White Paper

To: City of Walnut Creek and interested parties

From: Michael Fotheringham, Landscape Architect

Subject: **Town Square, Walnut Creek**

Date: August 26, 2011 Updated on July 2, 2014

The City of Walnut Creek has long sought a site for a town square. Several previous discussions and a few current studies continue to explore possible locations for a town square. This paper presents a feasibility study, conceptual plan and evaluation for locating a town square at the intersection of Mt. Diablo Boulevard and Main Street in Downtown Walnut Creek.

Abstract:

The most effective location for a useful town square is at or near the core of the central business district, sometimes referred to as the 100% intersection. This location, in most communities, is characterized as the most active pedestrian realm. The intersection of Mt. Diablo Boulevard (MDB) and Main Street (MS) is significant in that it both creates and connects the four quadrants of the downtown retail activity. Converting the intersection into a public square, including segments of MDB and MS, creates a pedestrian realm that bridges the various retail environments – the Locust Street Corridor, the traditional North Main Street Corridor, Broadway Plaza and the newer, southwest retail blocks – into one place, or the Town Square for Walnut Creek.

Locating a vacant parcel of land, suitable in size and location for a town square, is difficult. Even if a suitable parcel is available, conveyance to public ownership is not easy, given that centrally located land parcels tend to be more valuable as private sector development sites, and less likely to be affordable to city governments. Currently, no suitable vacant or under-utilized land parcels are available at or near the 100% intersection.

Closing streets to create public spaces has been successful in many cities around the world. In recent years, neighborhoods from New York City to Santa Monica have created a variety of public spaces from closing streets. Larger cities such as Copenhagen, Denmark and Florence, Italy have closed off the historic downtowns to cars. (See Appendix 1)

The transformation from street to public space is a remarkable experiment in reinventing public space in urban settings. Many of these projects begin with temporary street closures, sometimes referred to as 'pop-up public space'. (For a thought-provoking tour of similar projects, see www.streetfilms.org.)

Downtown Walnut Creek continues to evolve into a mixed-use commercial center as downtown residential development is introduced through the "conditional use permit" process. The trend to build residences in the downtown has emerged in Walnut Creek within the last five years, as a consequence of market forces to provide housing on infill sites, in commercial cores and within walking distance to rail-based transit. These forces most likely come from the advancement of thinking fostered by "new urbanism", "transit-oriented development" and "landscape urbanism", movements within architecture, urban design and development interests that promote the ideal of social vitality in higher-density, mixed-use developments that bring residents to downtowns, expanding the opportunities for an active night life. Some of the benefits of pedestrian-oriented downtowns with a market-driven balance of residential and commercial land uses, include enhanced social interaction that encourages a sense of community. Central Walnut Creek is becoming a successful, mixed-use downtown with an active nightlife, but one without a central gathering place.

Location:

The proposed location for the Town Square is at the intersection of Mt. Diablo Boulevard (MDB) and Main Street (MS), including the closure of Mt. Diablo Boulevard between Main Street and Broadway. Portions of MS both north and south of the intersection could also be closed. A portion of MDB west of the intersection could be closed as well. The size of the proposed site is 151,700 square feet (3.5 acres). (See Figures 1 & 2)

Alternate location:

An alternation location for consideration is the portion of MDB between the MS intersection and Broadway intersection. The two intersections would remain open under this alternative. The size of this option is 36,700 square feet (.85 acres).

Means:

The closing of the intersection and/or streets would be a temporary closure. The town square facilities located within the proposed site would also be temporary. The design of the town square would be thoughtfully delineated in such a way that the site would be fully functional as a town square for the duration of the project. The City of Walnut Creek could begin closing these streets on Sundays, weekends or for community events, followed by longer periods of closure.

Duration:

The town square would be functional for a period of three years. The first year would involve the setup and activation of the town square design, including the programming of several events. Once activated, the changes to vehicular traffic patterns would be measured. Levels of pedestrian use would be measured during the second year. An evaluation of the project would take place during the third year, with the possible outcome that the closure would remain, whereupon future, permanent improvements could be implemented.

Design Elements:

1. Barricades at street closures.
2. Potted trees – minimum 48" box and larger.
3. Additional potted plants throughout.
4. Benches
5. Tables and chairs with umbrellas
6. Power outlets connected to existing light poles.
7. Stage area (suitable for mobile stage setup)
8. Ice rink area
9. Temporary accent paving to hide existing curbs.
10. Temporary fountain.
11. Locations for temporary public art installations.
12. Reinforce and connect existing sidewalks, courtyards, and pedestrian walkways to the town square in order to fully integrate pedestrian access.
13. Create outdoor seating areas adjacent to existing restaurants and facilitate temporary permits for outdoor dining.
14. Other improvements to be determined.

Activation Analyses:

A post-activation user study would be performed that documents user behavior of the town square, including dynamic patterns of walking and sitting over the course of each day of the week. Levels of use would be calculated. Patterns of use would be mapped. Summaries of levels of use, compared to the anticipated number of uses, would be provided.

In 2008, the City conducted a pedestrian traffic audit of the downtown. One of the findings of particular interest was that the sidewalks immediately surrounding the intersection of MDB and MS had the highest pedestrian counts in the study area. (See Figure 4) Another finding was that the highest incidence of vehicular/pedestrian collisions had occurred along MDB from Locust Street to Broadway. (See Figure 3)

Design Process:

MD Fotheringham, Landscape Architects, Inc. has prepared this feasibility assessment that initiates the vision for this solution. The design process is unconventional in the sense that the town square is more of a staging exercise than a final design for THE town square. This project should also be envisioned as the anchor to the pedestrian master plan initiative and the future update of the Public Art Master Plan. The following additional studies are recommended:

1. Traffic Studies
2. Barricade design and placement
3. EVA/delivery vehicle access
4. Local driveway access
5. Striping, traffic control
6. Programming diagrams for special events
7. Shadow studies

8. Outdoor seating and staging studies for various events
9. Farmers Market layout
10. Layouts for various City festivals
11. Selection of off-the-shelf furnishings and materials systems to be used on a temporary basis, and then recycled for use in public spaces in the future.

Anticipated number of users:

MD Fotheringham has developed a formula for calculating an approximate number of anticipated users, based on the following data:

Number of residents of Walnut Creek, including those neighborhoods in Contra Costa County that are within the sphere of influence of the City limits: 64,500 plus (say 70,000)

Average number of employees who work within the city limits each day: 15,000

Average number of tourists/visitors who come to Walnut Creek each year: 200,000

Total acreage of parks and public spaces in the City, excluding regional parks: 50 acres

Accessible area (square feet) of the proposed town square site (approximately 80% of the gross area of the site): 88,200 square feet

Based on the above figures, we can estimate the baseline of users anticipated to be activating the town square site at 400 users per hour or 4,800 users per a 12-hour day. The post-activation actual levels of use would be measured to confirm this number, once the town square area is opened for use.

Design Opportunities and Constraints:

Figure 2 illustrates in diagrammatic form, the concept for public space designation and use. The following opportunities and constraints are identified for further discussion and refinement:

Opportunities:

- The project, as defined, is temporary and would allow a return to existing street function should the project fail to meet expectations.
- The town square design elements would be relatively inexpensive and easily recycled and reused in other public spaces.
- The project would easily support the temporary nature of city festivals, given that existing streets are routinely closed for many of those festivals.
- The project site is located where most of the downtown foot traffic already occurs.
- The City of Walnut Creek currently owns the land.
- Mt. Diablo Boulevard happens to define the edge between the traditional and new sub-areas of the downtown core. The segment of MDB from Broadway to California is centrally located between the traditional downtown and the relatively new and currently expanding downtown to the south. Locating a town square at the 100%

intersection and at the edge between the old and new downtown builds a bridge that links the two areas, unifying the core of the downtown.

- A number of existing parking structures are located within the downtown core and within one or two blocks of the proposed town square site. Existing parking structures include the Broadway Garage, the South Locust Garage, and several other garages associated with anchor retail uses in the Broadway Plaza and southern downtown. Future structures are proposed in area specific plans. The pattern of driving to downtown parking structures and parking for several hours is the norm. Many visitors to downtown visit several stores during one parking incident.

Constraints:

- The perceived impacts of altering traditional downtown traffic patterns could be difficult to overcome. Vehicular access to retail shops would be altered, but the number of parking spaces displaced is relatively minimal, since street-side parking within the proposed town square study area is generally prohibited. We estimate that 30 parking spaces would be displaced by this project.
- The character of temporary improvements, including many moving parts, will not yield an accurate assessment of a permanent public improvement.
- Funding for temporary improvements may be perceived as a waste of revenue.

Traffic Impacts:

Design of the town square within the public right-of-way of the street, including the closure of an intersection would result in rerouting local vehicular access to local businesses, parking lots and parking structures. In addition, traditional traffic patterns would be diverted. We have reviewed two traffic studies prepared by the City of Walnut Creek in order to provide a reasonable analysis of current traffic patterns, and how traffic and patterns would be altered.

Existing Traffic Summary:

The City conducted traffic counts at several intersections in the downtown, including MDB and MS, MDB and Broadway, MDB and Locust Street, and MDB and California Blvd. (See Table 1 and Appendix 2). In 2010, the City also prepared the Traffic Volume Map that documents average daily traffic volumes in the downtown, including Geary Road and Treat Boulevard to the north. (See Figure 3, additional graphics added by the author). From this data, we can draw some conclusions about how the downtown core relates to citywide traffic patterns.

Of the four north-south orienting streets, Broadway carries the majority of northbound and southbound traffic, followed in volume by California Boulevard. Essentially this pattern reflects drivers that are diverting around the local streets (Main Street, Locust Street) in the downtown. The AM peak traffic is predominately southbound with a highest percentage of southbound traffic on Broadway. The PM peak traffic is predominately northbound with the highest percentage of northbound traffic on California Boulevard. According to the observed traffic counts, the total count of northbound and southbound vehicles is essentially the same (4,981 northbound, 4,644 southbound). However, there was significantly more PM peak traffic (62%) compared to the AM peak traffic (38%). (See Table 1)

MDB conveys eastbound and westbound traffic throughout the day. The total number of vehicles is not a factor, since the observed traffic counts were taken along MDB at several intersections, and the counts would include the same vehicles. However, the number at each intersection is important because it can suggest traffic that is diverting to the northbound and southbound direction.

The traffic pattern during the AM peak period is predominately westbound from Broadway to the California Boulevard intersection. The predominant direction shifts to eastbound at California Boulevard with 20% of the AM peak traffic being diverted either in the north or south direction.

The traffic pattern during the PM peak period is reversed, compared to the AM peak, with one key exception. The predominant direction of flow from Locust Street to Broadway is eastbound. However, the predominant direction shifts back to westbound from Locust to California Boulevard. Main Street seems to be the seam that separates the east-west traffic flows.

Generally, the predominant east-west traffic flow along MDB is through-traffic. The turning patterns recorded at MDB and MS indicate that a relatively small number of vehicles are turning off of MS to contribute to the east-west traffic flows. The range is from 20% (westbound AM Peak) to 29% (eastbound PM peak).

In terms of intersection activity, as measured by comparing the north-south streets counted in the City's Downtown TMC 2 study, the MDB/MS intersection ranked third lowest. For both the AM peak and PM peak periods, the ranking for southbound traffic from most to least busy was Broadway, California Boulevard, Main Street and then Locust Street. For the AM peak period the ranking for northbound traffic from most to least busy was Broadway, California Boulevard, Main Street and then Locust Street. However, for the PM peak period for northbound traffic from most to least busy was California Boulevard, then Broadway, Main Street and finally Locust Street.

Even though the closing of this important intersection would impact traffic, traffic demand studies conducted by transportation planners have shown that over a short period of time, drivers adjust to the new circulation network to the point that congestion does not occur. This equilibrium occurs through drivers being induced to adjust their trip timing or destination, or drivers divert their path to one of less resistance. In general, an increase in congestion found on local streets in any city is more likely caused by increased capacity of nearby freeways. (See Appendix 3)

At this point in time, the trip patterns to the downtown cannot be surmised. However, we could deduce that many drivers will want to park in parking structures and accomplish more than one trip purpose. Fortunately, access to downtown parking structures is most direct along Broadway and Locust Street, not from Main Street.

Local business and property owners would need to embrace the aspects of any traffic adjustments that would ultimately improve access to businesses by pedestrians who freely roam the town square.

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The changes to traffic patterns would be documented over the three-year duration of the project. Any major, and/or unforeseeable patterns or volumes could be assessed at that time. If it is determined that traffic patterns have self-adjusted (due to changed behavior of drivers – striving for homeostasis) then a permanent closure could proceed and a permanent town square could be designed.

With regard to impacts to parking that may result from creating the Town Square, the City has investigated a related improvement project to remove one lane of traffic in each travel direction on MDB from Locust to California Boulevard, and add angled parking adjacent to storefronts. This project adds vitality to the Town Square concept introduced herein.

Hopefully, this white paper serves as a stimulus for stakeholders in the City of Walnut Creek to discuss the merits of creating a town square on public property in the heart of downtown. Initially, the idea of closing an intersection to create the town square is shocking. However, considering the benefits of knitting together the downtown retail shopping experiences, connecting the historic and contemporary retail areas and providing an expansive public space in the heart of Downtown Walnut Creek, on public property, as an experiment, is a wonderful opportunity.

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MD Fotheringham, Landscape Architects, Inc.

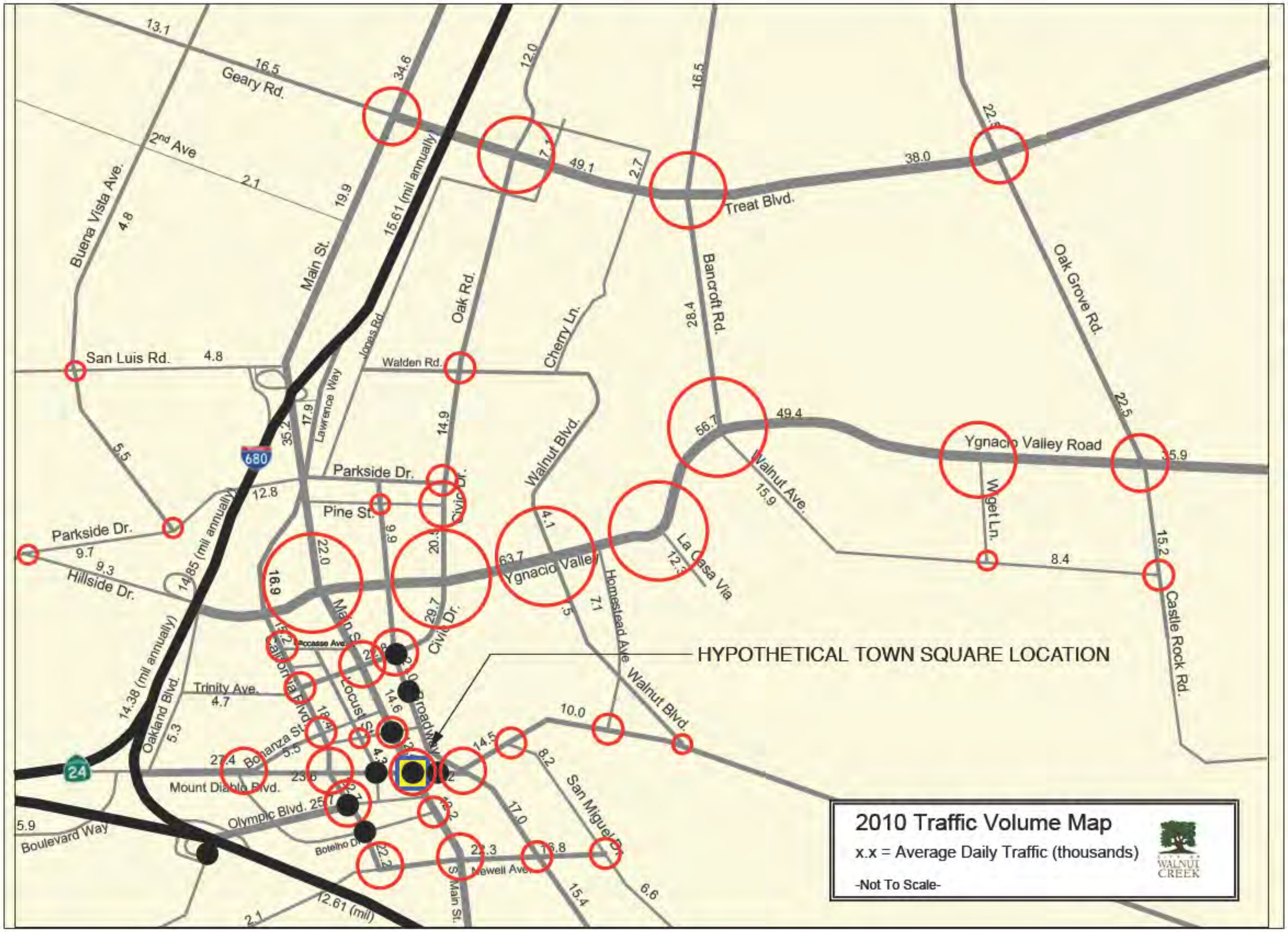
Member, Walnut Creek Design Review Commission

Figure 1

PROPOSED TOWN SQUARE SITE
3.5 Acres

Figure 2

IDEA FOR THE TOWN SQUARE



DAILY AVERAGE VEHICULAR TRAFFIC VOLUMES AT KEY INTERSECTIONS

- 50,000 and above
- 40,000 TO 50,000
- 30,000 TO 40,000
- 20,000 TO 30,000
- 10,000 TO 20,000
- Less than 10,000

The highest average volume approaching each intersection is used to define the hierarchy.

- Pedestrian-Vehicle Collisions (PSA 2008)

Figure 3

RELATIVE TRAFFIC VOLUMES IN AND NEAR THE DOWNTOWN

Figure 2. Existing Hourly Pedestrian Volumes on Downtown Sidewalks

Walnut Creek - Downtown Sidewalks

PROPOSED SITE IS THE LOCUS OF HIGHEST PEDESTRIAN LEVELS

Figure 4

HIGH CONCENTRATION OF PEDESTRIAN TRAFFIC AT PROPOSED TOWN SQUARE SITE

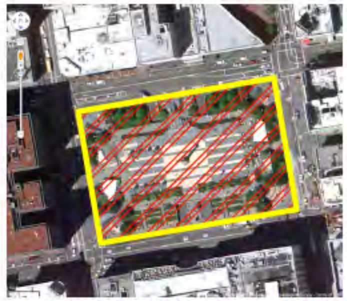
Table 1
PEAK HOUR TRAFFIC COUNTS AT MT. DIABLO BOULEVARD AND MAIN STREET

PEAK HOURS	**BROADWAY**		MAIN		LOCUST		**CALIFORNIA**		Total NB	Total SB	TOTALS
	NB	SB	NB	SB	NB	SB	NB	SB			
AM PEAK	589	**970**	319	**322**	69	**158**	568	**647**	1545	**2097**	3642
AM %	33.1%	**45.9%**	29.9%	**46.0%**	25.9%	**34.2%**	30.4%	**47.2%**	31.0%	45.2%	37.8%
PM PEAK	**1192**	1142	**749**	378	197	**304**	**1298**	723	**3436**	2547	**5983**
PM %	**66.9%**	54.1%	**70.1%**	54.0%	74.1%	**65.8%**	**69.6%**	52.8%	**69.0%**	**54.8%**	**62.2%**
TOTALS	1781	2112	1068	700	266	462	1866	1370	**4981**	4644	9625

PEAK HOURS	MDB @ BROADWAY		MDB @ MAIN		MDB @ LOCUST		MDB @ CALIFORNIA		Total EB	Total WB
	EB	WB	EB	WB	EB	WB	EB	WB		
AM PEAK	375	**590**	370	**593**	440	**531**	**671**	601	1856	**2315**
AM %	32.8%	**53.5%**	32.9%	**47.6%**	35.5%	**35.6%**	41.2%	**37.1%**	36.1%	42.4%
PM PEAK	**770**	513	**756**	653	799	**960**	958	**1017**	**3283**	3143
PM %	**67.2%**	46.5%	**67.1%**	52.4%	64.5%	**64.4%**	**58.8%**	62.9%	**63.9%**	**57.6%**
TOTALS	1145	1103	1126	1246	1239	1491	1629	1618	5139	**5458**

source: City of Walnut Creek Downtown TMC 2, See Appendix 2

NOTRE-DAME, PARIS
142,560 sf (3.3 acres)



UNION SQUARE, SAN FRANCISCO
115,000 sf (2.64 acres)

PIAZZA SAN MARCO, VENICE
215,125 sf (4.94 acres)

PIAZZA DEL CAMPO, SIENNA
124,085 sf (2.85 acres)

TODOS SANTOS, CONCORD
115,555 sf (2.65 acres)

THIRD STREET PROMENADE, SANTA MONICA
145,000 sf (3.32 acres)

PALAZZO ANTELLESI AT
SANTA CROCE, FLORENCE
109,516 sf (2.51 acres)

PALAZZO VECCHIO, FLORENCE
96706 sf (2.22 acres)

Appendix 1
COMPARABLE PUBLIC SPACES BASED ON LOCATION, SIZE AND FORM

Appendix 2

Provided by City of Walnut Creek
Engineering Services, Traffic Engineering Department

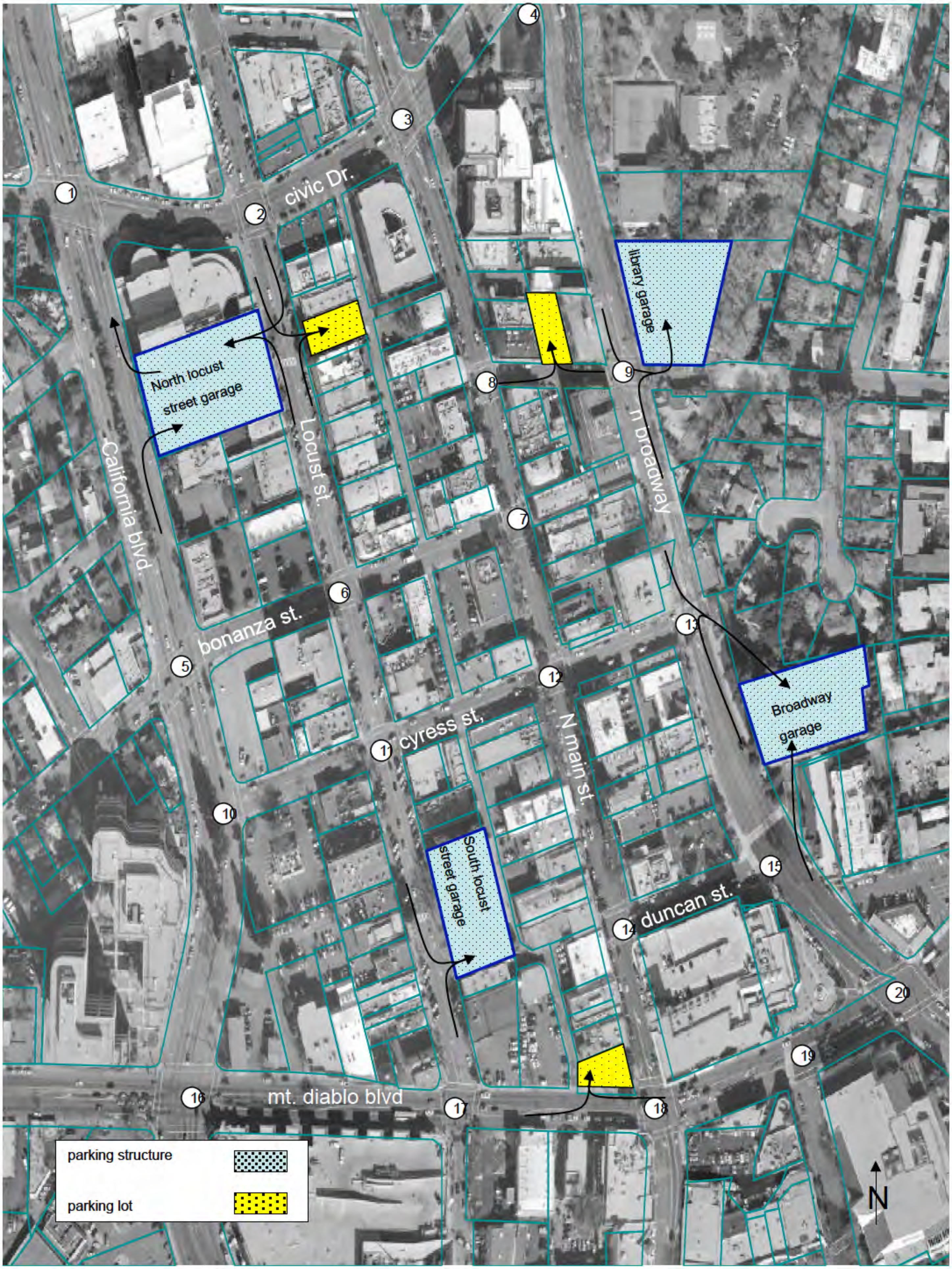
Downtown Turn Movement Counts

Intersection AM	N/B			S/B			E/B			W/B		
	L	T	R	L	T	R	L	T	R	L	T	R
1. Civic Drive @ California Boulevard	19	315	200	40	630	50	83	82	21	220	44	24
2. Civic Drive @ Locust Street	7	35	37	11	82	16	14	268	40	78	267	33
3. Civic Drive @ Main Street	52	167	15	53	263	32	11	187	19	32	304	70
4. Civic Drive @ Broadway	406	316	19	72	240	4	34	219	48	13	446	755
5. Bonanza Street @ California Boulevard	57	419	27	47	607	280	125	27	18	5	40	7
6. Bonanza Street @ Locust Street	15	49	13	11	115	14	19	47	42	19	47	42
7. Bonanza Street @ Main Street	0	212	20	36	311	0	18	0	34	0	0	0
8. Main Street @ Lincoln Avenue												
9. Lincoln Avenue @ Broadway	13	591	5	10	934	89	25	21	10	155	22	33
10. Cypress Street @ California Boulevard		450	40		529							28
11. Cypress Street @ Locust Street												
12. Cypress Street @ Main Street	15	219	16	14	283	16	10	26	12	22	35	5
13. Cypress Street @ Broadway	4	635	18	27	925	52	40	17	13	4	1	0
14. Duncan Street @ Main Street												
15. Duncan Street @ Broadway												
16. Mt. Diablo Boulevard @ California Boulevard	146	369	53	52	496	99	99	382	190	168	381	52
17. Mt. Diablo Boulevard @ Locust Street	5	46	18	36	48	74	36	371	33	25	481	25
18. Mt. Diablo Boulevard @ Main Street	63	183	73	55	218	49	35	282	53	59	475	59
19 Mt. Diablo Boulevard @ Broadway Plaza												
20. Mt. Diablo Boulevard @ Broadway	77	445	67	143	714	113	61	205	109	107	374	109

Downtown Turn Movement Counts

Intersection PM	N/B			S/B			E/B			W/B		
	L	T	R	L	T	R	L	T	R	L	T	R
1. Civic Drive @ California Boulevard	92	1048	441	112	497	74	55	151	27	179	51	118
2. Civic Drive @ Locust Street	35	145	66	16	97	63	52	535	78	84	262	53
3. Civic Drive @ Main Street	136	330	38	61	296	59	49	515	73	54	280	86
4. Civic Drive @ Broadway	47	472	872	96	363	14	99	588	55	15	307	609
5. Bonanza Street @ California Boulevard	95	1022	75	73	612	80	364	41	42	22	64	56
6. Bonanza Street @ Locust Street	26	141	12	30	143	17	22	100	55	15	97	26
7. Bonanza Street @ Main Street	0	432	28	82	356	0	81	0	82	0	0	0
8. Main Street @ Lincoln Avenue												
9. Lincoln Avenue @ Broadway	46	1206	56	25	908	143	50	54	16	160	8	45
10. Cypress Street @ California Boulevard	NO	999	88	NO	931	NO	NO	NO	NO	NO	NO	74
11. Cypress Street @ Locust Street												
12. Cypress Street @ Main Street	36	367	26	33	372	36	56	57	28	66	52	20
13. Cypress Street @ Broadway	5	1169	58	56	968	10	78	4	44	42	6	30
14. Duncan Street @ Main Street												
15. Duncan Street @ Broadway												
16. Mt. Diablo Boulevard @ California Boulevard	267	883	148	109	507	107	206	532	220	179	690	148
17. Mt. Diablo Boulevard @ Locust Street	43	81	73	52	143	109	96	589	114	58	844	58
18. Mt. Diablo Boulevard @ Main Street	225	365	159	91	200	87	121	540	95	69	495	89
19 Mt. Diablo Boulevard @ Broadway Plaza												
20. Mt. Diablo Boulevard @ Broadway	103	912	177	205	748	189	175	342	253	123	270	120

Street	Volume
1. Bonanza Street - Mt Diablo Mt. Diablo Boulevard to California Boulevard	3,600
2. Bonanza Street - California Boulevard to Locust Street	
3. Bonanza Street - Locust Street to Main Street	
4. Broadway	12,300
5. California Boulevard	20,700
6. Civic Drive	29,700
7. Cypress Street - California to Locust Street	
8. Cypress Street - Locust Street to Main Street	
9. Cypress Street - Main Street to Broadway	
10. Duncan Street	
11. Mt. Diablo Boulevard	34,200
12. Lincoln Avenue	
13. Main Street	18,400



civic Dr.
California blvd.
Locust st.
North locust street garage
library garage
n broadway
bonanza st.
cyress st,
N main st.
Broadway garage
South locust street garage
duncan st.
mt. diablo blvd
parking structure
parking lot
N

APPENDIX 3
Building a Road to Nowhere
Brooke Fotheringham

INTRODUCTION

With the tightening of government funding during the current economic recession, it is more important than ever to spend resources on capital improvements wisely. Investment in road expansion projects aimed at easing congestion is not an efficient use of resources. Since an increase in highway capacity reduces travel costs due to decreased travel times, the result is an overall increase in demand. Regardless of increased road capacity, traffic volume tends to reach equilibrium and level off. While the increased mobility increases speed in the short term, it does not actually save travel time. Research has shown that commute times tend to remain unchanged despite greater traffic congestion or considerable reductions in traffic volume. Rather than address congestion only through road building, it is imperative to utilize various strategies that encourage smart growth.

PERSPECTIVES ON ROAD EXPANSION

There are two alternative perspectives on the necessity of road expansion projects. Institute of Transportation Engineering researcher, Todd Litman, uses the following analogies to describe each of these views:

> *"Widening roads to ease congestion is like trying to cure obesity by loosening your belt" Roy Kienitz, executive director of the Surface Transportation Policy Project*
>
> *"Increasing highway capacity is equivalent to giving bigger shoes to growing children" Robert Dunphy, Urban Land Institute*

The "trying to cure obesity by loosening your belt" analogy points out that providing more room to contain a problem is a short-term solution at best. Furthermore, it does not truly address the fundamental issues that are causing the problem. It is not a sustainable solution, because highways cannot be expanded indefinitely.

The "giving bigger shoes to growing children" analogy purports that growth in population, employment, and income are more significant factors in growing vehicle travel, as opposed to increased highway capacity. This view holds that while new highways generate traffic, there are still net economic benefits, and increasing capacity does indeed reduce congestion. This argument ignores key issues and understates the travel impacts of generated and induced travel. Many times the incremental costs of induced vehicle travel are ignored, for example, the increased downstream traffic congestion on surface streets. This argument claims that roadway capacity expansion reduces fuel consumption, pollution and accidents, but it measures per vehicle mile and ignores increased vehicle miles, resulting in exaggerated roadway expansion benefits and understated total costs.

Proponents of increasing capacity urge road expansion by warning drivers of gridlock. However, these warnings are exaggerated because they do not consider traffic equilibrium. The Braess Paradox, named after the mathematician Dietrich

Braess, asserts that adding more capacity to a transportation network actually creates greater delays for drivers, rather than alleviate them. He attributes the phenomenon to "moving entities (who) selfishly choose their route."[1] Gridlock is specific to backups in street intersections, stopping traffic flow completely. This can be addressed through proper intersection design and traffic laws that affect individual travel choices. Highway expansion actually increases the risk of bringing additional vehicles to surface streets, where gridlock occurs, because it attracts a greater volume of traffic that will increase downstream traffic congestion.

In "Are Induced-Travel Studies Inducing Bad Investments?" Robert Cervero claims that many induced travel demand studies suffer from methodological problems that distort their findings.[2] He focuses on problems related to causality and attribution. Cervero claims that most studies have inadequately addressed whether increased traffic volumes are caused by increased road capacity, or if added road capacity is driven by historical growth in traffic. Cervero also points out that many studies have failed to attribute the chain of events between increased road capacity and traffic growth.[3]

TRAFFIC GENERATION

The necessity for road expansion can be determined by understanding how traffic is generated. Generated traffic consists of the additional vehicle miles travelled (VMT) that result from increasing road capacity; it is comprised of diverted and induced travel. Diverted travel is traffic that has shifted in time, route, or destination. Induced travel includes additional trips that increase the total VMT through shifts from other modes, new and longer trips. This can also work in reverse. When roadway capacity is reduced, a high portion of previous traffic may disappear.

Litman illustrates these concepts clearly by giving an example of diverted traffic when the driver chooses a closer destination: "I want to try the new downtown restaurant, but traffic is a mess now. Let's just pick up something at the local deli." Another example is the driver who is deciding where to live: "We're looking for a house within a 40-minute commute time of downtown. With the new highway open, we'll consider anything as far as Midvalley."[4]

An example of induced traffic that Litman shares is a traveler who shifts modes: "The post office is only five block away and with congestion so bad this time of day, I may as well walk there." When longer trips seem cost effective when congestion is light, and not when heavy, travelers make considerations such as: "We'd save $5 on that purchase at the Wal-Mart across town, but it's not worth fighting traffic so let's shop nearby."[5]

According to Institute of Civil Engineering researcher, J.G. Wardrop, a

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[1] Chudak , Fabian, and Eleuterio, Vania Dos Santos. "The Traffic Equilibrium Problem." *Swiss National Science Foundation*. Oct. 2006. Web 26 Apr. 2011. <www.ifor.math.ethz.ch/about_us/.../Leitartikel_Oktober_2006.pdf>.

[2] Cervero, Robert. "Are Induced-Travel Studies Inducing Bad Investments?" *Access* 22 (Spring 2003): 22-27. Web. 8 Apr. 2011.

[3] Cervero, Robert. "Are Induced-Travel Studies Inducing Bad Investments?" *Access* 22 (Spring 2003): 22-27. Web. 8 Apr. 2011.

[4] Litman, Todd. "Generated Traffic and Induced Travel." *Institute of Transportation Engineers Journal* 71.4 (2011): 38-47. *ITE*. Victoria Transport Policy Institute, 11 Mar. 2011. Web. 8 Apr. 2011. <www.ite.org>.

[5] Litman, Todd. "Generated Traffic and Induced Travel." *Institute of Transportation Engineers Journal* 71.4 (2011): 38-47. *ITE*. Victoria Transport Policy Institute, 11 Mar. 2011. Web. 8 Apr. 2011. <www.ite.org>.

transportation system is considered at “user equilibrium” when the traffic patterns are stabilized and drivers do not have any incentive to change their route or mode.[6] The social optimum state is when the collective decisions of drivers optimize the transportation system as a whole. Wardrop’s Second Principle states “congestion can only occur if users choose their routes individually to optimize their own utility functions.”[7]

Increased highway capacity, increases the latent demand for the road network, and attracts a greater volume of drivers. The number of trips will increase until congestion constrains further traffic growth, at which point user equilibrium is restored. This congestion is due to generated traffic. Litman calls this self-limiting equilibrium, as congestion increases, it discourages further growth in peak-period travel. While road expansion reduces short-term congestion, the additional peak-period trips it attracts generates traffic until congestion reaches a point limiting further growth.[8]

INDUCED TRAVEL ANALYSIS

Research that measures generated traffic supports the argument that road expansion increases traffic volume. Professor and Director of the Voorhees Transportation Center at Rutgers University, Robert Noland, analyzed how highway lane-mile additions can increase total VMT. He found a statistically significant relationship between lane miles and VMT, while controlling for population growth.[9] He also found that urban roads have a stronger relationship to VMT growth than smaller, rural roads, which is not surprising since urban roads are more congested than rural ones.

Economists measure the effect that price has on consumption in terms of elasticity. Initially, expanding roadways increases the supply, measured in traffic speed and road capacity, which increases the demand for road space. Price elasticity of travel demand measures the degree that a change in supply of road space causes a change in demand. Elasticity that is greater than one is considered an elastic demand, and represents flexible travel behavior and marginal value trips. Elasticity that is between zero and one is considered inelastic, and represents travel demand that is fairly constant regardless of supply, such as commute trips.

Elasticity estimates for drivers are usually between .5 and 1, indicating that there is latent demand for road space.[10] Collector roads often have larger elasticity value than interstates and arterials, which may be due to new development that is built in conjunction with the new collector road capacity.

Researchers have found that as travel time is reduced due to improvements in mobility, rather than reallocate the timesaving, people maintain their travel time and increase the distances that they are willing to travel. Research professor, David Metz,

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[6] Chudak , Fabian, and Eleuterio, Vania Dos Santos. “The Traffic Equilibrium Problem” *Swiss National Science Foundation*. Oct. 2006. Web 26 Apr. 2011. <www.ifor.math.ethz.ch/about_us/.../Leitartikel_Oktober_2006.pdf>.
[7] Wardrop, J.G. “Some theoretical aspects of road traffic research.” *Proceedings of the Institute of Civil Engineers, London Part II (1952): Vol.1.* 325-378.
[8] Litman, Todd. "Generated Traffic and Induced Travel." *Institute of Transportation Engineers Journal* 71.4 (2011): 38-47. *ITE*. Victoria Transport Policy Institute, 11 Mar. 2011. Web. 8 Apr. 2011. <www.ite.org>.
[9] Noland, R. "Relationships between Highway Capacity and Induced Vehicle Travel." *Transportation Research Part A: Policy and Practice* 35.1 (2001): 47-72.
[10] Litman, Todd. "Generated Traffic and Induced Travel." *Institute of Transportation Engineers Journal* 71.4 (2011): 38-47. *ITE*. Victoria Transport Policy Institute, 11 Mar. 2011. Web. 8 Apr. 2011. <www.ite.org>.

claims that congestion reductions do not actually save travel time. While road expansion increases travel speed, enabling greater mobility, this is not necessarily saving drivers time. Travelers have a “travel time budget” and make travel decisions based on travel time costs. As travelers increase distances, they tend to maintain their trip times.[11] According to Litman, people average 75 minutes daily travel regardless of transport conditions.[12] This implies that travelers have a certain tolerance for the time they are willing to travel, rather than the distance.

The economic interpretation of travel demand is that cost (including capital costs of the vehicle, fuel, maintenance, and relative travel time costs within a given network) influences demand for travel. Since an increase in highway capacity reduces travel cost as travel time decreases, the result is an overall increase in demand. Demand for transportation is usually addressed in these economic terms and is typically seen as a derived demand, which considers transportation as a means only of carrying out other economic activities. This is in contrast to the use of transportation and movement as a form of enjoyment in itself. It is very likely that demand for transportation is influenced by its utility, which may explain the leveling off of travel times even when trip length changes.

The economics and travel patterns behind generated traffic helps to identify the range in value of different types of trips. These fundamentals provide greater context to the Braess Paradox and are useful in placing value on the cost and benefits of using roadway expansion to address congestion.

COSTS AND BENEFITS OF INCREASED ROADWAY CAPACITY

A city can solve a congestion problem by increasing roadway capacity, or by implementing a variety of travel demand management strategies. Each solution has positive and negative externalities.

Increasing roadway capacity is associated with private sector costs. Since drivers do not have to pay for many of the costs directly, the generated traffic places a burden on the private sector, which typically cover the costs of “free” parking, infrastructure and services. In addition there are monetary externalities, such as crash damage to vehicle, medical expenses, etc. Based on a thorough literature review and analysis quantifying these externalities, Litman estimates that the magnitude of these “invisible” costs is almost 30 cents per vehicle mile.[13] There are also nonmonetary externalities, such as congestion, environmental damages, and crash pain that are not accounted for in this estimate.

The incremental external cost of generated traffic is the difference between external costs of generated travel and external costs of alternative activities. For diverted trips, it is the difference between the two trips’ external costs. For induced travel, the incremental external cost is the difference in external costs between the trip and the non-travel activity it replaces; this tends to be large since driving generally has greater external costs than other activities. Induced travel trips have the greatest incremental costs, because they increase auto dependent transportation and sprawling

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[11] Metz, David. "The Myth of Travel Time Saving." *Transport Reviews* 28.3 (2008): 321-36.
[12] Litman, Todd. "Generated Traffic and Induced Travel." *Institute of Transportation Engineers Journal* 71.4 (2011): 38-47. *ITE*. Victoria Transport Policy Institute, 11 Mar. 2011. Web. 8 Apr. 2011. <www.ite.org>.
[13] Litman, Todd. "Generated Traffic and Induced Travel." *Institute of Transportation Engineers Journal* 71.4 (2011): 38-47. *ITE*. Victoria Transport Policy Institute, 11 Mar. 2011. Web. 8 Apr. 2011. <www.ite.org>.

land use.

It has been argued that highway projects are good for economic development. However, because there is already a well-developed transportation infrastructure network established, new highway investments have not been shown to have a significant economic impact on development.

Road construction also increases greenhouse gas emissions, according to a study by the Norwegian Centre for Transport Research (2009).[14] These researchers found that improved road network quality increases speed, and that the marginal effect of speed on gas emissions is significant. In addition, due to the increased volume of traffic, overall gas emissions increase.[15]

There are, however, consumer benefits to increased capacity on roadways. Generated traffic that is a result of increased capacity means that more people are taking advantage of greater mobility, at least at first. However, because generated traffic represents a latent demand, much of the generated traffic is filled with marginal value trips. Marginal value trips consist of travel that is not vital and that most people will give up as costs increase.

The social benefits of shortened trip times allow more people to travel when and where they please. In addition, increased accessibility is capitalized into land value, as landowners benefit from access to a wider range of goods and services.[16] However, this benefit is limited to landowners who get greater accessibility to their land, and does not have any greater societal benefit.

The ratio of benefits to costs tends to decline as more travel is induced because the induced travel is generally of marginal value and imposes increasingly significant external costs. The benefits must be weighed against the economic, social, and environmental costs of increased road capacity.

SMART GROWTH

Smart growth development has economic, social and environmental benefits. The economic benefits include the reduction in development of public utilities, cost savings for travelers, agglomeration effects, and greater transportation efficiency. The social benefits include greater transportation choice (particularly for non-drivers), improved housing choices, and community cohesion. The environmental benefits include green space preservation, a reduction in air and water pollution, a decline in resource consumption, and a decrease in the “heat island” effect.[17]

TRAVEL DEMAND MANAGEMENT STRATEGIES

The research indicates that road expansion is like “trying to cure obesity by loosening your belt,” rather than “giving bigger shoes to growing children.” Once it is established that adding road capacity is not the solution, other strategic interventions

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[14] Strand, Arvid, et al. “Does road improvement decrease greenhouse gas emissions?” *Institute of Transport Economics* TθI report 1027/2009.

[15] Litman, Todd. "Generated Traffic and Induced Travel." *Institute of Transportation Engineers Journal* 71.4 (2011): 38-47. *ITE*. Victoria Transport Policy Institute, 11 Mar. 2011. Web. 8 Apr. 2011. <www.ite.org>.

[16] Noland, R. "Relationships between Highway Capacity and Induced Vehicle Travel." *Transportation Research Part A: Policy and Practice* 35.1 (2001): 47-72.

[17] Litman, Todd. "Generated Traffic and Induced Travel." *Institute of Transportation Engineers Journal* 71.4 (2011): 38-47. *ITE*. Victoria Transport Policy Institute, 11 Mar. 2011. Web. 8 Apr. 2011. <www.ite.org>.

must be explored to address road congestion.

The supply and demand of road space and capacity demonstrates a market failure, because consumers are not paying the true costs associated with driving. Pricing strategies and incentives are economically efficient solutions to more accurately assess consumers' willingness to pay for road space and capacity expansion. Some argue that using public expenditures for roadway improvements is more equitable, because it allows lower income households greater mobility. However, most benefits from increased capacity have been shown to benefit middle to upper class households. Improving travel mode choice is more equitable, as it addresses the needs of non-drivers, who often are of lower income.

By charging drivers the full cost for their vehicle travel, the market will encourage more efficient use of existing road capacity and may provide greater social benefits when considering all costs. Travel demand management, which attempts to assign true costs to the driver, results in a more efficient use of existing capacity. Travel demand management is not a single solution, rather it is a package of strategies that overall provides a greater benefit than increasing capacity of roads and highways. Some examples of more efficient uses of existing capacity include commute trip reduction programs, land use management, pedestrian and cyclist improvements, and public transit service investments.

Road pricing is another strategy that is used to more accurately charge motorists for their consumption of road space, clean air, and other community and environmental resources. It can be accomplished through VMT charges, weight-distance taxes (based on a combination of miles traveled and vehicle size and weight), smog fees (based on miles traveled and emissions per mile), and congestion pricing (tolls that vary by time of day, which are higher at peak periods).

In light of widespread government road-financing deficits, technologies that allow for more efficient and unobtrusive toll collection make road pricing increasingly attractive. However, road pricing is not an end in itself. It can be a way to reconfigure a transportation system by providing more travel options and reducing environmental impacts. However, road builders have been implementing their own road-pricing mechanisms for new roads or lanes paid for by tolls. This is not consistent with the environmentalist model of road pricing to reduce VMT by pricing existing roads and lanes. Pricing existing highways that do not have tolls will be revenue-positive. Pricing highways that have tolls can be revenue-positive or revenue-neutral. However, while pricing new roads raises revenue, it is generally used to finance expansion projects, which reinforces suburban development and increases VMT. This does not have to be the case.

LAND USE AND ENVIRONMENTAL IMPLICATIONS

The benefit of increased capacity brought by road expansion is reduced by the generated traffic that it produces. Generated traffic increases the drivers' costs and provides a smaller user benefit, especially since induced traffic consists of drivers who are willing to give up the trip once costs are too high. There are also implications on the environment. Increasing U.S. highway capacity at historic rates could result in 43 million metric tons more of carbon emissions compared to a no-build alternative.[18]

Transportation in general, and roadway expansion to increase capacity in particular, has implications for land use development. Improved accessibility stimulates certain types of development and locations for development. For example, highway improvements and increased capacity tend to encourage low-density, auto-oriented, sprawl at the urban fringe. Transit investment tends to encourage high-density, multi-modal, and urban redevelopment. Even in slow growth regions with moderate congestion, increasing highway capacity increases suburban development by 15-25%, with an even greater increase in larger cities with major congestion problems.[19]

Highways with user charges will almost always decrease VMT and should defray demand for highway expansion. Road pricing fees support development at the center of cities and discourage development at the urban fringe.[20] By strengthening the urban core, proceeds are used to offset the increased cost of driving by reducing taxes or funding transit improvements.

CONCLUSION

The long-term solution to traffic congestion is strategic travel demand management that is in keeping with smart growth principles. There are more efficient uses of existing capacity that can address congestion more economically than expensive capital improvement projects. Strategies including commute trip reduction programs, land use management, pedestrian and cyclist improvements, public transit service investments, and road pricing are more efficient congestion management tools.

This does not suggest that expansion has no utility or benefit and should never be applied. Nevertheless, accurate research and forecasts are imperative for an road expansion project to be beneficial in the long run. When they are considered appropriate, road and highway expansion projects should incorporate strategies to minimize negative externalities, for example, by making vehicle emission regulations more stringent in order to reduce pollution and by implementing land use regulations that limit sprawl. However, like “trying to cure obesity by loosening your belt,” roads and highways cannot be expanded indefinitely.

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[18] Noland, R. "Relationships between Highway Capacity and Induced Vehicle Travel." *Transportation Research Part A: Policy and Practice* 35.1 (2001): 47-72.
[19] Litman, Todd. "Generated Traffic and Induced Travel." *Institute of Transportation Engineers Journal* 71.4 (2011): 38-47. *ITE*. Victoria Transport Policy Institute, 11 Mar. 2011. Web. 8 Apr. 2011. <www.ite.org>.
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