Nationwide Investment Requirements for New Urban Highway Capacity Under Alternative Scenarios

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A range of new highway capacity needs is defined, including associated capital funding required to maintain 1985 levels of service on nonlocal highway systems in the nation's urban areas through the year 2005, under alternative travel growth scenarios and severity of land/use transportation management strategies. The analysis procedure, which has been computerized, estimates the number of lane-miles that would be required to maintain 1985 average intensities of use (i.e., vehicles miles per lane-mile) in the peak hour. These intensities of use are specified by functional class, location within the urban area (i.e., core, suburbs or fringe), and urban area size. The analysis results indicate that even under a relatively low annual rate of growth (2.36 percent per year), with high levels of land use and transportation management strategies, about 107,000 lane-miles of new capacity will be needed, amounting to a 22 percent increase above the 494,300 existing lane-miles within expanded urbanized area boundaries. This is estimated to cost $375 billion in 1988 dollars or about 1.7 cents per-vehicle-mile of travel.

Procedures are described that were developed to estimate new capacity needs by highway-functional class for the nation's urban highway systems through the year 2005, under alternative travel growth and land use and transportation management scenarios, and capital funding needed to pay for new capacity. The analysis was done to provide background information for the 1991 report to the U.S. Congress on the status of the nation's highways and bridges. The report is prepared biennially by the Secretary of the U.S. Department of Transportation (DOT).

BACKGROUND

A related effort (*1*) identified past trends in supply and use of the nation's urban highways and congestion levels. Another study, *An Evaluation of the Economic Efficiency of New Highway Capacity on Alternative Facility Classes* by FHWA's Planning Support Branch initiated an attempt to identify the best mix of new highway capacity by functional class. An adapted version of this study was published by TRB (*2*).

Other recent efforts (*3,4*) have attempted to assess the magnitude of new highway capacity needs in the future by using FHWA's Highway Performance Monitoring System (HPMS) analytical process (*5*). The HPMS analytical process estimates needs associated with maintaining the existing highway system at or above a defined set of "minimum tolerable conditions" for pavement condition, lane width, vehicular and volume-to-capacity ratio. Improvements are simulated on deficient highway sections, based on design standards and 20-year projected traffic.

In contrast to previous efforts based on the HPMS analytical process, this study considers the effects of policy changes—including land use and transportation system management policies. Three alternative policy scenarios were considered: (a) a base-scenario involving no policy changes, (b) a moderate management scenario involving moderate policy changes, and (c) an extreme, high-management scenario involving major changes in land use and transportation management policies.

The following factors distinguish this research from past studies.

1. The consideration of existing highway capacity outside the current urban area boundaries, which will become available as they expand (the procedure simulates the expansion of boundaries and corresponding conversion of rural lane-miles to urban fringe lane-miles),
2. The inclusion of needs unconstrained by right-of-way availability (i.e., lane-miles of needs are estimated both along existing highway alignments through widenings on available rights-of-way and along new alignments requiring new rights-of-way),
3. Consideration of supply beyond that estimated by the process, needed to provide access for new development and
4. Consideration of the effects of new supply on travel demand and
5. Consideration that service design standards used to determine needs vary across urban area size categories.

The last item is particularly significant in estimating new capacity needs. As we attempt to define this need, we are faced with the problem that "need" for new capacity is a value-laden term and means different things to different people. For the purpose of this study, "need" for new capacity has been defined as the requirement to maintain 1985 levels of service (LOSs) on the urban highway system. These levels of service are expressed as average vehicles per-lane during the peak hour, by functional class and location within the

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urban area (i.e., total vehicle-miles of travel divided by total lane miles). Some planners believe that urban areas of different sizes have different commonly accepted service standards or criteria for highway facility LOS. For example, large urban areas may be willing to accept LOS-D or even LOS-E during peak periods, but smaller urban areas may not be willing to accept such service levels. To account for the differences in LOS acceptability by urban area size, different LOS standards were defined by urban area size group based on 1985 LOS conditions.

The procedure presented in this paper is able to quickly simulate, in an aggregate manner, the effects of peak-spreading (i.e., spreading of traffic from the peak hour to other times of the day either due to congestion or due to nonstandard work hours of service industry workers who are projected to increase in future as a share of the labor force). Route diversion (because of congestion) is also simulated by the procedure in an aggregate manner.

Finally, in this study, the distribution of travel by highway functional class is derived through a rigorous analysis procedure developed as part of a recent study done for FHWA by Oak Ridge National Laboratory (*6*). The distribution procedure considers the interrelationship between highway supply and use and explicitly recognizes the effects of new supply on demand.

PUBLIC POLICIES AFFECTING HIGHWAY NEEDS

There are two types of public policy that can affect new capacity needs in urban areas: (a) land use policies and (b) transportation system management policies.

Land use policies can have significant impacts on new capacity needs. First, new development can be restricted to locations where existing capacity is available, helping to bring about a better match between available highway supply and travel demand. Second, alternative commuting modes can be encouraged by incentives for high density development at both ends of the commute trip—the residential end as well as the employment end. Third, mixed-use developments can be encouraged in the suburbs, both to spread travel throughout the day (since different types of uses have different peak periods) as well as to increase use of carpool, vanpool and transit modes (people will not need their cars during midday if service establishments are within walking distance). Fourth, integration of employment and residential uses can provide opportunities for those who wish to live near their workplaces, shortening trips and encouraging bicycling and walking. Finally, the physical layout and design of new developments can be used to create environments conducive to travel by transit, bicycle, or foot.

Transportation management includes strategies to reduce highway travel demand, as well as enhance its supply. Highway travel demand may be reduced by encouraging people to choose alternative commute modes, change their time of travel to off-peak-periods, and eliminate the need to travel. Peak-period travel demand management techniques include encouraging shifts in time of travel through work rescheduling programs, or peak-period road or transit pricing, discouraging solo commuting through parking management, parking pricing or peak-period road pricing, and encouraging alternative modes through preferential treatment for high occupancy vehicles (HOVs) on highways and at parking facilities, improvements to transit service, transit fare subsidies, and provision of bicycle and pedestrian facilities. Highway supply management techniques increase the effective capacity of existing highways through freeway surveillance and control, restriping of pavements to use shoulders and increase the number of lanes, and traffic signal operation improvements.

ALTERNATIVE FUTURE SCENARIOS

The analysis was done for nine scenarios, each of which was a combination of one of three travel growth scenarios and one of three policy scenarios. The three travel growth scenarios were based on previous work done by the Oak Ridge National Laboratory (*6*):

1. A low growth scenario, reflecting a 2.36 percent annual compound growth rate between 1985 and 2005,
2. A moderate growth scenario, reflecting an annual compound growth rate for total travel of 2.72 percent between 1985 and 2005, and
3. A high growth scenario, reflecting a 3.48 percent annual compound growth rate.

The three policy scenarios were as follows:

1. A base condition, involving no change in travel peaking characteristics and current levels of transportation system management—no increase in supply enhancement, and no increase in current (1985) levels of land use and transportation demand management.
2. A moderate management condition, involving changes in travel demand resulting from moderate increases in levels of land use and demand management and peak spreading, and a transportation system supply management strategy involving freeway surveillance and control, adding lanes by narrowing existing freeway lanes and shoulders, and signal improvements on arterials.
3. A high management condition, involving maximum changes in travel demand resulting from major changes in land use and demand management policies, and a supply management strategy as under the moderate management condition.

ANALYSIS PROCEDURE

The major steps in the estimation process are presented in Figure 1 and are described below. The spreadsheet-model, named NUHICAP.WK3, is available from FHWA's Office of Environment and Planning, Planning Support Branch.

Step 1: Development of Input Data

Using HPMS area-wide and sample data, daily vehicle-miles of travel (DVMT) and lane-mile data were obtained for each individual urbanized area in the United States for the years

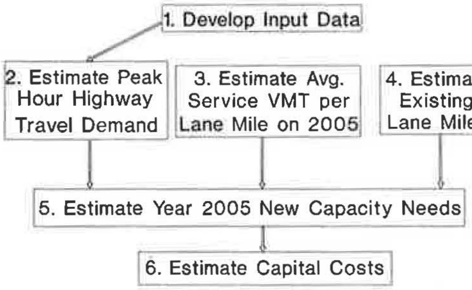

FIGURE 1 Analysis procedure.

1982–1988. The data were cross-tabulated by highway functional class, by location within urban areas, and by urban area size.

Highways were categorized into four classes: (a) freeways and expressways (HPMS Codes 11 and 12), (b) other principal arterials (Code 14), (c) minor arterials (Code 16), and (d) collectors (Code 17). Three urban location categories were used: (a) core (HPMS Codes 1 and 2), (b) suburb (Codes 2 and 3), and (c) fringe (Codes 4 and 5). Urban areas were divided into five population groups: (a) 50,000–75,000, (b) 75,000–200,000, (c) 200,000–500,000, (d) 500,000–1,000,000, and (e) more than 1,000,000.

The socioeconomic data and forecasts for every metropolitan statistical area (MSA) in the United States through the year 2005 were obtained from MSA profiles published by Woods and Poole Economics, Inc. (*7*). The MSA data were used as proxy for the urban area contained within the MSA boundary.

Step 2: Forecast of Future Peak Highway Travel

Using 1982–1988 data for 339 urban areas, a pooled time-series, cross-sectional regression model was developed for forecasting total DVMT for the urban areas. The DVMT/capita was used as the dependent variable. The independent variables were socio-economic variables (number of driver licenses per 1000 persons, household size, real income, and employment) and highway supply deficiency. The supply deficiency of the primary highway system was included as an independent variable to account for the impact of constrained supply on demand for travel.

This regression model was used with forecasts of socioeconomic variables for the year 2005 to estimate future DVMT for each urban area. The dynamics of shift in urban travel, between highway functional classes and locations within urban areas as the area increases in size, were modeled through conditional logit models in which population was used as an explanatory variable. These logit models, together with the forecast population of urban areas, were used to predict the shares of travel by functional class and by location within urban areas in the year 2005. Initially, the current supply (lane-miles) was also included as an independent variable in these models. However, it was found to be highly correlated to population and had very little impact by itself on the distribution of DVMT (*6*).

Traffic demand during the peak hour was estimated by multiplying the forecast DVMT by the peak hour travel shares and directional split percentages. These percentages were obtained by facility class, location within the urban area, and urban area size from NCHRP Report 187 (*8*). The assumption was that no changes in these shares would occur because of peak spreading, either from congestion or continuing increases in the share of service jobs in the economy.

For the scenarios that included land use/transportation policies, reduction in peak-hour, VMT was estimated by urban area size category on the basis of the following:

1. Percent of daily VMT for the work purpose by urban area size, derived from NCHRP Report 187 (*8*).
2. Percent reduction in peak hour work VMT due to modal shifts resulting from institution of land use and travel demand management strategies.
3. Percent reduction in peak-hour VMT because of work rescheduling, peak-period pricing, or spreading of peaks because of either congestion or shifts in the economy from manufacturing to service jobs.

The resulting percent reduction in peak-hour VMT, by urban area size, was entered directly into the spreadsheet used for the analysis and may be modified for alternative policy assumptions. Table 1 presents the procedures, assumptions, and resulting percent reduction estimates for each policy scenario.

Step 3: Estimation of Average Service VMT/Lane-Mile in 2005

The average service volumes per lane at the desired level of service (i.e., 1985 LOS for this analysis) were estimated by functional class, location and urban area size group on the basis of the following:

1. Average intensities of use in 1985 (from 1985 HPMS data).
2. A percentage increase in average intensity of use that can be sustained at a given level of service due to supply enhancement strategies. The increase was based on "enhanceable" mileage (*9*) and average percentage increases in capacity from enhancement strategies based on FHWA analysis (unpublished data from FHWA memorandum from Jeffrey Lindley to Larry Darnes, March 15, 1988). Table 2 presents the procedures, assumptions, and resulting percentage increases in capacity with the supply enhancement strategies for scenarios that included land use and transportation policies.

The procedure assumes a basic relationship between level of service and average intensity of use, which will not change by the year 2005, and that generally the mismatch in the distribution of available capacity and travel demand within the individual urban area will continue. If it can be assumed that the distribution of available capacity throughout the urban area will match more effectively the distribution of vehicular travel demand, average intensities of use could increase without any deterioration in level of service. Changes to average service volumes-per-lane could be made to reflect such alternative assumptions.

TABLE 1 Percent Reduction of Peak-Hour Travel Demand by Urban Area Size Group

	Base	mod mgmt[a]	max mgmt[b]
Work Trips			
A. Percent VMT in PM peak hour[c]:			
50-75K	30	30	30
75-200K	35	35	35
200-500K	40	40	40
500- 1M	50	50	50
> 1M	60	60	60
B. Percent work VMT reduction from management:			
50-75K	0	0	10
75-200K	0	0	11
200-500K	0	4	14
500K-1M	0	12	22
> 1M	0	20	30
Other Trip purposes			
C. Percent VMT reduction from management:			
50-75k	0	0	10
75-200k	0	0	10
200-500k	0	0	10
500k-1M	0	0	10
> 1M	0	0	10
All purposes			
D. Percent VMT reduction from management, i.e. (A*B) + [(100-A) *C]:			
50-75K	0	0	10.0
75-200K	0	0	10.3
200-500K	0	1.6	11.6
500K-1M	0	6.0	16.0
> 1M	0	12.0	22.0

[a] Moderate management policies include primarily travel demand management strategies which affect work trips only, and have significant potential as urban area size increases. Kuznyak and Schreffler (11) suggest that trip reductions in the range of 20% to 40% can be the norm if driving is not subsidized in the form of free parking and travellers are presented with realistic alternative commute modes.

[b] A doubling of the perceived costs of drive alone travel would reduce traffic by 10-30 percent (12).

[c] Based on NCHRP Report No. 187 (8).

TABLE 2 Percent Increases in Peak-Hour Capacity for Policy Scenarios

	Freeway	Other Princ. Art.
A. Number of miles to which "combined" supply management strategies may be applied (9)	1,196	1,611
B. Percent of lane miles "enhanceable" by combined strategies in urban areas:		
(1) 1985 total route miles (source: HPMS)	16,032	36,231
(2) Percent "enhanceable" route miles (A / B-1)	7.5%	4.4%
C. Average percent increase in capacity from combined strategies in urban areas	50% [a]	25%
D. Equivalent overall capacity enhancement (B * C)	3.75% [b]	1.1% 2/

[a] Average based on 64% increase for 4-lane facilities, 42% increase for 6 lane, and 30% increase for 8 lane, assuming 50%, 25%, 25% distribution of such facilities.

[b] These percentages were appropriately distributed by urban area size.

Step 4: Estimation of Existing Lane Miles in Expanded Urban Boundaries

Existing 1985 lane-miles within the 1980 Census urbanized area boundaries were estimated by functional class, location and urban area size group from 1985 HPMS sample data. Additional existing 1985 lane-miles within expanded 2005 urbanized area boundaries were estimated as follows:

1. First, average annual rate of growth in urban land area and average annual rate of growth in dwelling units between 1970 and 1980 were estimated from 1970 and 1980 census data. These rates of growth were used to estimate the excess annual growth rate of urban land resulting from reductions in urban densities.
2. Next, additional land area in 2005 within expanded urban area boundaries was estimated based on projected growth rates for dwelling units and excess land consumption because of reductions in urban densities. It was assumed that the rate of excess land consumption would be half of the 1970–1980 rate, owing to the saturation of demand for suburban life styles.
3. Average existing 1985 lane-miles per-square-mile in the urban fringe, by functional class and urban area size group were estimated from sample data as presented in Table 3.
4. Total existing lane-miles, which would become part of the expanded 2005 urban area, were obtained by multiplying *b* and *c*.

Estimates of lane-miles which would be reclassified from urban fringe to suburban in 2005 were obtained as follows:

1. Suburban dwelling unit growth was estimated by urban area size assuming that 80 percent of the increase in dwelling units would occur in the suburbs.
2. Suburban density estimates by urban area size (i.e., dwelling units per square mile) were derived from the ratio of the increase in dwelling units 1970–1980 to the increase in urban land area 1970–1980 obtained from census data.
3. New suburban land area in 2005 was estimated as $a \times b$.
4. Existing 1985 lane-miles per square mile in the urban fringe as presented in Table 3 were multiplied by *c* to get fringe lane miles reclassified to suburban lane miles.

Step 5: Estimation of 2005 New Capacity Needs

The total inventory of lane-miles needed in 2005 to serve the projected peak hour travel demand (from Step 2) at 1985 levels of service was obtained by dividing projected peak hour VMT by corresponding average service volumes-per-lane (from Step 3) by functional class, location, and urban area size group. New capacity needs for freeways, expressways and other principal arterials, in lane-miles, were obtained by subtracting existing lane-miles (from Step 4) from the total inventory needed to maintain 1985 LOSs.

TABLE 3 Fringe Lane-Miles per Square Mile

	Urban area Size Group				
	50-75K	75-200	200-500K	500K-1M	>1M
A. Lane miles per mile from sample data [a]:					
Freeway	0.087	0.076	0.117	0.093	0.097
Other princ. art.	0.096	0.038	0.120	0.102	0.138
Minor Art.	0.157	0.228	0.206	0.153	0.303
Collector	0.631	0.560	0.899	0.708	0.887
Local	1.942	1.955	2.702	1.768	2.768
Total	2.913	2.857	4.044	2.824	4.193
Total W/O local	0.971	0.902	1.342	1.056	1.425
B. "Smoothed" lane miles per sq. mile [b]:					
Freeway	0.09	0.09	0.10	0.10	0.10
Other princ.	0.10	0.10	0.10	0.10	0.14
Minor Art.	0.16	0.20	0.20	0.20	0.30
Collector	0.60	0.70	0.80	0.80	0.90
Total	0.95	1.09	1.20	1.20	1.44

[a] From HPMS sample data for fringe counties located in the following urban areas:

50-75K: Columbia, Mo; Charlottesville, VA; Medford, OR
75-200K: Tallahassee, FL; Boise, ID; Springfield, IL
200-500K: Toledo, OH; Little Rock, AK; Spokane, WA
500K-1M: Columbus, OH; Birmingham, AL; Salt Lake City, UT
> 1M: Washington, D.C.; Houston, TX; Atlanta, GA

[b] Appropriate adjustments were made for consistency in distribution of proportions of supply by functional class across urban area size groups.

For minor arterials and collectors, new capacity needs were estimated on the basis of access needs for new development. Additional lane-miles needed for access to new developments in the suburbs and the fringe were estimated on the basis of the percentage increase in dwelling units in these locations, assuming that 80 percent of the areawide increase in dwelling units will occur in the suburbs and 20 percent in the fringe. The assumption was made that access needs will increase in the same proportion as dwelling units.

New capacity needs were then divided between widenings on existing rights-of-way and new facilities on new rights-of-way. Feasible widenings by location were estimated on the basis of the following:

- An HPMS analytical process run that provided future constrained lane mile needs (i.e., needed new lane miles that can be provided on existing rights-of-way) by functional class (*3*).
- The distribution by location of new lane-miles actually built between 1982 and 1985 (from HPMS data). The assumption made is that the distribution of actual construction reflects the distribution of future constrained lane-mile needs by location.

Lane-miles to be provided on new facilities on new rights-of-way were obtained by subtracting new lane-miles on existing rights-of-way from total new capacity needs. Lane-mile needs were then distributed by urban area size group based on the distribution of overall lane-mile needs. The assumption is that the breakdown of needs between widenings and new facilities does not differ by urban area size.

Step 6: Estimation of Capital Costs for New Capacity

Capital costs per lane-mile (in 1988 dollars) for added lanes on existing rights-of-way were obtained from data inputs to the HPMS analytical process. Costs for new facilities were derived from nationwide low and high cost estimates and corresponding estimates of lane miles of new capacity needs above constrained needs which can be provided for on existing rights-of-way (*3*). Tables 4 and 5 present the procedures, assumptions and resulting estimated costs per lane-mile for widenings and for new facilities by functional class and urban location. Estimated lane-miles of new capacity (from Step 5) were multiplied by the estimated costs per lane-mile to get total capital costs for new capacity.

ANALYSIS RESULTS

Table 6 presents lane-miles of new capacity needed in 2005 for each of the nine scenarios. Under the base management

TABLE 4 Capital Costs per Lane-Mile for New Capacity

		Core	Suburbs (Built-up)	Fringe (outlying)
A.	HPMS data for major widening:			
	Freeways:			
	construction		2,654	1,583
	right-of-way		1,172	867
	Total	N.A.	3,826	2,450
	Other Divided:			
	construction		1,363	899
	right-of-way		728	500
	Total	N.A.	2,091	1,449
	Undivided:			
	construction		1,196	832
	right-of-way		496	400
	Total	N.A.	1,692	1,232
B.	Estimated widening costs:			
	Freeways	5,100 [b]	3,800 [a]	5,600 [a]
	Other Princ. Art.	2,800	2,100	1,500
	Minor Art.& Coll	2,300	1,700	1,200
C.	Estimated new facility costs [c]:			
	Freeways	11,300	8,500	5,600
	Other Princ. Art	5,500	4,100	2,900
	Minor Art & Coll	4,700	3,500	2,500

[a] HPMS data rounded off to nearest 100

[b] Core costs estimated as 33% above suburban costs

[c] Suburban costs estimated as shown in Table 5. Core and fringe estimates derived based on ratio of core and fringe widening costs to suburban widening costs in line B.

TABLE 5 Average Capital Costs per Lane-Mile for New Facilities

		Freeway	Oth. Pr. Art.	Mi.Art./Coll
Source of data: FHWA (3),pp.17-18.				
A.	Lane miles of new capacity needs over and above constrained needs.	45,777	31,674	34,740
B.	Minimum additional costs for new capacity, in billions of 1985 dollars.	$113	$39	$33
C.	Maximum additional costs for new capacity,in billions of 1985 dollars	$592	$198	$189
D.	Average additional costs per lane mile in millions 1985 dollars: (B+C)/(2*A)	$7.7	$3.7	$3.2
E.	Cost per lane mile in 1988 dollars [a]	$8.5	$4.1	$3.5

[a] Based on 1988 C.P.I./ 1985 C.P.I.

TABLE 6 Lane-Miles of New Capacity Needed in 2005 for Alternative Policy Assumptions

		GROWTH RATE		
		Low	Moderate	High
A.	Base conditions			
	Fwy	49,995	59,694	82,273
	OPA	64,074	78,266	109,360
	MA	34,635	34,635	34,635
	Coll	16,238	16,238	16,238
	Total	164,942	188,833	242,506
B.	Mod mgmt.			
	Fwy	39,253	48,155	68,577
	OPA	49,547	62,655	90,825
	MA	34,635	34,635	34,635
	Coll	16,238	16,238	16,238
	Total	139,673	161,683	210,275
C.	Max mgmt.			
	Fwy	26,128	34,057	52,219
	OPA	30,404	42,042	67,097
	MA	34,635	34,635	34,635
	Coll	16,238	16,238	16,238
	Total	107,405	126,972	170,189
Existing lane miles		494,300	494,300	494,300

scenario, additional lane-miles needed would range from about 165,000 (low growth) to about 243,000 (high growth), or an increase of 33 percent to 49 percent above the total number of existing lane-miles of about 494,000. With a high level of management, these needs would range from 107,000 (low growth) to 170,000 (high growth) additional lane-miles, or an increase of 22 percent to 34 percent above existing system capacity. New capacity needs for minor arterials and collectors do not change with different scenarios. This is because the population and dwelling unit growth assumptions which determine additional land area developed and access needs are the same for all scenarios.

Table 7 presents the range of new lane miles needed by urban area size group for the low growth scenarios. While the share of needs in the largest urban areas exceeds 50 percent under every policy scenario, the share is significantly lower under a high level of management (down to 52 percent from 59 percent under base policy conditions).

Graphic representations of the variations in new capacity needs are provided in Figures 2 through 4—by policy scenario in Figure 2, by travel growth rate in Figure 3, and by urban area size group in Figure 4. Figure 2 shows that management policies can result in significant reductions in new capacity needs on principal arterials. For low growth scenarios, about

TABLE 7 Lane-Miles of New Capacity Needed in 2005 for Alternative Policy Assumptions with 2.36 Percent Growth

	URBAN AREA SIZE GROUP					
	50-75K	75-200K	200-500K	500K-1M	>1M	Total
A. Base conditions						
Fwy	846	5,568	5,961	5,810	31,811	49,996
OPA	1,335	9,118	7,931	6,559	39,130	64,073
MA	836	5,859	5,713	4,579	17,648	34,635
Coll	529	3,484	2,279	1,726	8,220	16,238
Total	3,546	24,029	21,884	18,674	96,809	164,942
B. Mod mgmt.						
Fwy	846	5,568	5,671	4,899	22,269	39,253
OPA	1,335	9,118	7,472	5,382	26,240	49,547
MA	836	5,859	5,713	4,579	17,648	34,635
Coll	529	3,484	2,279	1,726	8,220	16,238
Total	3,546	24,029	21,135	16,586	74,377	139,673
C. Max mgmt.						
Fwy	580	3,988	3,862	3,381	14,318	26,129
OPA	827	6,057	4,602	3,421	15,497	30,404
MA	836	5,859	5,713	4,579	17,648	34,635
Coll	529	3,484	2,279	1,726	8,220	16,238
Total	2,772	19,388	16,456	13,107	55,683	107,406
Existing lane miles	14,995	75,129	78,833	54,321	271,022	494,300

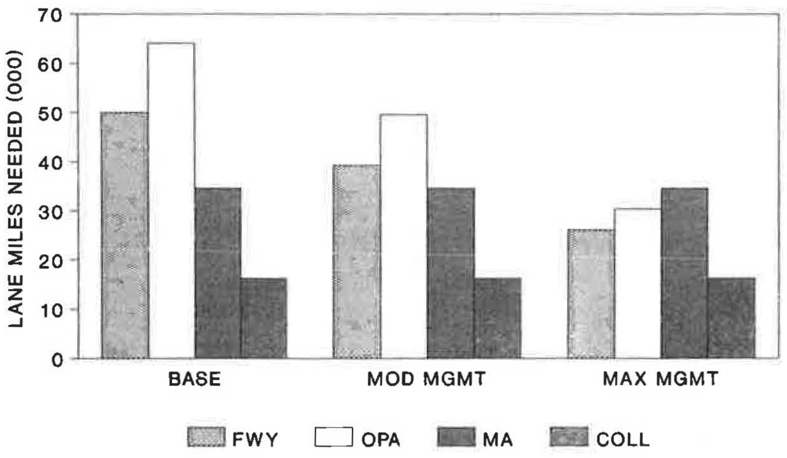

FIGURE 2 Effect of policies on lane-miles of new capacity needed (2.36 percent growth).

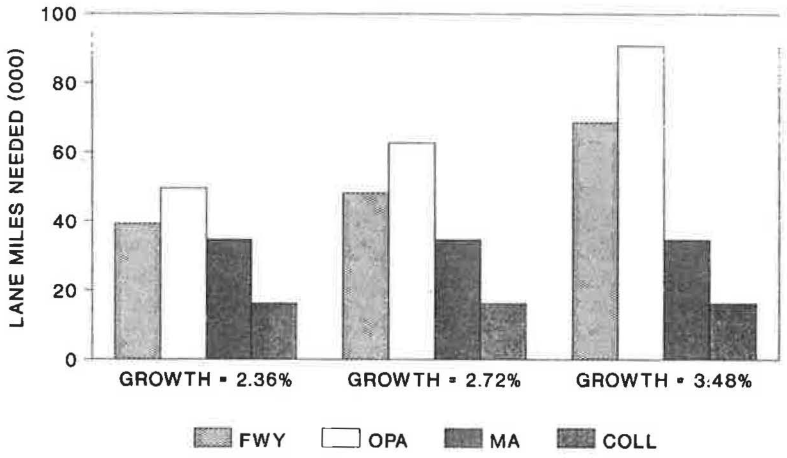

FIGURE 3 Lane-miles of new capacity needed by growth rate (with moderate management).

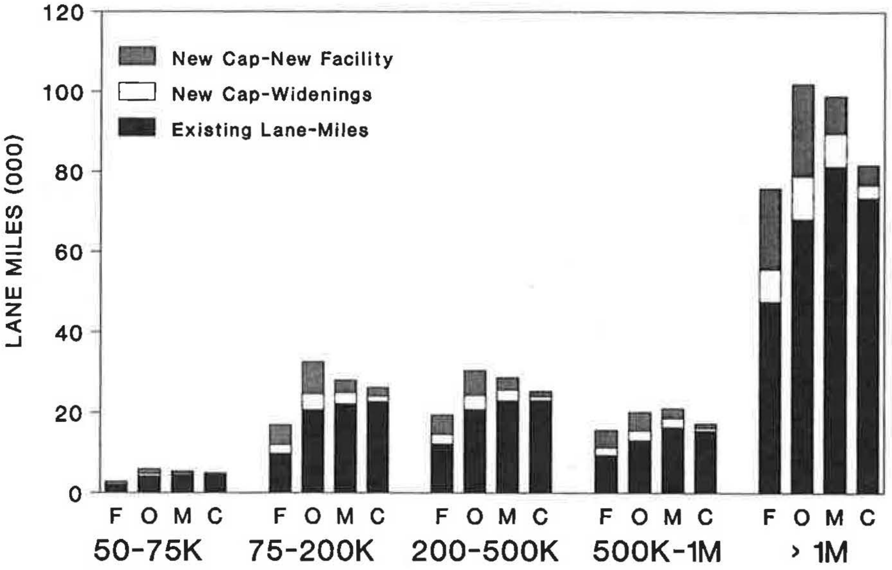

FIGURE 4 Lane-miles of new capacity needed by urban area size (2.36 percent growth/moderate management policies).

a 50 percent reduction from base conditions results from high levels of management. In Figure 3, travel growth rates are shown to have a significant effect on principal arterial needs—about an 80 percent increase in needs for high growth when compared with needs for low growth, when moderate management policies are in place. Finally, Figure 4 suggests that the bulk of new capacity needs will be in the largest urban areas. Even with low growth and moderate management, about 75,000 of the total of 140,000 new lane miles needed will be in areas with a population of more than 1 mil.

Table 8 and Figure 5 show capital investment needs for new capacity by urban area size group for each of the nine scenarios. Total investment needs vary from $375 billion under the low growth scenario with a high level of management to about $1.2 trillion under the high-growth scenario, with base management conditions. Assuming a 20-year-life for new capacity investments and 2005 levels of VMT, these costs equate to about 1.7 and 3.3 cents per vehicle-mile of travel, respectively (based on annual VMT ranging from 1.11 trillion (low growth/maximum management) to 1.76 trillion (high growth/base management)). These costs equate to a fuel tax of 34 cents to 66 cents per gallon, assuming average urban fuel economy of 20 mpg. Nationally, current total state and federal fuel taxes (which are used to fund maintenance and rehabilitation as well as new capacity needs) amount to about 30 cents per gallon on average.

The analysis also indicates larger variations when capital costs are broken down by functional class. On higher func-

TABLE 8 Capital Costs for New Capacity

		GROWTH RATE		
		Low	Moderate	High
A.	Base conditions			
	50-75K	$15.3	$18.6	$19.1
	75-200K	$93.4	$111.3	$128.1
	200-500K	$85.9	$105.1	$142.4
	500K-1M	$79.2	$94.4	$129.6
	>1M	$437.4	$520.0	$744.4
	Total	$711.2	$849.4	$1,163.6
B.	Mod mgmt.			
	50-75K	$14.8	$18.2	$18.8
	75-200K	$89.9	$108.3	$126.0
	200-500K	$79.1	$98.3	$135.4
	500K-1M	$66.1	$80.5	$113.7
	>1M	$312.4	$384.1	$579.6
	Total	$562.3	$689.4	$973.5
C.	Max mgmt.			
	50-75K	$10.3	$13.2	$14.1
	75-200K	$62.8	$80.2	$97.5
	200-500K	$52.0	$69.5	$103.2
	500K-1M	$44.8	$58.0	$87.9
	>1M	$205.6	$267.7	$438.7
	Total	$375.5	$488.6	$741.4

Note: Costs are in billions of 1988 dollars.

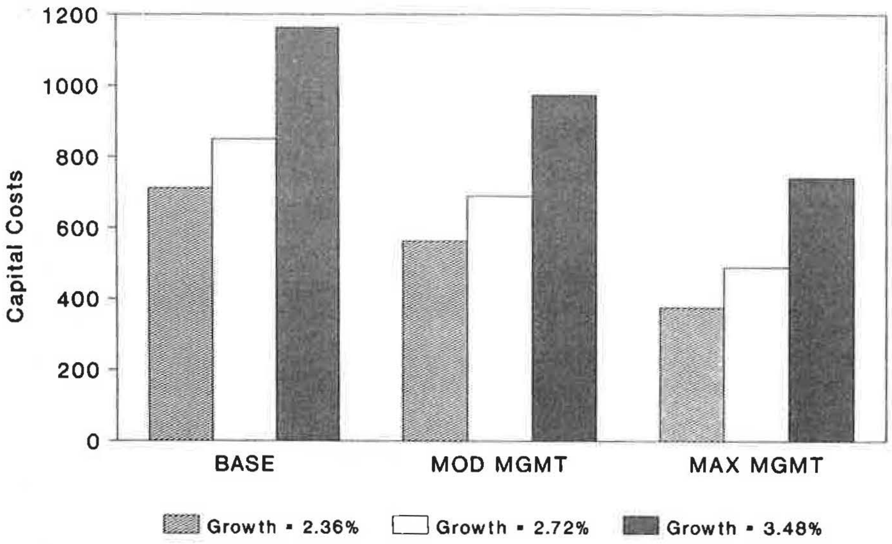

FIGURE 5 Capital costs for new capacity (billions of 1988 dollars).

TABLE 9 Comparison of Lane-Mile Needs and Capital Costs

	GROWTH RATE		
	Low	Moderate	High
A. Max mgmt.			
Lane-mile needs	107,405	126,972	170,188
Ratio with L/M [a]	1.00	1.18	1.58
Capital costs	$375.5	$488.7	$741.4
Ratio with L/M	1.00	1.30	1.97
B. Mod mgmt.			
Lane-mile needs	139,672	161,683	210,275
Ratio with L/M	1.30	1.51	1.96
Capital costs	$562.3	$689.4	$973.6
Ratio with L/M	1.50	1.84	2.59
C. Base conditions			
Lane-mile needs	164,941	188,833	242,505
Ratio with L/M	1.54	1.76	2.26
Capital costs	$711.3	$849.4	$1,163.6
Ratio with L/M	1.89	2.26	3.10

[a] L/M = low growth/max mgmt.

tional classes (e.g., freeways, expressways and other principal arterials), new capacity costs ranged from about 1.6 cents per vehicle-mile to about 4.2 cents per vehicle-mile, based on annual VMT estimates ranging from 0.78 trillion to 1.23 trillion on these functional classes. If these costs could be charged only to peak period users of these higher functional classes (who comprise about 40 percent of daily users) on the presumption that new capacity is needed primarily to serve them, they would equal 4.0 to 10.5 cents per peak-period vehicle-mile. By comparison, average operating costs for an intermediate-sized passenger car (for gas and oil, maintenance and tires) are about 8.4 cents per mile (*10*).

Table 9 presents a comparison of lane-mile needs and capital costs for each of the scenarios with the scenario that requires the smallest capital investment (i.e., the low travel growth scenario with high levels of management). The larger variation in capital costs (relative to the variation in lane-mile requirements) is because of the much higher proportion of new facilities needed on new rights-of-way as total lane-mile needs increase.

CONCLUSIONS

The analysis indicates that significant increases in highway funding will be needed if 1985 levels of service are to be maintained in the nation's urbanized areas. Funding needs for new capacity on the nonlocal highway systems in urbanized areas range from $375 billion, under a scenario representing a low underlying travel growth rate with stringent land use and transportation management strategies, to $1.2 trillion under an extreme scenario representing a high travel growth rate with no significant change in land use and transportation management policies. The moderate management policy scenario, with a low underlying travel growth rate, by historical comparison (i.e., 2.36 percent), is probably the most likely. It would require about $560 billion in new capacity investment. This is equivalent to about 2.4 cents per vehicle-mile of urban travel based on total annual VMT of 1.16 trillion, or a 48 cents per gallon fuel tax assuming average urban fuel economy of 20 mpg.

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