Sanchez, Stolz & Ma, 2003).

A good example of how transportation can affect land use patterns is Transit-Oriented Development (TOD), which refers to the development of residential and commercial areas around a public transit station designed specifically to maximize access to transit. TOD creates compact, mixed-use, walkable communities within a walking distance of a transit stop. TOD encourages walk to transit and transit use. Studies suggest that TOD can reduce per capita automobile travel (Lund, Cervero & Wilson, 2004; Kuzmyak & Pratt, 2003; Cervero, Murphy et al., 2004). However, these effects are probably only realized when transit systems reach sufficient coverage and efficiency so as to provide an attractive alternative to automobile travel (Lund, Wilson & Cervero, 2006).

In California, TOD is a strategy that has been identified to mitigate the potential adverse effects of rapid population growth that is set to occur in the next few decades (California Department of Transportation, 2002). Thus, there have been a number of TOD developments throughout the state. The leaders in TOD within California are San Francisco and San Diego. The Bay Area Rapid Transit (BART) in San Francisco and the Metropolitan Transit Development Board (MTDB) in San Diego have partnered with city and regional agencies to promote transit oriented development.

Furthermore, public transportation can impact land use through its influence on social capital. As detailed in the above section on social capital, public transit can directly improve social capital, which thus can bring about social mobility and community action in advocating for land use changes in a community.

V: Conclusion and Recommendations

Clearly, getting people out of their cars and into mass transit has the potential to benefit health in a number of ways—possibly reducing air pollution, increasing physical activity, improving mental health and boosting community social capital. In addition, having a well-functioning mass transit system in place can serve a number of other functions, including providing mobility to people with limited or no access to private vehicles, improving land-use and stimulating economic development. We are unsure, however, how the Governor's proposed cuts (or re-allocation) of $1.3 billion over two years will affect transit systems throughout the state and subsequently impact the health of Californians.

Considerable uncertainty exists as to the exact, on-the-ground manifestations of potential budget cuts. State funds comprise only a small part of the total revenue stream for most major transit agencies, some agencies might not receive any state funds, while for others, state funds may comprise a large and critical share of their revenue sources. Even when state funds make up only a small portion of a transit agency's revenue stream (see Table 4), these funds can be critical to continued operations. These funds may be critical for making up budget short-falls in the face of escalating costs and cuts in other revenue sources. The state transit funds that are the subject of these proposed cuts are one of the few non-local sources that can be used for transit operations in metropolitan areas over 200,000 people. Capital projects, such as building rail lines, can look to a number of different federal and state programs for funding, especially over the next several years with the availability of Proposition 1B bond revenue. Bus service operations, however, are

much more limited in where they can obtain non-local funding. It is bus service, not rail, that serves the preponderance of transit passengers in California, and bus passengers are much more likely to be poor and from disadvantaged ethnic groups.

While the proposed funding cuts will not lead to a wholesale shutdown of transit service in the state, there are vulnerable agencies and populations that these cuts are likely to impact: (1) smaller transit agencies for whom state funds make up a critical portion of revenue and which have limited ability to raise replacement revenue from other sources (e.g. fare increases), and (2) transit-dependent populations served by these transit providers, including the poor, children, seniors and mobility impaired who depend on transit for access to jobs, school, shopping, health care and social services. In general the scale of transit system changes resulting from the proposed budget cuts will not be sufficient to impact air, water or noise pollution, although impacts could be locally significant if loss of critical state funding leads to major cutbacks in transit that increase automobile traffic and congestion.

Even if the health impacts resulting from this specific proposal do not rise to the level of significance, the health effects of cumulative state and local policies that have favored highways and automobiles over transit need to be recognized. The substantial body of research on the negative health and environmental effects of automobile use and automobile-oriented land-use planning suggests that transit systems need to be better developed.

While uncertainty about how the effects of these state transit funding cutbacks will manifest at the local level makes it difficult to draw firm conclusions about the health impacts of this project,

local decision-makers can use the research synthesized in this HIA to evaluate options and identify mitigation measures to minimize negative impacts and maximize potential health benefits.

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