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Agenda Item #:_

Staff Report
City of Manhattan Beach

TO: Honorable Mayor Montgomery and Members of the City Council

THROUGH: Geoff Dolan, City Manager

FROM: Richard Thomson, Director of Community Development
Ana Stevenson, Management Analyst
Erik Zandvliet, Traffic Engineer

DATE: July 15, 2008

SUBJECT: Consideration of a Speed Hump Policy in School Areas as Identified in the City Council Work Plan 2008-2009

RECOMMENDATION:
It is recommended that City Council adds Speed Humps to the Neighborhood Traffic Management Program "Toolbox" as described in this report.

FISCAL IMPLICATION:
There are no fiscal implications at this time for the implementation of a speed hump policy. Potential installation costs of approximately $2,500-$5,000 per speed hump if specific locations are approved.

BACKGROUND:
On October 1, 2002 and November 19, 2003, the City Council reviewed and approved the Citywide Neighborhood Traffic Management Program (NTMP). The Program and the associated "Toolbox" of traffic control measures were adopted separately from the General Plan to allow more flexibility in the future for amendments if needed. On September 6, 2005, the City Council reviewed the Toolbox, and made selected changes to some of the criteria and measures. The attached list of toolbox measures currently excludes speed humps as a traffic calming measure in any part of the City.

The City Council's 2008-2009 Work Plan includes a task to consider the potential impacts of allowing speed humps on streets surrounding school locations only within the City. Staff has researched the current state of the practice for the installation of speed humps and explored the feasibility of this measure on streets affected by school traffic and student pedestrians.

DISCUSSION:
Speed humps are used in many communities in southern California, and have proven effective when installed under controlled conditions and in selected locations. Many years of trial and evaluation have resulted in more universal practice and criteria that have been adopted both

nationally and locally. The speed hump design has become standardized and has been tested both physically and legally. A summary of various local agency criteria and industry standards is attached to this report. The only speed humps currently in use in Manhattan Beach are in the El Porto area. There are two on Ocean Drive that were installed as part of a traffic study done in the early 1990s. They have been generally effective in reducing speeds on Ocean Drive.

Speed humps are not a cure-all for speeding or cut-through traffic. There are many advantages and disadvantages, some of which are listed below:

PROS:

- Vehicle speeds typically decrease in the vicinity of the speed hump to approximately 24 miles per hour.
- Speed humps reduce speeds 24 hours a day, 7 days a week.
- Speed humps may decrease traffic volume by discouraging non-resident traffic.
- Speed humps may help calm traffic in areas where signs or other measures have not worked.

CONS:

- Speed humps increase the emergency response time for fire and police vehicles. Speed humps may disturb or injure patients riding in ambulances.
- Passing over a speed hump can potentially cause damage to emergency vehicle.
- Traffic may be diverted to an adjacent street to avoid the speed humps.
- Drivers tend to speed up between humps or may drive in the gutter to make up for lost time.
- Speed humps can be hazards to bicyclists, motorcyclists and pedestrians. Pedestrians can confuse speed humps for crosswalks.
- Signs and striping associated with speed humps can be unsightly to the neighborhood.
- Vehicle noise increases in the vicinity of speed humps due to braking and suspensions.
- People with disabilities may experience discomfort going over speed humps.

Speed Cushions

Speed cushions are similar to speed humps, except that the hump is divided into segments such that a wide tracked vehicle, such as a fire engine, could pass without traversing the hump. Narrower wheeled vehicles would still have to drive over at least one cushion, effectively slowing speeding drivers. However, drivers may cross the center of the road or drive in the gutter to avoid the cushions and align at least one set of wheels with the gap. Because this can increase the risk of a collision at a speed cushion, its design should discourage these types of movement. For that reason, speed cushions work best on streets with sufficient width for two-way traffic, preferably with a painted centerline, so that drivers are not tempted to cross the centerline to avoid the cushion.

Staff Review

The Fire and Police Departments have historically opposed speed humps on the basis that it impairs their response in an emergency, can potentially damage vehicles and injure passengers, and introduces unexpected obstructions on the street. There have been studies that found that emergency response times are longer on streets with speed humps. However, this information is dependent upon the actual routes taken, and must be weighed against the overall safety picture of reducing speeds, enhancing traffic safety, and potential frequency of emergency vehicle usage.

One of these studies, entitled "The Influence of Traffic Calming Devices upon Fire Vehicle Travel Times" in the City of Portland, is attached to this report.

On June 24, 2008 Fire, Police and Community Development staff met to discuss the potential implications of speed humps on streets adjacent to schools only. There was general consensus that speed humps should not be installed on Collector streets, such as Pacific Avenue, Meadows Avenue and Redondo Avenue, since these streets are primary emergency response routes. Collector streets also carry high traffic volumes that may be diverted to other neighborhood streets if speed humps are installed.

The Fire and Police Department staff did not object to the installation on local residential streets, however, as long as the speed humps were clearly marked and were not on main response routes. Additionally, the Fire Department would prefer that such installation were designed in a way that fire equipment could circulate around the hump rather than go over it. Speed cushions were cited as a possible alternative to a full-length speed hump. The Police Department recognizes speeding in school areas is an important community safety issue, and supports the use of speed humps at locations that would lower prevailing speeds and improve driving conditions where small children are walking.

Most streets in the City would not be candidates for speed humps, based on one or more criteria. For example all "major local", "collector" and "arterial" streets would be disqualified because of their classification. Many other local streets are key emergency routes since there are few arterial streets in the City. Still others are too short, too steep or have horizontal curves. Narrower streets, such as those less than 30 feet wide, tend to have lower prevailing speeds already and would not meet the minimum speed requirement. Lastly, many candidate street segments fail because the minimum number of residents would not sign a petition. If added to the Toolbox, it is estimated that less than 10% of the residential streets would qualify for them, and even fewer would meet the petition requirement.

Speed humps near schools could be considered as a possible qualifying criteria. Often, drivers do not realize that students may be present along the street during critical time periods in the morning and afternoon. In areas where school congestion does not force drivers to slow down, faster moving drivers have less time to react to potential conflicts, such as pedestrian crossings or school loading operations. During the rest of the day, on weekend and during the summer, children are less present but speed humps would remain effective in moderating speeds. This can be especially beneficial where schools and shared fields are used for extracurricular activities and intramural sports. Speed hump locations should be carefully chosen, because their effectiveness may be reduced for various reasons, such as school related congestion or other factors that reduce speeds. Evidence of speeding should be verified before placing speed humps. Speed humps should also be compared against other traffic calming measures in the Toolbox which may be more or less appropriate near schools, such as near school crosswalks.

Exhibits:

A. NTMP Toolbox Application Criteria
B. Speed Hump Eligibility Criteria Comparison Spreadsheet
C. Speed Cushion Description
D. Emergency Response Routes
E. Control Study Document-American Journal of Public Health
F. "The Influence of Traffic Calming Devices Upon Fire Vehicle Travel Times", City of Portland

EXH'⁾IT
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APP... DIX D

TABLE 1 (continued)

NEIGHBORHOOD TRAFFIC MANAGEMENT PROGRAM TOOLBOX APPLICATION CRITERIA –SEPTEMBER 6, 2005

TRAFFIC MANAGEMENT MEASURE	PROBLEMS TARGETED	STREET TYPE (1)	MINIMUM CRITERIA				
			VOLUME	SPEED	DIVERSION TO ADJACENT STREETS	GRADE	OTHER CRITERIA
LEVEL ONE TOOLS							
Enhanced Police Enforcement	Moving Vehicle Violations Running Stop Signs	All	(2)	(3)	None expected	N/A	None
Speed Monitoring Trailer	High Speeds	All	(2)	(3)	None expected	N/A	None
Neighborhood Traffic Watch Program	Moving Vehicle Violations Running Stop Signs	All	(2)	(3)	None expected	N/A	Requires willing participants/volunteers
Warning Signs, Posts and Markings	*Moving Vehicle Violations* *High Speeds* *Pedestrian Safety*	*All*	*(2)*	*(3)*	*None expected*	*N/A*	*Must indicate physical roadway condition*
Higher Visibility Crosswalk	Moving Vehicle Violations Pedestrian Safety Running Stop Signs	All	>500 ADT	(3)	None expected	N/A	-At current crosswalk location -Near pedestrian generating land use
Pedestrian Crossing and Paddle Signs	Moving Vehicle Violations Pedestrian Safety Running Stop Signs	All	> 500 ADT *> 100 peds/day*	(3)	None expected	N/A	-At current crosswalk location -Near pedestrian generating land use *-Crossings with limited visibility*

APP. DIX D

TABLE 1 (continued)

NEIGHBORHOOD TRAFFIC MANAGEMENT PROGRAM TOOLBOX APPLICATION CRITERIA –SEPTEMBER 6, 2005

TRAFFIC MANAGEMENT MEASURE	PROBLEMS TARGETED	STREET TYPE (1)	MINIMUM CRITERIA				
			VOLUME	SPEED	DIVERSION TO ADJACENT STREETS	GRADE	OTHER CRITERIA
LEVEL TWO TOOLS							
Traffic Signal Adjustments to Discourage Cut-Through Traffic	Cut-Through Traffic	All	>15% of peak hour volume is cut-through traffic	(3)	Must meet diversion chart criteria	N/A	-Must have identified cut-through traffic -Must have traffic signal adjacent to residential neighborhood
Turn Restrictions Via Signage	Cut-Through Traffic	All	> 15% of peak hour volume is cut-through traffic	(3)	Must meet diversion chart guidelines	N/A	Must have identified cut-through traffic
Rumble Strips/Dots	High Speeds	All	(2)	(3)	None expected	Less than 5 %	None
Speed Awareness and Electronic Signs	High Speeds	All	> 500 ADT	Critical speed is > 7 mph over posted limit	None expected	N/A	Conditions not readily apparent to driver such as topography, vegetation, etc.
Crosswalk Warning System	High Speeds, Pedestrian Safety	All	> 500 ADT	(3)	None expected	N/A	< 30 gaps per hour of sufficient length to cross
Raised Median Island	High Speeds, Cut Through Traffic	All	> 15% of peak hour volume is cut-through traffic	Critical speed is > 7 mph over posted speed	None expected	less than 10%	-Must not significantly impede emergency vehicle access -Must meet drainage requirements
Entry Island (Neighborhood Identification Island)	High Speeds, Cut Through Traffic	All	> 15% of peak hour volume is cut-through traffic	Critical speed is > 7 mph over posted speed	None expected	less than 10%	-Must not significantly impede emergency vehicle access -Must meet drainage requirements

APP. .DIX D

TABLE 1 (continued)

NEIGHBORHOOD TRAFFIC MANAGEMENT PROGRAM TOOLBOX APPLICATION CRITERIA –SEPTEMBER 6, 2005

TRAFFIC MANAGEMENT MEASURE	PROBLEMS TARGETED	STREET TYPE (1)	MINIMUM CRITERIA				
			VOLUME	SPEED	DIVERSION TO ADJACENT STREETS	GRADE	OTHER CRITERIA
Mid-Block Narrowing	High Speeds, Cut-through Traffic	All	> 15% of peak hour volume is cut-through traffic (between 500 and 2,000 total ADT on the street)	Critical speed is > 7 mph over posted speed	None expected	less than 10%	Must not significantly impede emergency vehicle access
Chokers at Intersections	High Speeds, Cut-through Traffic	L, ML, RC (ALL IF NO RC)	> 15% of peak hour volume is cut-through traffic (between 500 and 2,000 total ADT on the street)	Critical speed is > 7 mph over posted speed	None expected	less than 10%	Must not significantly impede emergency vehicle access
Lane Reduction/Lane Narrowing/Restriping	High Speeds, Cut-through Traffic	All	> 15% of peak hour volume is cut-through traffic (between 500 and 2,000 total ADT on the street)	Critical speed is > 7 mph over posted speed	Must meet diversion chart criteria	N/A	Must not create significant parking impact due to loss of parking
Stop Sign as Neighborhood Traffic Control Measure	High Speeds, Cut-through Traffic	L, ML, RC (ALL IF NO RC)	> 15% of peak hour volume is cut-through traffic (between 500 and 2,000 total ADT on the street)	(3)	Must meet diversion chart criteria	N/A	Requires review by City Traffic Engineer and City Council approval
Parking Restrictions	Non-Residential Parking Intrusion	All	N/A	N/A	Review impacts to Surrounding Streets	N/A	Parking Study

TABLE 1 (continued)

NEIGHBORHOOD TRAFFIC MANAGEMENT PROGRAM TOOLBOX APPLICATION CRITERIA –SEPTEMBER 6, 2005

TRAFFIC MANAGEMENT MEASURE	PROBLEMS TARGETED	STREET TYPE (1)	MINIMUM CRITERIA				
			VOLUME	SPEED	DIVERSION TO ADJACENT STREETS	GRADE	OTHER CRITERIA
LEVEL THREE TOOLS							
Raised Crosswalk	High Speeds, Pedestrian Safety	L, ML, RC (ALL IF NO RC)	(2)	Critical speed > 7 mph over posted speed	None expected	less than 10%	-Must meet drainage requirements Must not significantly impede emergency vehicle access > 25 pedestrians during peak hour, near pedestrian generator
Raised Intersection	High Speeds, Pedestrian Safety,	L, ML, RC (ALL IF NO RC)	(2)	Critical speed > 7 mph over posted speed	Must meet diversion chart criteria	less than 10%	-Must meet drainage requirements -Must not significantly impede emergency vehicle access > 25 pedestrians during peak hour, near pedestrian generator
Traffic Circle	High Speeds, Accident History, Vehicle Conflicts	L, ML, RC (ALL IF NO RC)	from 500 to 5,000 ADT	Critical speed > 7 mph over posted speed	Must meet diversion chart criteria	less than 10%	-Intersecting roadways must be of sufficient width -Loss of parking must be assessed
Restricted Movement Barrier	Cut-trough traffic, Vehicle conflicts	L, ML	> 15% of peak hour volume is cut-through traffic	(3)	Must meet diversion chart criteria	N/A	-Must meet drainage requirements -Must not significantly impede emergency vehicle access
Entrance Barrier-Half Closure	Cut-through Traffic, Vehicle Conflicts	L, ML	> 15% of peak hour volume is cut-through traffic	(3)	Must meet diversion chart criteria	N/A	-Must not significantly impede emergency vehicle access
Diagonal Diverter	Cut-through Traffic, Vehicle Conflicts	L, ML	> 15% of peak hour volume is cut-through traffic	(3)	Must meet diversion chart criteria	N/A	-If full diverter, cannot be truck or transit route, -Must not significantly impede emergency vehicle access

APPENDIX D

TABLE 1 (continued)

NEIGHBORHOOD TRAFFIC MANAGEMENT PROGRAM TOOLBOX APPLICATION CRITERIA –SEPTEMBER 6, 2005

TRAFFIC MANAGEMENT MEASURE	PROBLEMS TARGETED	STREET TYPE (1)	MINIMUM CRITERIA				
			VOLUME	SPEED	DIVERSION TO ADJACENT STREETS	GRADE	OTHER CRITERIA

Notes:

1) Street Type key: L – Local, ML – Major Local, RC – Residential Collector, C- Collector, All – All Residential Streets, excludes arterials

2) Specific volume (ADT) criteria may not be appropriate for this tool, it may be applied over a range of volume

3) Specific speed criteria may not be appropriate for this tool, it may be applied over a range of observed speeds at the discretion of the City Traffic Engineer or the Police Department

General Notes:

- final determination of certain control application based on review by City staff

- subject to modification by City Council on a case-by-case basis

EXHIBIT B

ELIGIBILITY CRITERIA FOR THE INSTALLATION OF SPEED HUMPS

CRITERIA	INSTITUTE OF TRANSP. ENGRS.	CITY OF PASADENA	CITY OF LA CANADA FLINTRIDGE
Type of Street	Residential	Residential	Local or residential street
Street Length	n/a	Minimum 800 feet Do not install on cul-de-sac	Full block length
Street Width	No greater than 40 feet	n/a	40 feet or less
Number of Lanes	No more than 2 travel lanes	No more than 2 travel lanes	no more that two travel lanes
Street Grade	8 percent or less	5 percent or less	8% or less
Horizontal/Vertical Alignment	Avoid within horizontal curves of less than 300 feet centerline radius and on vertical curves with less than the minimum safe stopping sight distance.	Street must have adequate vertical and horizontal alignment and sight distance	Roadway should not have a substantial horizontal or vertical curvature.
Sight Distance	Minimum safe stopping sight distance	Adequate sight distance	n/a
Traffic Speeds	Prima facie speed limit is 30mph or less. Carefully consider for street where the majority of the vehicles travel at relatively fast speeds (45 mph or greater)	25 mph or less	Posted 30 mph or less with prevailing speeds greater than 35 mph.
Traffic Volumes	Less than 3000 vehicles per day. When considering streets with higher volumes, should give special evaluation and justification for their use.	Less than 3000 vehicles per day. Determination on a case by case basis	500 - 2000 vehicles per day
Traffic Safety	Determination that such an installation will not introduce increased accidents.	n/a	n/a
Vehicle Mix	Do not install on street with more than 5 percent of long wheel-base vehicles unless there is a reasonable alternative route.	Do not install on truck routes.	n/a
Emergency Vehicle Access	Do not install on emergency routes.	Do not install on emergency routes	n/a
Transit Routes	Do not install on transit routes	Do not install on transit routes	Not on a public transit roadway
Citizen Support	Majority of the residents along the affected portion of street should ideally support their installation.	67 percent of residents along affected portion of subject street must support their installation	80% of properties in favor of installation.
Other	Give special consideration to motorcycles, bicycles and other type of special vehicles that use the street.		The proposal must be reviewed by LA County Fire and Sheriff's departments

BILITY CRITERIA FOR THE INSTALLATION OF SPEED HUMPS

CRITERIA	LA COUNTY PUBLIC WORKS	CITY OF PALO ALTO	CITY OF BURBANK
Type of Street	Local residential street	Local residential streets	Residential
Street Length	No minimum - humps shall be spaced up to 600 feet.	No minimum requirements provided that there can be at least 250 feet between a hump and a stop sign.	n/a
Street Width	Not over 40 feet	n/a	No greater than 40 feet
Number of Lanes	1 lane each direction	n/a	No more than 2 travel lanes
Street Grade	5% of less	not to exceed 5%	Less than 5 percent
Horizontal/Vertical Alignment	Do not install on street that have curbs.	Not to be installed within 100 feet of the beginning or end of a curb of less than 300 feet centerline radius.	300 feet or more horizontal center line radius
Sight Distance	n/a	stopping sight distance	n/a
Traffic Speeds	30 mph or less	Minimum of 32 mph	Prevailing speeds of 30 mph or more
Traffic Volumes	500 - 2000 vehicles per day	500 - 4000 ADT	Minimum daily traffic volumes over 500 cars per day
Traffic Safety	Shall not be located on a thoroughfare which impacts an area servicing more than 75 homes or resident units.	n/a	n/a
Vehicle Mix	n/a	Do not install on truck or transit routes	n/a
Emergency Vehicle Access	Do not install on primary route for fire and ambulance or 25 feet of either side of fire hydrants	Do not install on primary or routine access route for emergency vehicles	Do not install on designated emergency vehicle access routes.
Transit Routes	Do not install on bus routes	Do not install on transit routes	Do not install on transit routes
Citizen Support	75% of the residents fronting the roadway must support the installation.	66% of all dwelling units with addresses on affected streets	67 percent of owners/residents on the impacted street and at least 80 80 percent of residents must be contacted and noted on petition
Other	Installation is approved by the Fire Prevention Unit.	At least 6 reported speed related traffic accidents in the last 3 years.	

BILITY CRITERIA FOR THE INSTALLATION OF SPEED HUMPS

C[illegible]ERIA	CITY OF CAMARILLO	CITY OF SANTA BARBARA	CITY OF WESTLAKE VILLAGE
Type of Street	Residential or Local road	Local or Collector roadways	Residential street
Street Length	n/a	n/a	At least 1/4 mile long
Street Width	No greater than 40 feet	n/a	40 feet or less
Number of Lanes	No more than 2 traffic lanes	n/a	one lane each direction
Street Grade	n/a	6% or less	5% or less
Horizontal/Vertical Alignment	n/a	n/a	n/a
Sight Distance	n/a	n/a	n/a
Traffic Speeds	87 percent of the surveyed motorists exceeds a speed of 25 mph	no more than 30 mph	67% of the motorists exceed the 25 mph speed limit
Traffic Volumes	exceeds 2500 vehicles in a 24 hour period.	must be greater than 1000 but no more than 4000 vehicles in a 24 hour period	Greater than 2000 ADT
Traffic Safety	n/a	A speed survey must show that more than 25 percent of the motorist traveling exceed the posted speed by 5 mile or more	n/a
Vehicle Mix	n/a	n/a	n/a
Emergency Vehicle Access	City to notify Fire, Sheriff and Ambulance services on new installations of speed humps	Shall not be constructed on streets that are designated as primary emergency response w/o fire approval	n/a
Transit Routes	n/a	n/a	n/a
Citizen Support	60 percent of the residents, excluding churches and apartments, that face the street within 75 feet from the curb.	A three-quarter (75%) majority must agree that speed humps are desired	At least 60% of the property owners that abut the proposed speed hump.
Other			City will publish notice of a public hearing to all property owners within 300 feet of the street segment

3ILITY CRITERIA FOR THE INSTALLATION OF SPEED HUMPS

CRITERIA	CITY OF GLENDALE	CITY OF THOUSAND OAKS	CITY OF CALABASAS
Type of Street	Street must be located in "residence district" as defined in CVC, and designated local/collector in Gen Pln	Residential road	Residential road
Street Length	Minimum block length of 500 feet	Minimum 1/4 of a mile	n/a
Street Width	No greater than 40 feet	No more than 40 feet	n/a
Number of Lanes	No more than 2 travel lanes	No more than 2 traffic lanes	n/a
Street Grade	10 percent or less	n/a	5% or less
Horizontal/Vertical Alignment	Adequate vertical and horizontal alignment	n/a	n/a
Sight Distance	Shall provide a min. of 200 feet clear visibility on approach to hump	n/a	n/a
Traffic Speeds	Speed limit shall be no greater than 25 mph as determined in accordance with state law. The measured 85th percentile speed of traffic shall be equal to or greater than 30 mph.	25 mph	25 mph
Traffic Volumes	Between 1500 and 5000 vehicles on local residential streets, between 3000 and 5000 on residential collector streets, total in both directions, in 24 hr period avg wkdy	must exceed 2500 vehicles in a 24 hour period	Under traffic calming guidelines
Traffic Safety	n/a	More that 87 percent of the surveyed motorists exceed a speed of 25 mph	n/a
Vehicle Mix	Do not install on truck routes	n/a	n/a
Emergency Vehicle Access	Do not install on emergency routes	n/a	n/a
Transit Routes	Do not install on transit routes	n/a	n/a
Citizen Support	75 percent in support of installation	60 percent of the residents that face the street	75 percent of the residents fronting the roadway in question
Other			Speed humps shall not be installed within 100 feet of any intersection

BILITY CRITERIA FOR THE INSTALLATION OF SPEED HUMPS

CRITERIA	CITY OF CULVER CITY	CITY OF AGOURA HILLS	COUNTY OF VENTURA
Type of Street	Local residential streets only	Residential streets	Residential road or local road
Street Length	Approx. 1/4 mile for streets w/ intersections at both ends. At least 800 feet on cul-de-sac streets.	Minimum of 1/4 mile and conform to the definition of "Residential District" in the California vehicle code.	Definition of "Residential District" in the California vehicle code.
Street Width	No greater than 40 feet	n/a	40 feet or less
Number of Lanes	No more than 2 travel lanes	n/a	no more than two traffic lanes
Street Grade	6 percent or less	6% exceptions for steeper grades	n/a
Horizontal/Vertical Alignment	Shall not be installed where street curvature has a radius of 300 feet or less.	may be allowed. Care should be taken with respect to visibility over crest vertical curves.	Can not be installed due to severe horizontal and vertical curves and excessive street down grade.
Sight Distance	n/a	n/a	Inadequate sight distance
Traffic Speeds	Legal speed limit of 25 mph or less. At least 66.7% of traffic observed during non-peak hrs exceeding posted or legal speed limit.	60% of the vehicles on the street are exceeding the 25 mph speed limit	67% of the motorists exceed the 25 mph speed limit
Traffic Volumes	Between 2500 and 7500 vehicles per day.	Minimum daily volume of 2000 vehicles or 200 during any peak hour. Amend the minimum volume criteria when the prevailing speed exceeds 40 mph to 1400 per dayor 140 per hour.	Greater than 1000 vehicles per day.
Traffic Safety	n/a	n/a	n/a
Vehicle Mix	n/a	n/a	n/a
Emergency Vehicle Access	Do not install on primary emergency vehicle access routes.	n/a	Notify P.D. and Fire of new speed humps.
Transit Routes	Do not install on transit routes	n/a	n/a
Citizen Support		At least 60% of the affected residents	At least 67% of the property owners.
Other		Humps should be installed at approximately 400 feetspacing. The minimum number of humps on any street should be three.	Speed humps shall not be installed on streets where the traffic will be diverted to a nearby residential or local street

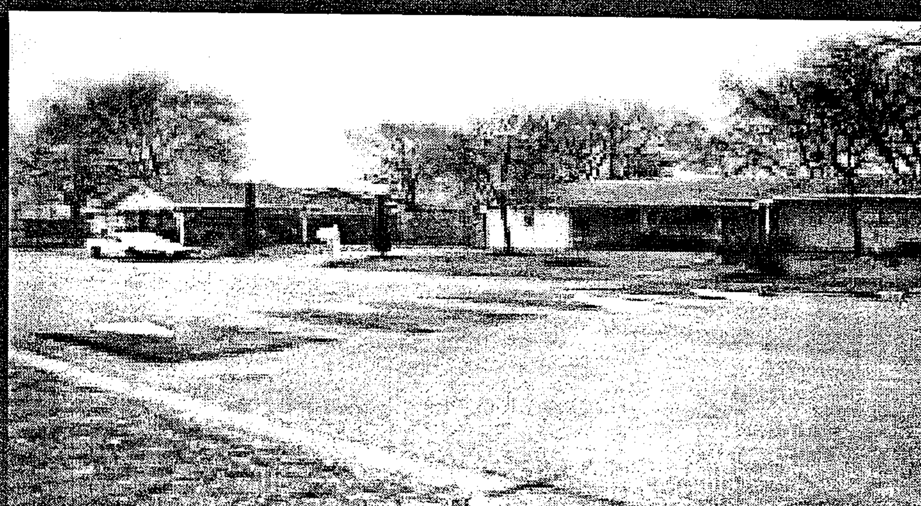
.BILITY CRITERIA FOR THE INSTALLATION OF SPEED HUMPS

CRITERIA	CITY OF PLACENTIA	CITY OF MISSION VIEJO	CITY OF SIMI VALLEY
Type of Street	Local residential streets only	Residential streets	Residential road or local road
Street Length	Minimum of 1,500 feet between stop signs or traffic signals.	Minimum of 1/4 mile and conform to the definition of "Residential District" in the California Vehicle Code. Not on very short blocks or cul-de-sacs	Minimum of 1/4 mile and conform to the definition of "Residential District" in the California Vehicle Code. Not on cul-de-sacs.
Street Width	n/a	40 feet or less	40 feet or less
Number of Lanes	No more than 2 travel lanes	no more than two traffic lanes	no more than two traffic lanes
Street Grade	n/a	5% or less	n/a
Horizontal/Vertical Alignment	n/a	Only on roads with adequate horizontal and vertical alignment as determined by City Engineer	n/a
Sight Distance	n/a	Not on roads with inadequate sight distance	Inadequate sight distance
Traffic Speeds	Legal speed limit of 25 mph or less. Prevailing speeds must exceed 30 mph	15% of the vehicles on the street must exceed the 32 mph critical speed Legal speed limit of 25 mph.	85% of the motorists exceed the 25 mph speed limit
Traffic Volumes	Greater than 3,000 vehicles per day	Minimum daily volume of 2000 vehicles per day	Average daily volume greater than 2,000 vehicles per day
Traffic Safety	n/a	Collision history considered.	n/a
Vehicle Mix	n/a	n/a	n/a
Emergency Vehicle Access	Do not install on priority emergency vehicle access routes.	n/a	Police Dept. must concur that it will not adversely affect access.
Transit Routes	Do not install on transit routes	n/a	n/a
Citizen Support	At least 65% of homes on street as well as 65% of homes on adjacent parallel streets, as determined by City Engineer.	At least 67% of the households with addresses on the street segment	At least 67% of the residents fronting the street. Includes apartment residents.
Other	Notify w/in 300' of subject street. Staff, Traffic Commission and Council review. Priority List, annual funding limits	Review by emergency service agencies. City Council approval.	Notice posted in local newspaper, on street, at intersections, and on parallel streets.

EXHIBIT C

NTMP Toolbox
Potential Revisions

- Speed Cushions
  - Similar to speed humps
  - Divided into segments
  - Wheel track for larger vehicles
  - Drivers adjust alignment to avoid cushion



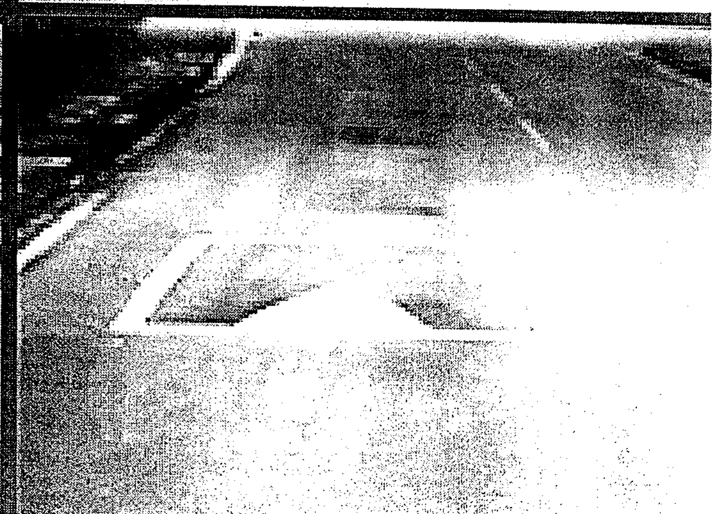


EXHIBIT
D

Manhattan Beach Fire Department

EMERGENCY RESPONSE ROUTES

EXHIBIT
E

16

A Matched Case–Control Study Evaluating the Effectiveness of Speed Humps in Reducing Child Pedestrian Injuries

| June M. Tester, MD, MPH, George W. Rutherford, MD, Zachary Wald, MCP, and Mary W. Rutherford, MD

Objectives. We evaluated the protective effectiveness of speed humps in reducing child pedestrian injuries in residential neighborhoods.

Methods. We conducted a matched case–control study over a 5-year period among children seen in a pediatric emergency department after being struck by an automobile.

Results. A multivariate conditional logistic regression analysis showed that speed humps were associated with lower odds of children being injured within their neighborhood (adjusted odds ratio [OR]=0.47) and being struck in front of their home (adjusted OR=0.40). Ethnicity (but not socioeconomic status) was independently associated with child pedestrian injuries and was adjusted for in the regression model.

Conclusions. Our findings suggest that speed humps make children's living environments safer. (*Am J Public Health.* 2004;94:646–650)

Pedestrian injuries caused by automobile collisions are a leading cause of death among children aged 5 to 14 years.[1] The demographic characteristics of children injured by automobiles have remained the same over the past 20 years, with boys, children between the ages of 5 and 9 years, and children living in neighborhoods of low socioeconomic status (SES) at highest risk.[2–4]

Children en route to school or at play in front of their homes are exposed to roads and street traffic. Modifying traffic patterns is a passive and sustainable public health intervention that may make children's living environments safer.[5] Traffic patterns can be modified with a number of engineering strategies that fall under the rubric of "traffic calming." Distinct from speed limit signs or stop signs, traffic calming measures such as speed humps, street closures, median barriers, and traffic circles are successful in providing long-term safety for pedestrians and motorists because they are physical structures with designs that are self-enforcing rather than requiring police enforcement.[6–8]

For years, European countries such as Denmark, the Netherlands, and Great Britain, as well as Australia and New Zealand, have implemented and tested the effects of traffic calming.[6] A report published in British Columbia summarized 43 international studies that demonstrated reductions in collision frequency rates ranging from 8% to 100% after implementation of traffic calming measures.[6] A Danish study showed that, in comparison with control streets, 72% fewer injuries occurred on experimental streets incorporating a variety of traffic calming measures in addition to new speed zoning requirements.[9]

As a result of the successful efforts in other countries, there is developing interest in traffic calming in the United States, and the Federal Highway Administration, in cooperation with the Institute of Transportation Engineers, has initiated a national traffic calming technical assistance project.[6] However, the majority of safety studies focusing on traffic calming measures have assessed accident statistics before and after installation, and there is no available hospital-based information on the specific effects of these interventions on childhood pedestrian injury.

Oakland has historically been one of the most dangerous cities in California in which to be a pedestrian, exhibiting, for example, the highest rate of pedestrian fatalities among the state's cities in 1995.[10] In that year, after a series of child pedestrian deaths, the Oakland Pedestrian Safety Project was formed. This multidisciplinary alliance addressed child and senior pedestrian injuries occurring in the city of Oakland and advocated for installation of speed humps. Over the 5-year period 1995 to 2000, Oakland installed about 1600 speed humps on residential streets. In this study, we examined the effect of residing on a street with speed humps on the odds of child pedestrian injuries in Oakland.

METHODS

We conducted a matched case–control study among Oakland residents younger than 15 years over the 5-year period March 1, 1995, to March 1, 2000. Case patients were children who were seen in the emergency department at Children's Hospital Oakland after having been struck and injured by an automobile on a residential street. Since this hospital receives all pediatric ambulance trauma transports (including deaths on the scene) from the city of Oakland, it was considered an appropriate choice to target child pedestrians injured in Oakland. Case patients were each compared with 2 respective controls matched in regard to age and gender. The purpose of the study was to determine whether these children who had been struck by automobiles were any less likely to live near a speed hump than their peers who lived in the same city boundaries but visited the emergency room that day for a reason other than being hit by a car.

We identified case patients retrospectively from a trauma database using *International Classification of Diseases* (9th Revision)[11] E-code E814.7 (motor vehicle traffic accident involving collision with a pedestrian). Cases were limited to those involving children younger than 15 years who were residents of the city of Oakland and who were injured or died as a result of the collision. We reviewed charts and emergency medical service data sheets to eliminate parking lot injuries, injuries involving bicyclists who had been misclassified as pedestrians, and injuries suffered by children in driveway rollover collisions. In addition, we reviewed traffic report data from the Oakland Police Department, primarily to

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confirm locations of collisions. When necessary, we reviewed original traffic reports for further clarification.

We also restricted our analysis to children injured or killed within 0.25 mi (0.4 km) of home and used a street atlas[12] to determine whether the injury occurred on the street block of the child's residence (defined by Mueller et al.[2] as the "index street"), within a 0.25-mi radius (about 5 blocks, considered the "surrounding neighborhood"[2]), or at a more distant location within Oakland. The type of street on which a child lived was classified with the street atlas as well.[12] Only children residing on minor roads (residential streets) were eligible for the study, because speed humps are installed only on such roads.

Living on a street with a speed hump, or within 1 block of a speed hump, was our principal predictor variable. We used data from the Department of Traffic Engineering in Oakland to determine the exact locations and dates of installation of speed humps (Department of Traffic Engineering, unpublished data, 1995–2000). Speed humps that were located on the other sides of primary or secondary roads (arteries) or were installed after the date of the injury were not considered.

As mentioned, we matched each case patient, according to age, gender, and date of emergency department visit, with 2 controls seen in the emergency department that same day for a reason other than being struck by a car. We identified all eligible controls of the same sex and with the same year of birth as the case patient from the daily log and randomly selected 2 such individuals. In situations in which there were fewer than 2 control patients born in the same year as the case patient, we made a random decision to search the 1 year above or below the age of the case patient, and then 2 years above or below and so on, until a suitable control was identified. Ninety-three percent of all controls were within 2 years of age of their respective case patients.

Controls were restricted to Oakland residents living on residential streets. We collected information on ethnicity and insurance status (classified as private, public, or self-pay) from medical records. In addition, we categorized the SES of patient and control households, using 1990 census data on median household income within the case patient or control's census tract, as low ($0–$15 736), medium ($15 737–$30 115), or high (more than $30 115).[13] Finally, we examined the records of case patients and controls to ascertain the presence of certain preexisting diagnoses, such as cerebral palsy, mental retardation, paraplegia, and developmental delay, that would have affected their walking ability and, thus, their potential to be exposed as pedestrians to automobile traffic.

Statistical analyses were performed with Stata software (Stata Corp, College Station, Tex). We used McNemar matched pairs analyses in examining the 200 case–control pairs (100 case patients each matched to 2 controls). When a factor is truly protective against disease, there are more case–control pairs in which the case lacks (and the control has) this protective factor than the converse. Separate univariate analyses focused on ethnicity, census tract household income, and insurance status to determine whether they were independent predictors of child pedestrian injuries. Once significant ($P<.05$) variables were determined, we constructed a multivariate conditional logistic regression model that included only these variables.

RESULTS

We identified 236 individuals who had been seen in the emergency department during the study period and had been assigned an E-code of E814.7. We eliminated 52 potential case patients because they (1) were not Oakland residents at the time of admission, (2) were injured outside Oakland, (3) were more than 14 years of age, (4) were bicyclists who had been misclassified as pedestrians, or (5) had been injured by an automobile backing up within a driveway or parking lot. We eliminated an additional 84 potential patients because they either lived on an artery street or had been injured outside of their neighborhood, yielding a final study sample of 100 case patients.

Case patients and controls were similar in terms of age, gender, insurance status, median household income, and proportion with an underlying premorbid neurodevelopmental disease (Table 1). Case patients were more likely to be Asian or of Hispanic ethnicity. The odds of Asian children having been involved as a pedestrian in an accident were 5.8 times as high as those for White children ($P=.018$), and the odds of Latino children having been involved were 4.3 times as high ($P=.038$). Admitting diagnoses of controls are available on request from the authors.

Unadjusted odds ratios (ORs) derived from a matched pairs analysis showed a protective effect of speed humps. In comparison with children living more than a block from a speed hump, those living within a block of a speed hump were significantly less likely to be injured as pedestrians within their neighborhood (14% vs 23%; OR=0.50; 95% confidence interval [CI]=0.27, 0.89) (Table 2). Among the 100 case patients, 49 were actually hit on the block in front of their home (index street). As a subset, these children were even less likely to have a nearby speed hump than their controls (12% vs 24%; OR=0.38; 95% CI=0.15, 0.90) (Table 2).

We performed multivariate logistic regression analyses using both predictor variables and included race and ethnicity in the model. After control for race and ethnicity, speed humps were associated with significantly lower odds of children being injured in their neighborhood (adjusted OR=0.47; 95% CI=0.24, 0.95) and being struck on the block immediately in front of their home (adjusted OR=0.40; 95% CI=0.15, 1.06) (Table 2).

DISCUSSION

In our observational study, we found that children who lived within a block of a speed hump had significantly lower odds of being struck and injured by an automobile in their neighborhood. Living within a block of a speed hump was associated with a roughly 2-fold reduction in the odds of injury within one's neighborhood (adjusted OR=0.47). This protective effect was even more pronounced among the subset of children who were injured on the block immediately in front of their house (index street). Children living within a block of a speed hump exhibited a 2.5-fold reduction in the odds of being injured on their street (adjusted OR=0.4). These results highlight the effectiveness of speed humps in reducing child pedestrian injuries.

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TABLE 1—Demographic Characteristics of Case Patients and Controls

	Case Patients (n = 100)	Controls (n = 200)	Odds Ratio	P^a
Male, No. (%)	68 (68)	136 (68)	...	...
Age, y, mean (SD)	6.8 (3.5)	6.6 (3.7)	...	.63
Ethnicity, %				
White	3 (3)	16 (8)	Reference	
Black	49 (49)	117 (58.5)	2.4	.187
Native American/other	11 (11)	21 (10.5)	3.2	.115
Hispanic	22 (22)	31 (15.5)	4.3	.038
Asian	15 (15)	15 (7.5)	5.8	.018
Insurance status				
Private insurance	17 (17)	43 (21.5)	Reference	
Public insurance	78 (78)	147 (73.5)	1.3	.366
Self-pay	5 (5)	10 (5)	1.3	.717
Household income, $ (census tract)				
High (> 30 115)	12 (12)	39 (19.5)	Reference	
Medium (15 737-30 115)	75 (75)	136 (68)	1.8	.105
Low (0-15 736)	13 (13)	25 (12.5)	1.7	.265
Premorbid diagnosis[b]				
Mild mental retardation	1 (1)	1 (0.5)	...	
Developmental delay	0 (0)	3 (1.5)	...	

Note. A univariate analysis of age, ethnicity, insurance status, household income, and presence of a premorbid diagnosis showed that only ethnicity was independently associated with child pedestrian injury.
[a]All *P* values were obtained from conditional logistic regression analyses, except for age, which was obtained with a 2-tailed test of means.
[b]Case patients and controls were screened for the presence of any of the following premorbid diagnoses: cerebral palsy, mental retardation, quadriplegia, paraplegia, and developmental delay.

Exposure to Traffic

Increased exposure to traffic (especially traffic at high volume and speed) is a known risk factor for child pedestrian injury. Stevenson and colleagues showed that an increase in volume of 100 vehicles per hour is associated with an incremental increase of about 2.0 in the odds of pedestrian injury.[14] Average speeds traveled on streets are also associated with risk of injury, and at least 2 studies have demonstrated that a higher proportion of vehicles exceeding the posted speed limit is associated with higher odds of child pedestrian injuries.[14,15] In addition to the type of street, the number of streets that children cross on their way to school seems to affect their risk.[16]

Need for Passive Environment Modification

Given the relationship between exposure to traffic and risk of child pedestrian injuries, we have essentially 2 prevention strategies at our disposal: we can protect children from fast-moving traffic by modification of either their behavior or their traffic environment. There have been multiple attempts to modify children's behavior, including school training programs,[17] "traffic clubs" designed to educate parents and children about safe behavior on streets,[18] simulation games,[19] and community-level interventions.[20] For the most part, however, these educational efforts have been unable to exert meaningful changes in the long-term behavior of children, largely owing to the developmental limitations of preschool-aged children.[20] As a result, a great deal of attention has shifted to environment modification and the promise it holds for affecting child pedestrian injury rates.

TABLE 2—Odds of Pedestrian Injury Within a Child's Neighborhood and Odds of Injury on a Child's Index Street of Residence When Child's Home Is Within 1 Block of a Speed Hump: Multivariate Model

	Case Patients (n = 100), No. (%)	Control Subjects (n = 200), No. (%)	OR (95% CI)[a]	Adjusted OR (95% CI)[b]
Neighborhood injury	14 (14)	46 (23)	0.50 (0.27, 0.89)	0.47 (0.24, 0.95)
Index street injury	6 (12)	24 (24)	0.38 (0.15, 0.90)	0.40 (0.15, 1.06)

Note. OR = odds ratio; CI = confidence interval.
[a]Calculated from McNemar matched pairs analysis.
[b]Calculated from multivariate model including ethnicity.

Focus on Neighborhood Injury

The deliberate focus of our study was on pedestrian injuries occurring in a child's own neighborhood (defined here as within a 0.25-mi radius of the child's home) as opposed to all injuries, including those occurring at more distant sites. We focused on such injuries because although children leave their neighborhoods with adults (and often in automobiles), most of their unsupervised time is likely to be near home. In addition, the traffic calming methods we examined can be applied only to residential streets. One 8-year study that examined fatal head injuries revealed that injuries to pedestrians were the most common cause of fatal head injuries and that 53% of those injured were playing in the street at the time of the injury. Of the 135 accidents that fell into this category, only 1 involved a child who had been under adult supervision at the time of the accident (the remaining children had been supervised by siblings or other children).

The same study showed that 80% of fatal pedestrian injuries had taken place within 1 mi (1.6 km) of the child's home.[21] Among the 184 children we initially identified for this study, 125 (68%) were eligible for the study because their injury occurred within 0.25 mi of home (the other children were eliminated because they lived on arterial streets). Therefore, our data suggests that roughly two thirds of injuries occur within the 0.25 mi surrounding a child's home. Passive interventions that

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reduce child pedestrian injuries are likely to be of greater benefit in areas where children are prone to spend time without adults.

In our study, SES was not a significant independent predictor of child pedestrian injury. Mueller and colleagues found that living in a census tract with a median household income level below $20 000 was associated with 7.0-fold higher odds of injury than living in a census tract with a median income level above $30 000.[2] Other research points toward an association between increasing rates of pedestrian injury and lower SES, as approximated by census tract of residence,[4] spatial modeling of census tract and other data with a geographic information system,[22] and more indirect indicators of lower SES such as living near a convenience store, gas station, or fast food store.[15]

It is possible that, in our population, "overmatching" was the reason SES was not found to be an independent risk factor. Case patients were not matched with controls on SES, but if lower SES is associated with both increased odds of injury[2] and increased odds of an emergency department visit,[23] choosing controls from the emergency department may have resulted in overmatching in terms of SES.

Limitations

Our study involves potential methodological limitations. For example, limiting measurement to speed humps on a child's street ignores the potential protective effect of speed humps around the corner from a child's house. Thus, by measuring speed humps lateral to an index street (rather than in a 1-block radius), we may have underestimated the relevant rate of exposure to this intervention, which would have affected our estimation of the intervention's protective impact.

There are also limitations involved with our study sample. While relying on emergency department visits ensured that we incorporated higher severity injuries (including deaths), injuries that were not reported to the emergency medical services (and for which children may have been taken by their family to their regular doctor) would have been missed. This would mean that our sample underrepresented lower acuity injuries. It is also possible that our sample underrepresented younger children, in that children younger than 5 years are more likely to be hit in their driveway (often by a backing automobile)[24,25]; we excluded children in this age group from our study because such injuries are not related to the flow of street traffic.

Finally, it is possible that significant confounding factors were not addressed in this study. Some research suggests that the presence of sidewalks is not a significant contributor to odds of injury,[2,15] and other research suggests that the presence of sidewalks is a strong risk factor, with an odds ratio of 11.0.[14] We would have liked to control for the presence of sidewalks, but there were no reliable retrospective data on sidewalk or curb presence available to do so. Also, since much of the earlier literature points to lower SES as a risk factor for child pedestrian injury, the reason for our inability to reproduce this relationship may have been that the factors we used to approximate SES—census tract household income and medical insurance status—are inappropriate proxies for SES.

CONCLUSIONS

We found that speed humps were associated with a 53% to 60% reduction in the odds of injury or death among children struck by an automobile in their neighborhood. These findings invite additional research on the protective effects of traffic calming interventions and offer a framework for studying pedestrian injuries in relation to physical interventions implemented within a localized geographic region. Further confirmation of the protective effects of speed humps would be useful and could be augmented by additional information on stop signs or other factors that would affect slowing distances on either side of a speed hump. Our study provides direct observational evidence that speed humps are associated with a reduction in the odds of childhood pedestrian injuries and supports the installation of speed humps by traffic engineering departments. ■

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Contributors

J.M. Tester conceived the study, performed all analyses, and led the writing of the article. G.W. Rutherford assisted in data analyses, interpretation of findings, and revisions of the article. Z. Wald contributed to conceptualization of ideas as well as reviews of the article. M.W. Rutherford contributed to the study design and interpretation of the findings.

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Human Participant Protection

This study was reviewed and approved by the institutional review board of Children's Hospital and Research Center at Oakland. Informed consent was not required by the review board because patients did not need to be contacted for this retrospective data analysis.

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EXHIBIT
F

The Influence of Traffic Calming Devices upon Fire Vehicle Travel Times

Michael A. Coleman

INTRODUCTION

The City of Portland is well known for its high quality of life and the efforts that have been made to maintain and enhance neighborhood livability. Part of this success is a result of the City's Traffic Calming Program which has been effective in minimizing the impacts of traffic on neighborhood streets. The program's primary goal is to reduce overall traffic speeds on residential streets and in school zones. Traffic circles and speed bumps are the program's most effective tools. To date, 65 traffic circles and approximately 300 speed bumps have been installed on numerous neighborhood collector and local service streets throughout the City.

Unfortunately, traffic calming devices that reduce overall vehicular speeds can also impact some emergency response vehicles by increasing their response times. Given the number of existing and planned traffic calming devices, the City of Portland's Fire Bureau has become more concerned in recent years about the cumulative impact of these devices on their ability to respond quickly to emergencies. Neighborhoods are also struggling with how to best address the problem of speeding traffic on their neighborhood streets while not significantly reducing response times for emergency service providers.

A survey of other cities found no information on this subject that would help Portland deal with it's problem. Thus, to gain a better understanding of the impacts of traffic calming, the City conducted a research project to measure the affects of both traffic circles and speed bumps on response times for various types of fire apparatus. This information is now available for planning and designing individual traffic calming projects. More importantly, though, it will be useful as part of community-wide discussions on the broader public safety policy issue; this being the implications associated with slowing vehicular traffic on neighborhood streets while increasing emergency vehicle response times.

The City is currently addressing this policy issue with an 18-month planning process that will take this question out to the community for a public discussion and review of the competing safety issues. From this, an adopted set of emergency response routes will be incorporated into the City's transportation master plan. Policies will be written based on the type of emergency response route and the extent to which traffic calming may be used on those routes.

PURPOSE

There are two purposes for this paper. The first is to show how traffic calming devices affect fire vehicle travel times and to describe the testing that quantified the relationship between the two. The second purpose is to describe the City of Portland's planning-based approach to addressing the conflict between traffic calming and emergency service response.

CALMING DEVICE IMPACTS ON FIRE RESPONSE TIMES

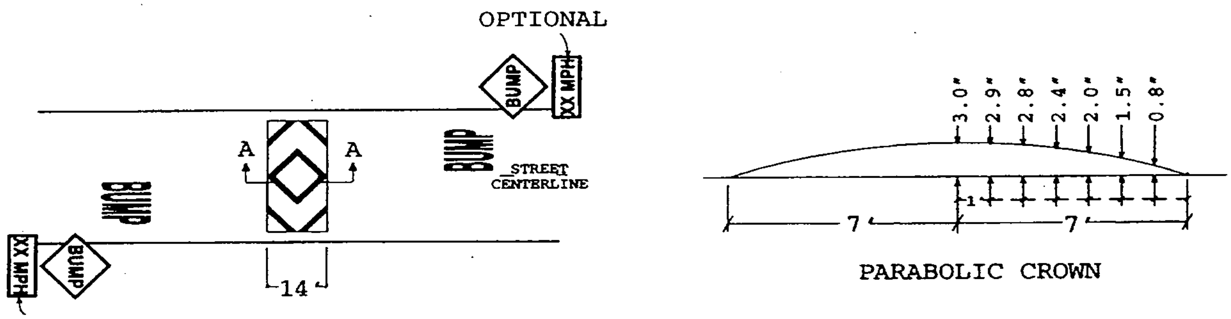
During the Fall of 1995 Portland's Fire Bureau and Bureau of Traffic Management conducted a thorough data collection effort to help quantify the relationship between three types of traffic calming devices and fire vehicle travel times. Six different types of fire vehicles were driven on streets calmed with traffic circles, 22-foot speed bumps, and 14-foot speed bumps. The resulting test data were the basis for determining the travel time impacts of the calming devices. Figures 1, 2, and 3 illustrate the three devices. Table 1 lists basic information about the fire vehicles used in the study.

Table 1
Fire Vehicle Specifications

Vehicle	Overall Length	Wheel-base	Weight (lbs)	Horse-power (HP)	Wt./HP Ratio (lbs/HP)	0-40 mph Accel. Time (sec)
Engine 18	29'10"	15'5"	34,860	185	188	19
Rescue 41	21'0"	11'6"	na	185	na	12
Squad 1	27'0"	14'6"	23,170	275	84	17
Truck 1	48'0"	21'0"	53,000	450	118	20
Truck 4	57'0"	13'0"	53,960	450	120	22
Truck 41	37'6"	16'9"	42,100	350	120	27

The testing attempted to take into account four factors that might influence the speed at which fire vehicles are driven around traffic circles or across speed bumps. The four factors were: the driver, the type of fire vehicle, the desirable vehicle speed, and the type of calming device.

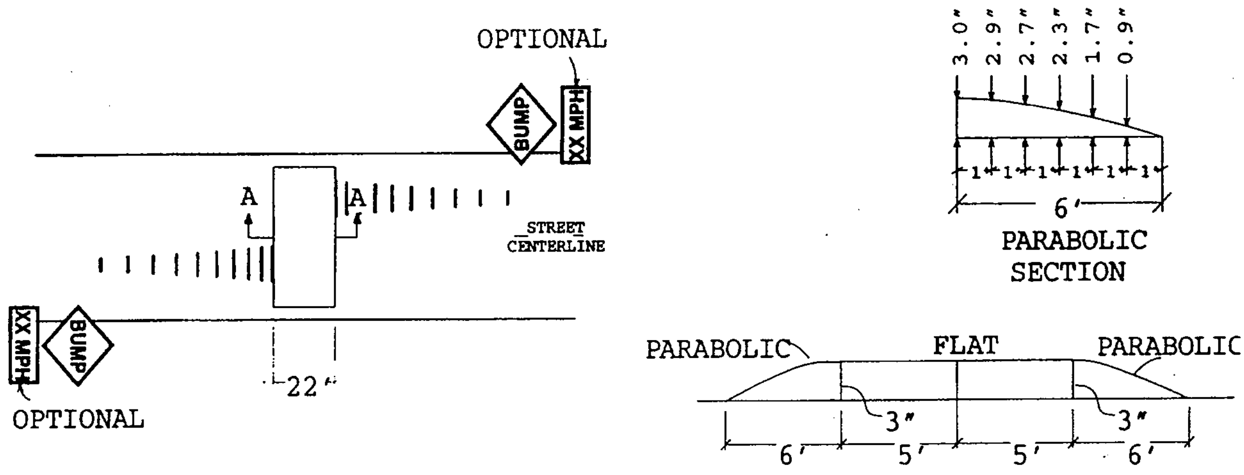
Six different fire vehicles were tested. Test runs were conducted on a total of six streets. Two streets had 22-foot speed bumps. Two streets had 14-foot speed bumps, and two had traffic circles. A total of 36 different drivers participated in the testing. The total number of test runs on each street was four per vehicle, or 24 runs per street.



Plan View

Cross-Section A-A

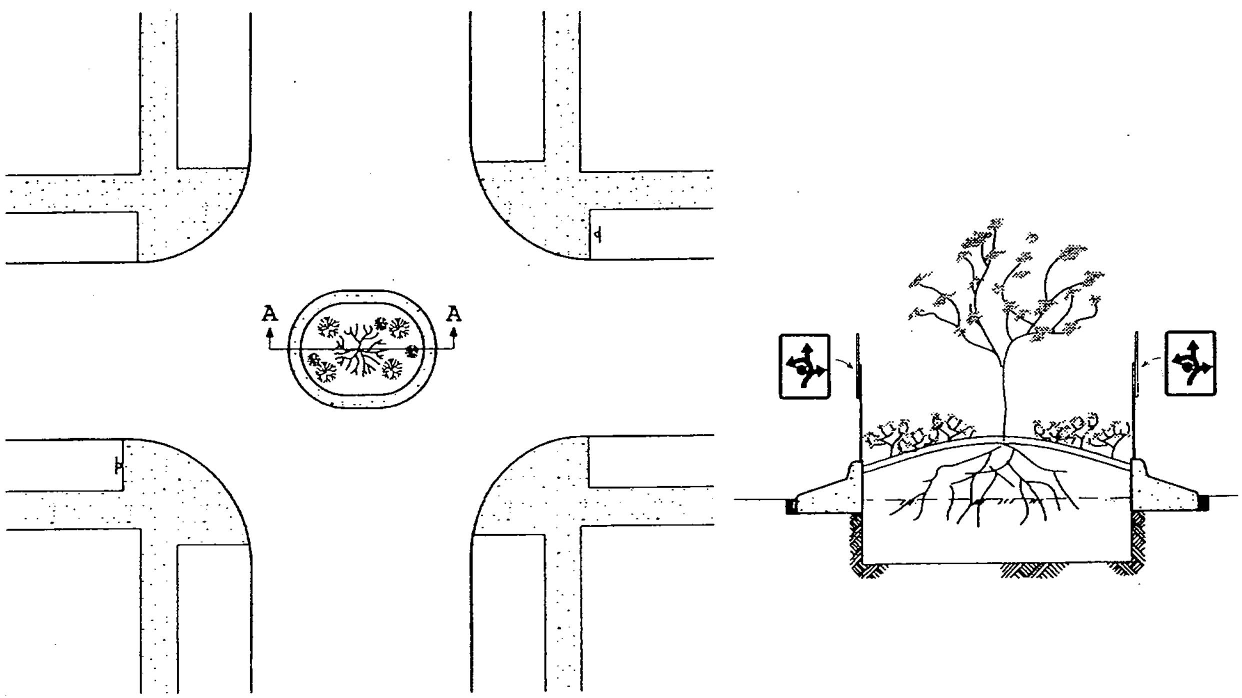
Figure 1: 14' Speed Bump (Typical)



Plan View

Cross-Section A-A

Figure 2: 22' Speed Bump (Typical)



Plan View

Cross-Section A-A

Figure 3: Traffic Circle (Typical)

Each test run was video taped. The camera recorded the vehicle speeds that were detected and displayed by a radar gun. Also the time of day, to the nearest second, was superimposed on the recording.

The speed and time information for each test run was transcribed from the video tapes to a spreadsheet. The data was manipulated to create a table of speed-vs-time and speed-vs-distance information for each test run.

For the various combinations of the four variables, the time needed to travel a length of street that had no calming device was compared to the time needed to travel the same length with a calming device. The average time and distance required for each vehicle to decelerate from a desirable response speed, negotiate the calming device, and accelerate back to the desirable speed was determined from the data. The time required to travel the same distance without a calming device's influence was calculated. The difference between the two travel times equals the delay associated with the calming device. This delay-per-device was determined for all six vehicles as they negotiated every calming device on the six test streets. Delays-per-device were calculated for desirable response speeds of 25, 30, 35, and 40 mph.

RESEARCH FINDINGS

The results of the testing are presented in Tables 2, 3, and 4. As one would expect, the delay-per-device increases as the desirable response speed increases. Depending on the type of fire vehicle and the desirable response speed, the three devices were found to create a range of delays:

22-foot bumps:	0.0 to 9.2 seconds of delay per bump
14-foot bumps:	1.0 to 9.4 seconds of delay per bump
Traffic circles:	1.3 to 10.7 seconds of delay per circle

The drivers' performances did not appear to significantly influence the results. Their choices of deceleration and acceleration rates as well as their choices of minimum speeds near the devices were very consistent.

Of the three traffic calming devices, the 22-foot bumps had the least impact on vehicle travel times. For the longer heavier vehicles the traffic circles impacted travel times the most. For the shorter more maneuverable vehicles the 14-foot bumps had the most impact.

For a given emergency response route, the test results can be used to predict the impacts of one or more traffic calming devices on fire response times.

The results provide new quantitative data to help weigh the pros and cons of traffic calming. The findings can be added to the findings already confirming that traffic circles and speed bumps effectively reduce the frequency of collisions, the speed of passenger cars, and the amount of traffic on a street.

Table 2

Typical Impacts of Traffic Circles on Emergency Vehicles

Vehicle	Lowest Speed (mph)	Desirable Speed (mph)	Travel Time Delay (seconds)	Impact Distance (feet)
Engine 18	14	25	2.8	260
	14	30	4.3	490
	14	35	6.1	670
	14	40	8.5	810
Rescue 41	16	25	1.3	170
	16	30	2.3	300
	16	35	3.1	470
	16	40	5.1	610
Squad 1	17	25	1.2	170
	17	30	2.3	330
	17	35	3.7	500
	17	40	5.3	780
Truck 1	10	25	4.8	320
	10	30	6.4	520
	10	35	8.4	750
	10	40	10.7	1030
Truck 4	11	25	4.3	320
	11	30	6.2	550
	11	35	8.1	800
	11	40	10.3	1140
Truck 41	11	25	3.9	340
	11	30	5.2	560
	11	35	7.3	850
	11	40	9.2	1260

Lowest Speed: This is the lowest speed at which a vehicle travels when driven around a traffic circle.

Desirable Speed: This is the speed at which a driver might wish to travel if there were no traffic circles.

Travel Time Delay: This is the additional time required to travel to a destination because of a traffic circle's influence.

Impact Distance: This is the length of street where a given vehicle cannot be driven at a given desirable speed because of a traffic circle's influence.

Table 3
Typical Impacts of 14-foot Speed Bumps on Emergency Vehicles

Vehicle	Lowest Speed (mph)	Desirable Speed (mph)	Travel Time Delay (seconds)	Impact Distance (feet)
Engine 18	13	25	2.3	240
	13	30	3.7	400
	13	35	5.2	580
	13	40	7.7	810
Rescue 41	17	25	1.0	150
	17	30	1.7	270
	17	35	2.9	480
	17	40	4.9	630
Squad 1	12	25	2.7	240
	12	30	4.1	440
	12	35	5.9	610
	12	40	8.3	850
Truck 1	11	25	3.4	270
	11	30	4.9	460
	11	35	6.6	650
	11	40	9.4	930
Truck 4	12	25	3.4	320
	12	30	4.9	490
	12	35	6.8	730
	12	40	9.1	1050
Truck 41	12	25	3.5	330
	12	30	4.7	470
	12	35	6.6	760
	12	40	8.6	1150

Lowest Speed: This is the lowest speed at which a vehicle travels when crossing a 14-foot speed bump.

Desirable Speed: This is the speed at which a driver might wish to travel if there were no speed bumps.

Travel Time Delay: This is the additional time required to travel to a destination because of a 14-foot speed bump's influence.

Impact Distance: This is the length of street where a given vehicle cannot be driven at a given desirable speed because of a speed bump's influence.

Table 4
Typical Impacts of 22-foot Speed Bumps on Emergency Vehicles

Vehicle	Lowest Speed (mph)	Desirable Speed (mph)	Travel Time Delay (seconds)	Impact Distance (feet)
Engine 18	21	25	0.8	140
	21	30	1.7	320
	21	35	3.0	510
	21	40	5.0	750
Rescue 41	34	25	0.0	0
	34	30	0.0	0
	34	35	0.3	120
	34	40	1.5	260
Squad 1	24	25	0.4	80
	24	30	1.0	210
	24	35	2.1	430
	24	40	3.4	710
Truck 1	22	25	0.6	140
	22	30	1.4	320
	22	35	3.0	600
	22	40	4.9	890
Truck 4	16	25	1.8	250
	16	30	3.4	450
	16	35	5.9	670
	16	40	7.7	1040
Truck 41	14	25	3.0	320
	14	30	4.8	620
	14	35	7.2	910
	14	40	9.2	1320

Lowest Speed: This is the lowest speed at which a vehicle travels when crossing a 22-foot speed bump.

Desirable Speed: This is the speed at which a driver might wish to travel if there were no speed bumps.

Travel Time Delay: This is the additional time required to travel to a destination because of a 22-foot speed bump's influence.

Impact Distance: This is the length of street where a given vehicle cannot be driven at a given desirable speed because of a speed bump's influence.

PUBLIC POLICY DEVELOPMENT

In an effort to provide both good emergency service response times and slower overall traffic speeds on neighborhood streets, a public process has been undertaken to address the trade-offs between these two community values and to provide policy direction for implementing traffic calming on a city-wide basis. This is being done by revising the Transportation Element of Portland's Comprehensive Plan to include a network of emergency response routes and policies to guide the treatment and operation of those routes.

The Transportation Element classifies Portland's streets according to their intended role in serving the various transportation modes and provides policies meant to accomplish the objectives of each classification. The Transportation Element currently defines networks and policies for serving pedestrians, traffic, bikes, transit, and trucks.

A classification system and set of policies is now being developed for emergency response routes and will be added to the Transportation Element upon its completion. Transportation and Fire Bureau staff are working together to develop a draft version of the "Emergency Response" classification. A citizen advisory committee has also been established to advise the two bureaus in the following areas:

- defining the criteria to be used in selecting emergency response routes
- applying the criteria to identify the recommended routes
- developing a hierarchy of emergency response routes
- developing classification policies and procedures
- recommending ways to manage and mitigate conflicts between traffic calming and prompt response.

The final product will be a written report recommending changes to the Transportation Element of the Comprehensive Plan . It will include the criteria, definition, and policies for the response routes, as well as a map that identifies the network of routes. A series of public meetings will be held to present the recommendations and take testimony. The resulting final version of the report will be presented to the Portland City Council which has the final approval authority.

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