APPENDIX A. COSTS OF THE INTERSTATE SYSTEM 1/

Interstate program costs fall into five categories:

- o Cost to complete routes not yet open;
- o Cost to complete final stages of work on segments already open;
- o Cost to upgrade routes already open;
- o Cost of repairs; and
- o Cost of reconstruction.

The total completion bill of $38.8 billion (in 1979 dollars) includes all costs in the first three categories, namely, completion of routes not yet open ($26.1 billion); final stage construction ($1.4 billion); upgrading open highways ($11.1 billion); and miscellaneous costs ($0.2 billion). 2/

Repairs are projected to cost an additional $16 billion between calendar years 1980 and 1990, and reconstruction projects could add another $26.4 billion if all such projects were built. Each of the five cost categories is discussed below. Together, they total more than $80 billion between 1980 and 1990.

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1. All costs in Appendix A are in 1979 dollars.

2. The most recent estimates of the completion costs for the Interstate System came from a nationwide survey of the states conducted by the Federal Highway Administration (FHWA) in January, 1980. CBO has updated the survey to the extent possible, using the FHWA monitoring system, but a comprehensive update will not be available until January, 1983.

Costs to Complete Routes Not Yet Open

Route completion is the largest single category of Interstate costs, totalling $26.1 billion. This estimate is uncertain for two major reasons. First, it depends upon the extent to which states decide not to finish incomplete route segments, an option available to them under the Federal-Aid Highway Acts of 1973 and 1978. 3/ The estimate of $26.1 billion presented here assumes that states will withdraw about $2.5 billion in unbuilt route segments, and that the completion costs will decline by the same amount.

Second, under the 1981 act, new routes must meet "essential environmental requirements." The $26.1 billion includes a rough estimate of $3.0 billion for these environmental requirements, based on the graction of the cost of environmental features for recently designed highways. Since many unbuilt segments have not yet been fully designed, it is impossible to make a precise cost allowance for environmental features, such as carpool lanes, noise walls, landscaping, and so on. In particular, over 70 percent of the undesigned mileage is in urban areas where congestion makes carpool lanes highly desirable from the local standpoint, although extremely expensive (over $40 million per mile) from the federal standpoint. Few carpool lanes have been built as parts of recently completed segments--many of which are in rural areas--and their cost may, therefore, be underrepresented in the $3.0 billion projected here. On the other hand, these costs might be offset somewhat if states decide not to finish more segments than allowed for in this report. On balance, the estimated cost of $26.1 billion appears reasonable for routes not yet open in light of these uncertain factors.

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3. Under the Federal Highway Acts of 1973 and 1978, states are permitted to make such withdrawals from the plan and apply for an equivalent sum to be spent on non-Interstate highway projects or on public transit projects. The equivalent sum must be appropriated from general revenues, however, rather than paid from the Highway Trust Fund. Thus, in deciding whether to withdraw routes, states must consider the risk of losing funds because the Congress may not appropriate funds for substitute projects because of federal budget constraints. The deadline for withdrawing routes is September 1983.

Stage Construction Costs

The second category of costs applies to states that built their Interstate routes in two or more stages. Some states, notably Georgia, built a number of Interstate routes to a minimum standard and planned to upgrade them at a later date to allow the opening of other segments as quickly as possible. The deferred work, which involves adding layers of pavement and, in a few cases, lanes and interchanges, is generally known as "stage construction." Stage construction that is eligible for federal financing will cost about $1.4 billion.

Cost to Upgrade Routes Now Open

In addition to unbuilt routes and stage construction, the third category of completion costs includes upgrading projects that were added after the program began. Compared to more recent Interstate highways, early routes were built with less capacity and fewer safety and environmental features. Such features have been included in the program mainly through new legislation over the years, but also in response to applications from individual states to add capacity, such as extra interchanges, lanes, and other facilities to accommodate traffic growth.

The cost of upgrading segments of the Interstate System is estimated to be about $11.1 billion. The kind of projects involved in upgrading Interstate highways varies greatly, including additional lanes and interchanges; safety improvements, such as nonskid pavement and breakaway signs; rest areas; bicycle and pedestrian paths; and noise barriers. About $9.1 billion of these upgrading costs is to increase capacity; the remaining $2.0 billion is for safety projects, noise barriers, and amenities (see Table A-1).

Construction of additional lanes is the most costly type of upgrading. Part of the total is for state-built roads incorporated into the Interstate program. The West Virginia Turnpike for example requires additional lanes to bring them up to the four-lane minimum Interstate standard. Of the $7.9 billion to complete additional lanes, around $1.9 billion is to bring two-lane routes up to minimum.

Repair Costs

Keeping the Interstate System in good repair will cost increasingly more in the years ahead, whether these costs are assumed by the federal government or left to the states. Since 1956, an average of 1,400 Interstate

miles have been opened annually, and mileage is now reaching the end of its design life at about the same pace. Current federal authorizations for repairs fall far short of their projected cost.

TABLE A-1. COST OF UPGRADING OPEN INTERSTATE HIGHWAYS, BY CATEGORY (In billions of 1979 dollars)

	New Interstate Highways Built With Federal Funding	Existing Roads Later Incorporated Into the Interstate System	All Interstate Highways
Additional Lanes and Interchanges			
Mixed traffic lanes	2.3	5.6	7.9
Carpool lanes	1.2	0.0	1.2
Additional Safety and Environmental Improvements and Amenities	0.6	1.4	2.0
Total	4.1	7.0	11.1

SOURCE: Congressional Budget Office and U. S. Federal Highway Administration.

Repairs include the addition of pavement layers, the replacement of malfunctioning joints, repair of shipping and splintering, pavement undersealing, grinding and grooving of faulted pavements to restore smoothness, and reworking or strengthening of bases or sub-bases. Bridge repairs, including the complete removal and replacement of an entire bridge deck, are eligible for repair funds, as well. Collectively, these repair activities

are often referred to as resurfacing, rehabilitiation, and restoration, or "3Rs". For simplicity, this paper refers to all these activities as repairs.

The measurement of pavement and sub-base conditions is largely judgmental, and projected needs are thus subject to a great deal of uncertainty. Based on studies made by individual states, the Department of Transportation projected that repairs would cost $21 billion (in 1979 dollars) between calendar years 1980 and 1989. Further, this projection warned that delaying these projects could increase their costs disproportionately, since the rate of deterioration is thought to accelerate as pavement condition worsens, depending upon traffic conditions, age, weather, drainage, and other conditions. There are, however, several reasons why this estimate may be too high. First, from 1980 to 1989, about 26,000 miles of Interstate highways will reach the end of their design lives of 20 years. (This number also includes estimated mileage that reached design life in the 1970s and has not been repaired.) Assuming that the current cost-per-mile for repair work remains constant (in real dollars) at $570,000, 4/ then repair in accordance with design life implies that about $15 billion would be needed for repairs during the 1980s.

Second, there might have been an incentive for states to overstate their repair needs. These studies were prepared in response to a Congressional directive, for use in assessing the federal financial role in highway maintenance. State-assessed needs to determine federal funding have led to overstated estimates of highway needs in the past, notably where tight, objective standards were not established as a basis for the self-assessment. Neither minimum nor maximum standards were uniformly enforced for the 1980 study; the only restraint imposed was that roads had to be in service for five years before qualifying for the study.

Third, a separate study of repair costs made by the Department of Transportation (DOT) projected costs of $16 million. 5/ The DOT study did not rely exclusively on each state's own assessments of its repair needs. Rather, it relied upon a subjective but standardized "Present Serviceability Rating" of the road surface, ranging from four to five for new pavement in good condition (see Figure A-1-a) to zero for pavement is in poor condition.

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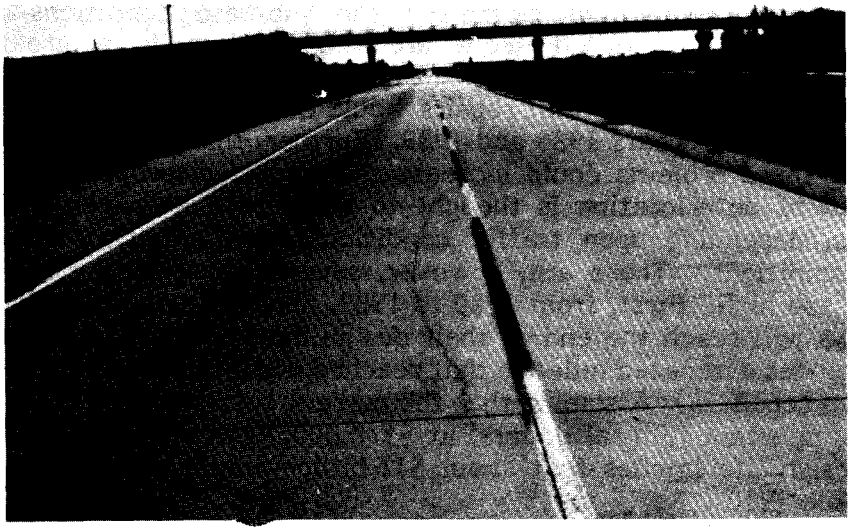
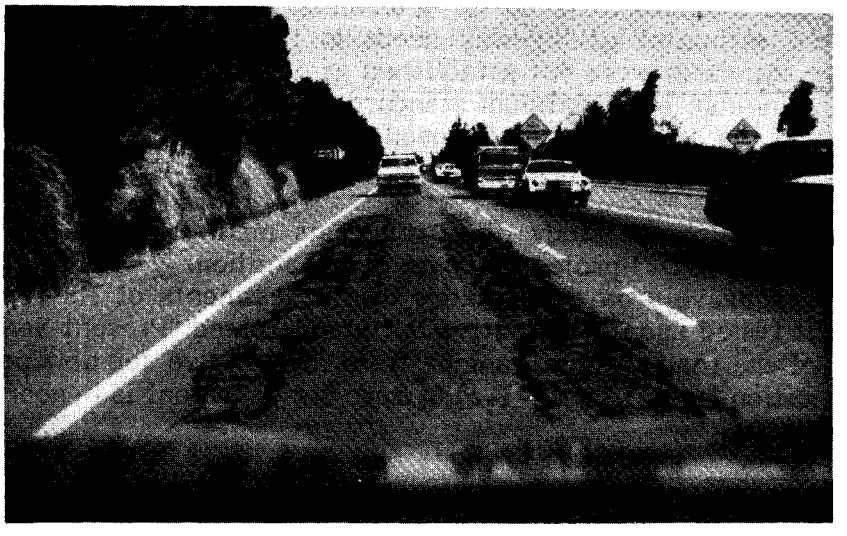
4. This estimate assumes that repairs are made as soon as a road reached its design life.

5. U. S. Department of Transportation, The Status of the Nation's Highways, Conditions and Performance (1981).

Figure A-1.
Degree of Pavement Condition



a. *Pavement in good condition.* About 62 percent of all Interstate highway mileage was in this condition in 1978. Such pavement may exhibit some light cracking, but in general it is smooth and safe for high-speed traffic. The section shown above exhibits some low-severity longitudinal cracking.

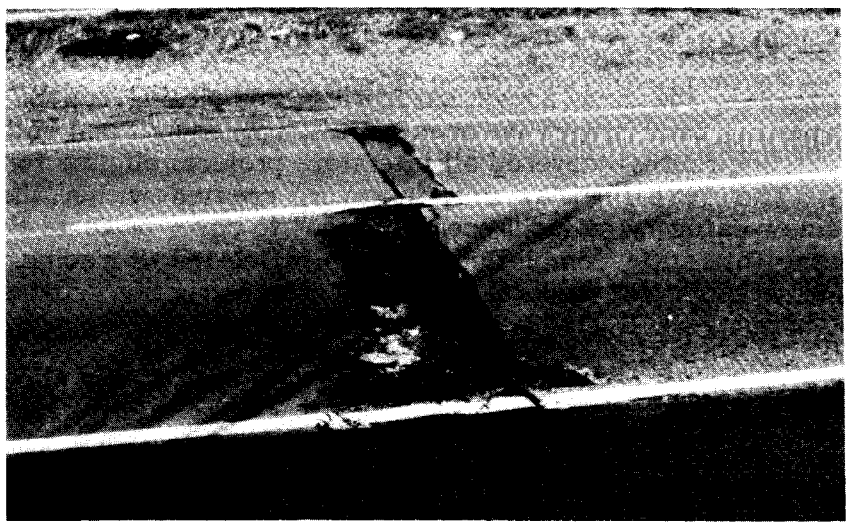


b. *Pavement in fair condition.* This represented about 29 percent of all Interstate highway mileage in 1978. Fair pavement exhibits rutting and cracking and may be barely adequate for high-speed traffic. The above section exhibits medium severity "alligator cracking" in the wheel paths.

SOURCE: U.S. Department of Transportation, *Highway Pavement Distress Identification Manual for Highway Condition and Quality of Highway Construction Survey* (March 1979).

Figure A-1. (Continued)

c. *Pavement in poor condition.* About 9 percent of all Interstate highway mileage was in this condition in 1978. Poor pavement is in extremely deteriorated condition, and may need new sub-base and base material in addition to resurfacing. The above section exhibits high-severity longitudinal cracking in the center lane.



d. *Pavement in poor condition.* Same characteristics as photograph c. The above section shows high-severity joint load transfer system associated deterioration.

About 9 percent of all Interstate highway mileage was found to be in poor condition (see Figure A-1-c and d). The term poor covers pavement that is in an extremely deteriorated condition (cracked, splintering, and uneven) and that may need new sub-base and base material in addition to resurfacing; it also covers pavements that have not deteriorated quite as badly, but do need resurfacing. 6/ Another 29 percent of all Interstate mileage was reported to be in "fair" condition, defined as pavement that exhibits rutting, cracking and extensive patching, and that is barely adequate for high-speed traffic (see Figure A-1-b). Such pavements do not require immediate resurfacing, but delay in resurfacing the worst of them is thought to accelerate wear and tear, and cause premature need for major sub-base and base restoration.

The DOT study's projected repair requirements were based on the assumption that roads will be resurfaced as soon as their pavement serviceability ratings fall below 2.5, a point at which the riding quality of pavement is noticeably inferior to that of new pavement and, according to engineering tests, may be barely tolerable for high-speed traffic. Such pavement exhibits visible signs of wear, such as cracking and extensive patching. In view of these considerations, this paper assumes that repairs will cost approximate $16 billion between 1980 and 1990, in line with the later DOT study.

Reconstruction Costs

Before 1981, the four above categories--completing routes not yet open, completing final stages on open routes, upgrading open routes, and repaving existing routes--covered all Interstate projects eligible for federal financing. The 1981 highway act, however, created within the repair program a new category called "reconstruction" to cover projects that were cut from the Interstate completion program. Deleted upgrading projects were made eligible for federal funds as reconstruction costs. Over

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6. About half the states are reported to have less than 2 percent of their Interstates in poor condition. Only five states--Arizona, Minnesota, North Carolina, Ohio, and Oregon--are reported to have more than 10 percent in poor condition, indicating that these states have substantially poorer roads than the other states.

$14 billion of such work was redefined as reconstruction projects (see Table A-2).

In addition, other deleted projects could be reclassified as reconstruction. Based on a recent national survey by the Federal Highway Administration, the estimated demade for additional reconstruction projects, above those previously included in the completion plan, would cost about $12.2 bil-

TABLE A-2. COST OF RECONSTRUCTION OF INTERSTATE HIGHWAYS AND BRIDGES, BY CATEGORY (In billions of 1979 dollars)

Reconstruction Category	Cost
Projects Transferred From the Interstate Completion Plan [a]	
Spot Improvements	4.40
Rest Areas	0.80
Bridges and Tunnels	0.74
Landscaping	0.70
Highway separation	0.55
Traffic control	0.54
Noise abatement	0.47
Railroad separation	0.20
Pedestrian and bicycle facilities	0.19
Stage Construction of Safety and Environmental Improvements	0.40
Miscellaneous Construction	1.00
Engineering and Contingencies	4.21
Subtotal	14.20
Other Projected Costs	12.20
Total	26.40

a. Breakdown of costs by type of project estimated by CBO.

lion (in 1979 dollars) over the next ten years. 7/ This would bring the total cost of reconstruction of $26.4 billion. A large portion of reconstruction costs--about 30 percent--stem from spot safety improvements, while the remaining 60 percent covers rest areas, landscaping, noise abatement, and other environmental projects (see Table A-2).

7. Unpublished estimate drawn from U. S. Department of Transportation, Interstate Resurfacing, Restoration, and Rehabilitation Study (1980 update).

APPENDIX B. THE DEVELOPMENT OF PROGRAMS FOR FEDERAL AID TO HIGHWAYS

The federal government operates more than 30 programs that help finance highways or highway-related activities (see Table B-1). Most of these are funded from the Highway Trust Fund. In addition to financing the Interstate System from the fund, in fiscal year 1982 the federal government authorized $1.5 billion for the primary system, $400 million for the secondary, $800 million for the urban system, $900 million for bridge reconstruction, and $813 million for various other highway programs. More than $500 million in general revenues also were spent to support various highway activities, and several programs were authorized with joint financing from the Highway Trust Fund and general revenues.

Primary Program

Federal assistance for the primary highway system dates back to 1916, when the inadequacy of the main intercity arteries represented the paramount highway needs of the nation. Today, federal highway legislation defines the primary system, which consists of 269,433 route miles, as "an adequate system of connected main roads." These highways are primarily the U. S.-numbered roads--routes U. S. 1, U. S. 66, and so forth--many of which are similar in character to Interstate routes, since they are intercity, have more than two lanes, and have limited access. Even with the creation of the Interstate system, the primary system today carries twice as much traffic in rural areas as the Interstate System.

Although the primary system is national, the designation of all 269,433 route miles as nationally important may well overstate the mileage that is essential to a national network of primary routes. Whereas the federal government plays a decisive role in the selection of Interstate routes, the designation of primary routes is left largely to the states. Currently, the law requires that the system shall "consist of an adequate system of connected main roads important to interstate, statewide, and regional travel, consisting of rural arterial routes and their extensions into or through urban areas." 1/ While there is no systematic basis for distinguish-

1. Federal-Aid Highway Act of 1973 (P. L. 93-87).

TABLE B-1. HIGHWAY PROGRAM AUTHORIZATIONS IN FISCAL YEAR 1982, BY SOURCE OF FUNDS AND PROGRAM (In millions of dollars)

Source of Funds and Program	Fiscal Year 1982 Authorization	Amount Available for Spending in 1982
Programs Financed by the Highway Trust Fund		
Interstate System	3,100.0	3,100.0
Interstate apportionment	125.0	125.0
Interstate 4R a/	800.0	800.0
Federal-aid primary	1,500.0	1,500.0
Federal-aid secondary	400.0	400.0
Federal-aid urban	800.0	800.0
Forest highways	33.0	33.0
Public lands highways	16.0	16.0
Economic growth center development highways	50.0	50.0
Emergency relief	100.0	100.0
NHTSA	100.0 b/	92.5
Highway safety R&D (NHTSA)	31.0	23.8
Federal Highway Administration (FHWA) safety grants	10.0	10.0
Highway safety R&D (FHWA)	13.0	4.9
Bridge reconstruction	900.0	900.0
Elimination of hazards	200.0	200.0
Pavement marking	65.0	65.0
Rail-highway crossings	190.0	190.0
Accident data collection	5.0	1.0
Programs Financed Jointly by the Highway Trust Fund and General Revenues		
Bicycle program	20.0 c/	0.0
Great River Road	35.0 d/	25.0
Demonstration projects for railroad/highway crossings	100.0 e/	0.0

(Continued)

TABLE B-1. (Continued)

Source of Funds and Program	Fiscal Year 1982 Authorization	Amount Available for Spending in 1982
Programs Financed by General Revenues		
Forest development roads and trails	140.0	313.7 f/
Public lands development roads and trails	10.0	18.0 g/
Public roads and trails	30.0	0.0
Parkways	45.0	3.5
Indian reservation roads and bridges	83.0	47.2
Appalachian development highways	140.0	140.0
Administration expenses for highway beautification	1.5	0.5
Territorial highways	12.0	3.0
Control of outdoor advertising	30.0	0.0
Safer-Off system roads	200.0	0.0
Access highways to lakes	15.0	0.0
Total	9,299.5	8,962.1

a. 4R = Resurfacing, Restoration, Rehabilitation, and Reconstruction.

b. Grants made by the National Highway Traffic Safety Administration (NHTSA). Also includes $20 million for enforcement of maximum speed limit.

c. 50 percent trust fund, 50 percent general fund.

d. $25 million in direct spending from the trust fund and $10 million for appropriation from the general revenues.

e. 67 percent trust fund, 33 percent general fund.

f. Part derived from timber sales.

g. Part derived from grazing fees.

ing routes within the primary system that serve local versus intercity purposes, there is little doubt that the vast majority of travel between states is on the Interstate and primary systems, making these systems of considerable national importance in their facilitation of interstate commerce, communication, and personal travel.

Secondary Program

The secondary road system was started in 1944. It originally consisted of farm-to-market routes, but because of very loosely defined criteria, it rapidly grew to include every type of rural road from local access to the highest grade arterial roads. The only restriction was that a secondary route could not be part of the primary system.

In 1976, the secondary system was redesigned so that only roads that functionally serve as major rural collector routes are eligible for inclusion in the program. Today the system includes 402,000 (93 percent) of the some 430,000 miles of major rural collectors in the country. These routes, unlike those in the primary system, do not form an interconnected network of highways. Instead they are collectors of traffic funneling onto and off the state arterial network.

The secondary system currently serves three major purposes. First, the routes provide service to county seats not on an arterial route and to other places of intracounty importance, such as mining or agricultural areas, shipping points, and so forth. Second, they link major county locations with nearby larger towns or cities. Finally, they serve the more important intracounty travel corridors and connect with routes of higher classifications within the county.

The federal secondary program provides almost 25 percent of the capital improvement funds spent on these routes--a proportion that has held fairly constant over the last 10 years. State spending on secondary routes has declined as a proportion of total funding, while local participation has become more prominent.

The chief purpose of the program--to develop paved farm-to-market routes--has largely been accomplished since 85 percent of all secondary routes now are paved. In addition, the often amatuerish and inadequate engineering practices of the local administrative units responsible for these roads generally have been replaced by competent engineering methods. Continued federal support to the secondary program has essentially evolved

into a revenue-sharing program. Lask year the Administration proposed to eliminate the secondary program by fiscal year 1984.

Urban Program

Early highway legislation explicitly excluded roads in urban areas from receiving federal aid. This urban exclusion was not eliminated until the depression years of the 1930s, and by 1944, a separate urban program was created to finance urban extensions of the national primary system.

If fiscal year 1970, this program was broadened to include any urban arterial or collector route not on another federally funded system. Local officials select the routes to be eligible. Federal urban program funds may also be used to purchase public transportation facilities and rolling stock, both fixed rail and bus. As with the secondary program, the urban program has become essentially a form of revenue sharing, and the Administration also proposed last year to eliminate the urban program by fiscal year 1984.

Bridge Replacement and Reconstruction Program

In 1982, a special program authorized $900 million for replacement and reconstruction of bridges. About half of all authorized funds are spent on bridges on the Interstate and primary systems; these improvements are considered nationally important since they are located on routes with that designation. The remaining funds are spent on bridges on the secondary or urban systems, or on bridges on nonfederally aided routes. This second group of projects are predominantly of local importance, although some argue that the associated safety improvements should be considered a national priority. For example, although the Administration proposed last year to discontinue a number of locally oriented highway programs, the entire bridge program, including federal expenditures on bridges not located on the Interstate and primary systems, would have been retained on the grounds that a high national interest exists in reducing the safety problems presented by deficient and obsolete bridges.

Safety, Emergency Relief, and Recreational Programs

Safety Programs. In recent years, several highway safety programs related to vehicles, drivers, and roadways were enacted because of increased Congressional concern over the loss of life and the drain on public and private resources caused by accidents. Since 1976, the number of

highway fatalities per mile travelled has risen, and, if the rate continues, the total number of highway deaths will soon again exceed 55,000, the number of fatalities in 1973. (The rate had dropped after imposition of the 55 mile-per-hour speed limit and decreased travel after fuel prices increased, as a result of the OPEC embargo.) Significant changes now taking place potentially could accelerate recent trends. For example, the changing vehicle mix resulting from smaller cars, more motorcycles, larger trucks and the growing number of vehicles are placing increasing demands on vehicles and highways designed for different conditions.

Accident frequency and severity on the nation's highways is a complex interaction of drivers, vehicles, and roadway environment. Responsibilities for these factors rests with many levels of government and in different departments and agencies, as well as many parts of the private sector. The Highway Safety Act of 1973, for example, initiated several programs to address roadway-related hazards and deficiencies that contribute most to injuries and fatalities. Authorized programs gave states funds to eliminate bridge deficiencies, improve high-hazard locations, remove roadside obstacles, reduce hazards at railroad-highway crossings, demonstrate the value of standard pavement markings, and improve safety on roads and streets located off the federally financed highway system. In addition, federal highway tax receipts support the National Highway Traffic Safety Administration, a branch of the Department of Transportation that conducts safety-related research and development. These safety programs differ from the other major road programs in that they are not tied to some specific system of roads, such as the secondary system, but rather apply to all road systems. In fiscal year 1982, over $500 million was authorized for trust fund programs that promote highway safety.

Emergency Relief. The Federal-Aid Highway Act of 1956 established the emergency relief program, which authorizes the Secretary of Transportation to help states fund the repair of highways, minor roads, and trails that have been seriously damaged as the result natural disasters, such as floods, hurricanes, and earthquakes. These funds are used for local as well as national roads, and the program reflects what is often perceived as the federal government's broad role as a safety net in times of unforeseen disasters.

Recreational Programs. Several federal highway programs authorize funds for the development of roads and trails on public lands. The economic benefit of these programs are derived almost entirely by the states in which the facilities are located.

APPENDIX C. GAPS IN THE INTERSTATE SYSTEM

TABLE C-1. GAPS IN THE INTERSTATE SYSTEM, BY STATE AND CHARACTERISTICS a/

State	Route	Cost (In millions of 1979 dollars)	Length (In miles)	Federal Design Concept Approval Received b/	Designated by DOT as an Essential Gap c/	Designated by DOD as a Gap of Defense Importance d/	Balanced or Peaked Traffic Flow e/	Functional Classification f/	National or Local Significance g/
Alabama	I-65, Birmingham	81.7	8.1	Yes	Yes	Yes	Peaked	Through-Route	National
	I-65, Near Birmingham	42.2	6.4	Yes	Yes	Yes	Peaked	Through-Route	National
	I-210, Mobile	170.2	6.2	No	No	N/A	Peaked	Downtown Circulator	Local
	I-565, Near Huntsville	105.6	16.2	Yes	Yes	Yes	Highly Peaked	Spur	Local
	I-565, Huntsville	144.2	5.1	No	No	Yes	Highly Peaked	Spur/ Downtown Circulator	Local
	I-759, Gadsden	34.8	4.5	Yes	No	No	Balanced	Spur/ Downtown Circulator	Local
Arizona	I-10, Phoenix	49.9	5.4	Yes	Yes	Yes	Peaked	Through-Route	National
	I-10, Phoenix	207.1	7.5	Yes	Yes	Yes	Peaked	Through-Route Feeder	National
	I-10, Phoenix	272.7	6.3	Yes	No	No	Balanced	Downtown/ Circulator	Local
	I-40, Near Flagstaff	15.4	2.7	Yes	Yes	Yes	Balanced	Through-Route	National

(Continued)

TABLE C-1. (Continued)

State	Route	Cost (In millions of 1979 dollars)	Length (In miles)	Federal Design Concept Approval Received [b]	Designated by DOT as an Essential Gap [c]	Designated by DOD as a Gap of Defense Importance [d]	Balanced or Peaked Traffic Flow [e]	Functional Classification [f]	National or Local Significance [g]
Arkansas	I-630, Little Rock	31.6	0.8	Yes	No	No	Peaked	Downtown Circulator	Local
California	I-15, San Diego	44.4	2.4	Yes	Yes	Yes	Peaked	Feeder	Local
	I-15, North of San Diego	45.7	4.1	Yes	Yes	Yes	Peaked	Through-Route	National
	I-15, San Bernadino	152.2	11.1	Yes	Yes	Yes	Highly Peaked	Through-Route	National
	I-80, Auburn	60.3	2.1	Yes	Yes	N/A	Peaked	Through-Route	National
	I-105, Los Angeles	397.3	1.6	Yes	Yes	No	Balanced	Spur Connector Downtown Circulator	Local
	I-105, Los Angeles	1,216.6	15.7	Yes	No	No	Balanced	Downtown Circulator/ Connector	Local
	I-180, San Francisco	185.5	5.9	Yes	No	Yes	Balanced	Connector/ Downtown Circulator	Local
	I-380, San Francisco	40.7	1.2	Yes	Yes	N/A	Balanced	Spur/ Downtown Circulator	Local
	I-580, San Francisco	79.8	1.3	Yes	Yes	Yes	Balanced	Connector/ Downtown Circulator	Local

(Continued)