TRANSPORTATION INVESTMENT AND ECONOMIC EXPANSION: CASE STUDIES

VOLUME II

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Transportation Research Board
National Research Council

LOUIS BERGER INTERNATIONAL, INC.
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Preface

This report is the second of a two-volume report prepared as part of a project sponsored by the American Association of State Highway and Transportation Officials (AASHTO) Special Committee on Economic Expansion and Development. The main objective of the project was to prepare a report on what we know about the **fundamental ways in which transportation investment affects economic expansion** in today's global economic climate. The research project was conducted by Louis Berger International, Inc., based on a synthesis of previous studies and the results of selected case studies covering all modes and types of transportation investments. This work is intended to help focus on priority transportation investments that are most supportive of the nation's and the states' economic expansion objectives. Readers may particularly be interested in Section V of Volume I which discusses what we know and what we don't know about the linkages between transportation and economic expansion. A brief overview of the findings and conclusions of the project is also presented in a Summary Report. This second volume presents a full version of each of the case studies reviewed.

Acknowledgment

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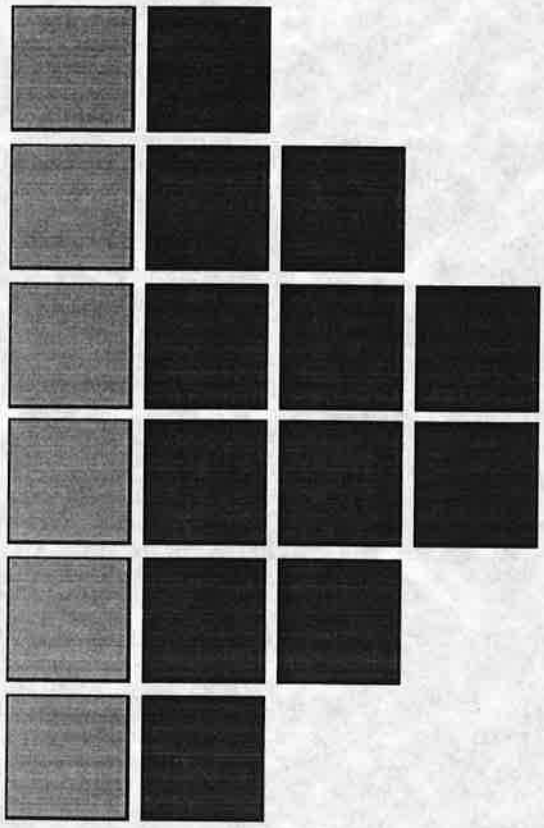
VOLUME II

Appendices and References

ABBREVIATIONS AND ACRONYMS

AAPA	American Association of Port Authorities
AASHTO	American Association of State Highway and Transportation Officials
ATLF	Advanced Truck Load Freight
ARC	Atlanta Regional Commission
ARTCC	Air Route Traffic Control Center
BART	Bay Area Rapid Transit
BPR	Bureau of Public Roads
CAAA	Clean Air Act Amendments
CAPUFE	Caminos y Puentes Federales de Ingresos y Servicios Conexos
CAT	Category
CBO	Congressional Budget Office
CIP	Capital Improvement Program
CIP	Capital Investment Plan
COE	Corps Of Engineers
CTPS	Central Transportation Planning Staff
DOT	Department of Transportation
DVRPC	Delaware Valley Regional Planning Commission
DWT	Dead Weight Tons
FAA	Federal Aviation Administration
FAIP	Freight Access Improvement Program
FHWA	Federal Highway Administration
FNM	Ferrocariles Nacionales de Mexico (Mexico's National Railroad)
FTA	Federal Transit Administration
FY	Fiscal Year
GATT	General Agreement on Trade and Tariffs
GaDOT	Georgia Department of Transportation
GDP	Gross Domestic Product
GM	General Motors
GNP	Gross National Product
GSP	Gross State Product
HOV	High Occupancy Vehicle
IRR	Internal Rate of Return
ISTEA	Intermodal Surface Transportation EfficiencyAct
ITS	Intelligent Transportation System
IVHS	Intelligent Vehicle Highway System
JIT	Just-In-Time
LA	Los Angeles
LBS	Laredo Bridge System
LRP	Long Range Plan
LOS	Level of Service
MAPC	Metropolitan Area Planning Council
MARTA	Metropolitan Atlanta Rapid Transit Authority
MDPW	Massachusetts Department of Public Works

MLS	Microwave Landing System
MnDOT	Minnesota Department of Transportation
MPO	Metropolitan Planning Organization
MTC	Metropolitan Transportation Commission
NAFTA	North America Free Trade Agreement
NAS	National Airspace System
NASP	National Airspace System Plan
NCHRP	National Cooperative Highway Research Program
NEPA	National Environment Policy Act
NHS	National Highway System
NPIAS	National Plan of Integrated Airport Systems
NPV	Net Present Value
PaDOT	Pennsylvania Department of Transportation
PCN	Priority Commercial Network
POB	Port of Baltimore
PSR	Pavement Serviceability Ratings
RISE	Revitalize Iowa's Sound Economy
SEPTA	Southeastern Pennsylvania Transportation Authority
TCM	Traffic Control Measures
TEA	Transportation Economic Assistance Program
TEU	Twenty Foot Equivalent Unit
TEDF	Transportation Economic Development Fund
3C PROCESS	Cooperative, Comprehensive and Continuing Planning Process
TIP	Transportation Improvement Program
TRACON	Terminal Radar Approach Control Facilities
TRB	Transportation Research Board
TxDOT	Texas Department of Transportation
UPS	United Parcel Service
US	United States
USDOT	United States Department of Transportation
V/C	Volume/Capacity
VMT	Vehicle Miles of Travel
WMATA	Washington Metropolitan Area Transit Authority



Appendix A

Advisory Panel for NCHRP

LOUIS BERGER INTERNATIONAL, INC.

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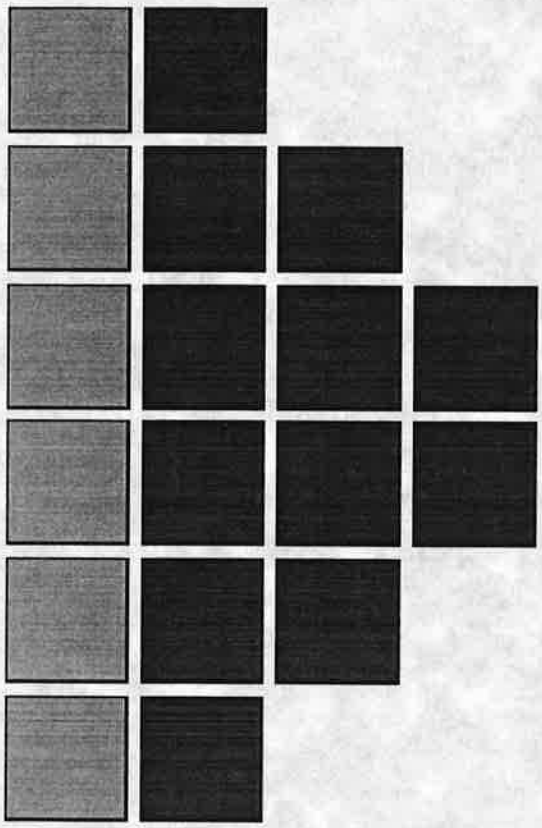

Appendix B

Case Study I:

Interstate Highway System

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APPENDIX B

CASE STUDY:

INTERSTATE HIGHWAY SYSTEM

I. Investment Description

The National System of Interstate and Defense Highways (generally known as the Interstate Highway System) represents perhaps the largest single infrastructure investment ever undertaken. The basic rationale for the system was to connect all major cities in all states, most state capitals, tourist attractions and key industrial areas, defense establishments, and major economic centers by the construction of a limited access highway network to the highest engineering standards (70 mph design speed) that would be able to move long-distance interstate commerce traffic faster and more efficiently. The system was designed based on estimated traffic volumes to meet the anticipated demand for a twenty year planning period. It now carries more than 22% of all highway travel.

The Interstate System was selected as a case study because it highlights the effects of a transportation investment at the national level involving a new system using existing technology to achieve a higher level of service (faster travel) for the long distance movement of individuals and freight. In addition, this case study will also be used to discuss the implications of such a massive investment in terms of longer-term maintenance and rehabilitation requirements.

More than 37 years after a funding source was approved for construction of the system, less than 100 miles remains to be completed on the 42,800-mile system. In 1956, the initial 38,548-mile system was estimated to cost $27 billion to complete. By 1974, the estimated completion cost had risen to $76 billion. The latest estimate to complete the now expanded system is $129 billion of which $116 billion has been spent.

The cost of new interstate highways has escalated since the initial estimates were prepared because of inflation, increased relocation costs, environmental mitigation and other factors. Although the initial system was aimed at interregional, long distance traffic, beltways and radial highways were included to provide the needed connections to economic centers in and around metropolitan areas. Urban interstate highway costs, in particular, have increased well beyond the inflation rate as construction through a fully developed city can cause significant dislocation and other impacts. One of the recently completed urban segments, the Century Freeway (I-105) in Los Angeles, cost $127 million per mile, compared to the average $660,000 per mile initial estimate to complete the Interstate System.

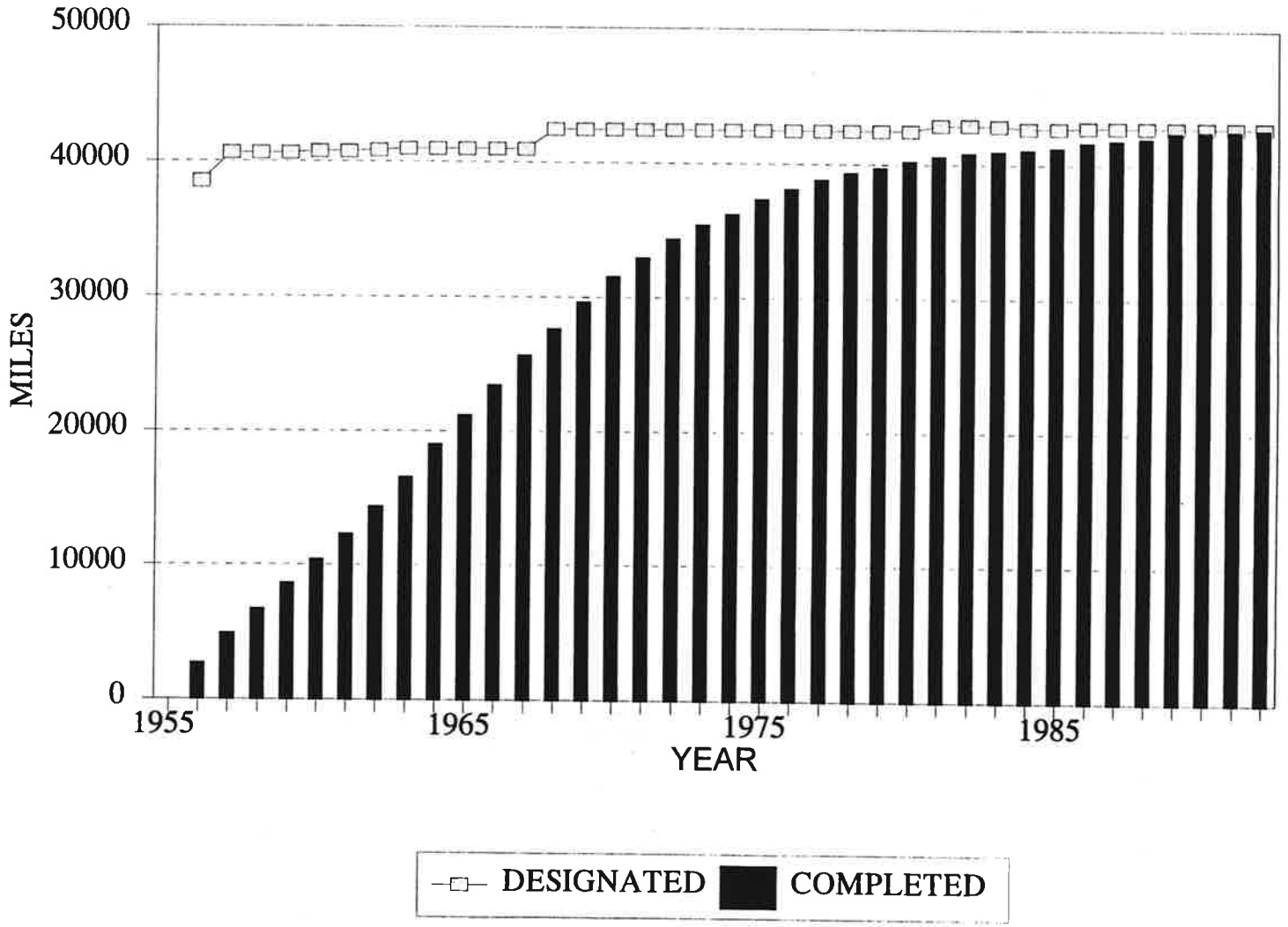
Construction of the Interstate Highway System was begun in 1956, and continues through the present. Table B-1 and Figure B-1 show the progress of construction, through 1992, compared with

TABLE B-1: INTERSTATE HIGHWAY SYSTEM COMPLETION STATISTICS

YEAR	DESIGNATED MILEAGE	MILES OPEN	PERCENT COMPLETE
1956	38,548	2,719	7.1%
1957	40,650	4,952	12.2%
1958	40,650	6,747	16.6%
1959	40,650	8,642	21.3%
1960	40,780	10,440	25.6%
1961	40,790	12,296	30.1%
1962	40,854	14,336	35.1%
1963	41,000	16,555	40.4%
1964	41,000	19,019	46.4%
1965	41,000	21,185	51.7%
1966	41,000	23,476	57.3%
1967	41,000	25,642	62.5%
1968	42,500	27,604	65.0%
1969	42,500	29,638	69.7%
1970	42,500	31,543	74.2%
1971	42,500	32,988	77.6%
1972	42,500	34,393	80.9%
1973	42,500	35,461	83.4%
1974	42,500	36,273	85.3%
1975	42,500	37,392	88.0%
1976	42,500	38,182	89.8%
1977	42,500	38,907	91.5%
1978	42,500	39,412	92.7%
1979	42,500	39,777	93.6%
1980	42,500	40,253	94.7%
1981	42,944	40,634	94.6%
1982	42,945	40,870	95.2%
1983	42,897	40,984	95.5%
1984	42,713	41,138	96.3%
1985	42,713	41,297	96.7%
1986	42,797	41,661	97.3%
1987	42,780	41,859	97.8%
1988	42,798	42,004	98.1%
1989	42,799	42,436	99.2%
1990	42,795	42,532	99.4%
1991	42,795	42,596	99.5%
1992	42,796	42,692	99.8%

Sources: US Department of Transportation, Federal Highway Administration, Office of Engineering, Interstate and Program Support Branch, 1994.

FIGURE B-1: INTERSTATE HIGHWAY SYSTEM DESIGNATED AND COMPLETED MILES



the designated (planned) mileage. Three quarters of system construction was completed prior to 1970. By 1980, 95 percent of the designated mileage had been completed; in 1992, 99.8 percent had been completed.

The total capital investment in the Interstate Highway System, in current dollars, was $111,210,000,000 through 1985. Annual expenditures of capital are shown on Figure B-2. The level of funding was consistently in the $2 billion to $5 billion range for nearly 30 years, with a general trend of annual increases throughout this period. However, when the investment is adjusted to reflect inflation (using FHWA construction price data), it can be seen that investment peaked in the mid sixties at nearly three times its level in 1985. Using this data, the total investment between 1956 and 1985 was $269 billion in 1987 dollars, or $6.5 million for every mile of the system completed up to that time.

Figure B-3 is a map of the Interstate Highway System. It can be seen that the system is fairly evenly distributed across most of the more densely populated areas of the country, and is clustered in the large urban areas. It also intersects international borders in several locations. The 1973 Highway Act allowed non-essential segments of the Interstate Highway System to be withdrawn from the designated mileage. Between 1974 and 1989, 340 miles of Interstate segments were withdrawn; most were urban segments. The total saving in current dollars was $9.8 billion.

With most of the Interstate System now completed and many of the highways over 20 years old, the central issues today revolve around maintenance, improvement of efficiency, enhancement of the system at key locations, and added connections to other highways, other cities and economic centers, and other modes of transportation. After making the significant investment that the Interstate System represents, the questions faced include how to effectively improve the system to handle additional demand, how to preserve and maintain facilities, and what is the best way to assure continued contribution of the system to the overall expansion of the nation's economy.

II. Investment Objective and Decision-Making Process

Although the Interstate Highway System was conceived in 1939 and formally designated in 1947, it was not until 1956 that adequate funding was approved and construction accelerated. Over that 17-year period, the nation's major transportation issues were debated thoroughly, and a landmark compromise achieved in the Federal Aid Highway Act of 1956 and its companion Highway Revenue Act of 1956. The need for the system was widely recognized with the arrival of the economic boom following World War II. The heavy cost of congestion on the nation's patchwork roadway system needed to be addressed.

The public debate recognized that highway construction enhanced economic activity, both in terms of direct outlays and broader longer-term development impacts. President Eisenhower, who spearheaded the final push for the 1956 legislation, asserted, "With our roads inadequate to handle an expanding industry, the result will be inflation and a disrupted economy (AASHTO, 1991: 25)."

FIGURE B-2: INTERSTATE HIGHWAY SYSTEM CAPITAL EXPENDITURES

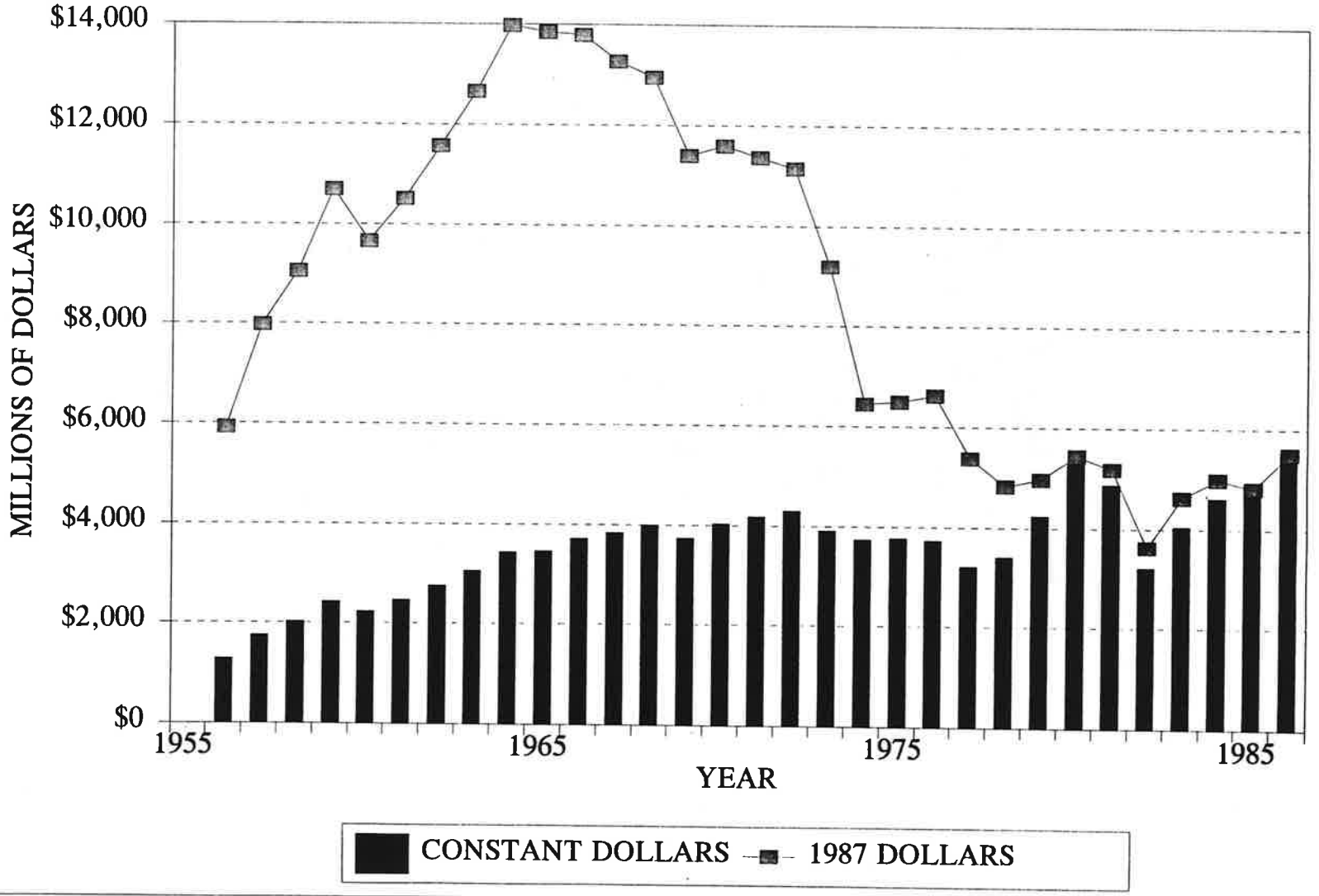


Figure B-3
INTERSTATE HIGHWAY NETWORK

Metropolitan Statistical Area

Interstate Highway

However, rather than focusing on the need for the investment or the economic impacts, the debate turned instead on issues such as sources of funding and precisely where the investments should take place. The 1956 acts eventually reached several compromises (AASHTO, 1991):

- The Highway Trust Fund was created with funding from highway user taxes.
- Funding allocation formulas were developed to provide a balance between urban and rural highways, with difficult tax equity issues and the role of toll collections deferred by funding future studies.
- The federal government was to bear 90 per cent of the Interstate System construction cost, in recognition of the national scope and importance of the project.

During the public debate on the Interstate System, its role as a catalyst in land development, increasing national economic productivity, and changing the pattern of economic activity was not clearly articulated and probably not fully understood. However, it was foreseen as early as 1941 that national limited access highway planning should proceed hand-in-hand with local urban highway planning, and that construction of interregional highways "in the absence of complementary facilities would distort land use and urban form." (Gifford, p. 12)

With the Interstate Highway System virtually complete, the nation now faces new challenges regarding the effective use of this vast transportation resource. Most of these challenges are identified in the Intermodal Surface Transportation Act (ISTEA) of 1991. ISTEA has been characterized as "one of the most significant reformations of U. S. surface transportation policy since the creation of the Highway Trust Fund in 1956." (Gifford, p. 1)

In general terms, the overall objective of ISTEA is:

> "to develop a National Intermodal Transportation System that is economically efficient and environmentally sound, provides the foundation for **the Nation to compete in the global economy**, and will move goods in an energy efficient manner."

The emphasis has changed from building faster transportation systems to managing and operating them to compete internationally. ISTEA stresses the preservation of the Nation's existing transportation investment, it increases the flexibility to transfer funds between highways and other modes, and it places emphasis on better management of the transportation system. The ISTEA transportation planning requirements are now more integrated, emphasizing trade-offs among modes, complementarity of modes and projects, connectivity within and among modes, rigorous prioritization in response to fiscal constraints, and consideration of social and environmental goals.

ISTEA has established several objectives that relate to the future of the Interstate System and how it can continue to facilitate economic expansion:

- **System Maintenance and Management**. Highway maintenance was becoming a serious issue by 1980, when it was projected that $21 billion would be required for repairs to the Interstate System by 1990 (CBO, 1982). The collapse of several bridges on Interstate Highways, the increased need for fuel economy, and concern for vehicle operating costs (which is affected by potholes and pavement failure) brought this issue to the public eye by the middle of the decade. Under ISTEA, an Interstate Maintenance Program is funded (at a level of $2.7 billion in 1993) to cover repair projects which do not involve expansion of capacity. USDOT is responsible for determining the criteria to define what constitutes adequate maintenance of the System. Thus far, $4.4 billion has been obligated under the ISTEA Interstate Maintenance Program. A similar maintenance program, 4-R, was started in 1976; it obligated $24.9 billion. Congress has authorized $17 billion through the end of the 1990's for the Interstate System Maintenance Program.

  Industrial logistic executives are expressing uneasiness about highway quality and the level of maintenance, although, when interviewed, few could point to specific instances of highway maintenance problems affecting their productivity. Weight restrictions caused by maintenance problems and deterioration of bridges were some of the problem types identified. (FHWA 1994, p. 81)

  Traditional highway maintenance, however, is only part of the overall system maintenance and management issue. State DOTs are required under ISTEA to develop management systems intended to assist in allocating scarce funding resources in the most efficient manner. Management systems are required to include physical condition of facilities such as highway pavement and bridges, as well as information to manage use, such as congestion management, safety, and intermodal transfer.

- **National Highway System (NHS).** A new highway system of approximately 159,000 miles (including the Interstate System) has been proposed to provide and maintain an interconnected system of nationally significant roads serving interstate and interregional multi-state corridors, and to improve efficiency in the movement of people and goods. In late 1993, USDOT identified the proposed NHS routes, emphasizing modernization, strengthening of north-south corridors, improving access to other modes of transportation, and improving access to rural America (Neuwirth, 1993). Congress is scheduled to complete its review of the proposed NHS in 1995.

  The NHS will function as the backbone of the nation's transportation system. While it will constitute roughly four percent of America's roads, it will accommodate about 40 percent of all vehicle miles, and 75 percent of commercial vehicle miles. The NHS is seen as a significant step in adapting the nation's highway system to the changes that have taken place since the Interstate Highway System was designated. These changes include factors such as geographic shifts in many types of economic activity, demographic changes, the advent of just-in-time (JIT) inventory control, new information technology, trucking industry deregulation, the need for better intermodal connections, and the requirements of

multinational manufacturing. The development of the NHS will also provide opportunities for the implementation of innovative strategies such as IVHS and congestion pricing. (FHWA 1993)

- **Improved Intermodal Connections**. Intermodal connections to ensure an efficient transfer between various modes for goods and people movement will be an important component of future transportation investment. Because the National Highway System (and the Interstate Highway System) represents the highest level of service road system in the nation, the potential for national economic expansion benefits is greatest along its routes. These improved connections can enhance transport efficiencies and serve as catalysts for nearby land development, in the same way as Interstate highways (USDOT 1993). Examples of intermodal connections include:

    - connectors to airports, port facilities and rail intermodal terminals, and
    - construction of rail mass transit transfer stations in locations accessible to Interstate Highways, with interchange and parking facilities being provided to facilitate the transfer.

- **Intelligent Vehicle Highway System (IVHS)**. The IVHS concept involves developing and applying new technology to manage traffic flow more efficiently and is aimed at economic objectives such as the reduction of congestion costs and increased safety. Some of the specific goals of IVHS include the following (USDOT, 1992):

    - reduce the number of annual fatalities and injuries due to accidents,
    - reduce costs associated with congestion,
    - increase capacity of existing facilities, particularly in highly traveled corridors,
    - improve travel time predictability,
    - reduce fuel wasted by congestion inefficiencies,
    - reduce the costs for all users of the surface transportation systems,
    - make better use of existing facilities and reduce the need for additional investment in the construction of additional lanes of new facilities, and
    - initiate programs that facilitate the establishment of a significant U. S.-based IVHS industry that can achieve a substantial domestic market penetration and a strong international market presence.

The IVHS concept currently envisions broader deployment of new technology. Some of the potential benefits from the technology can result in increased productivity and economic expansion:

- Electronic devices which permit tracking of individual vehicles through global positioning satellite data could improve travel and freight movement reliability.

- Devices that permit the electronic collection of tolls and transportation user fees could result in faster movement through toll gates and reduction of personnel related costs.

- Up-to-the-minute information for motorists, concerning traffic congestion through road messages, broadcasts on radio and television, and computer map displays in vehicles can reduce travel time and improve access for businesses, employees and customers.

The relationship of these programs to economic productivity and expansion is particularly important in today's economic environment, where businesses place increasing importance on the timing and reliability of product delivery. It is well established that time-savings or accident reductions results in economic user benefits. However, the specific relationships to measures such as jobs and income is not so obvious. The broad economic benefits of IVHS can be summarized as increased productivity and reliability, improved international competitiveness, product innovation and increased on-time delivery (USDOT 1992).

- **Congestion Relief and Management**. Congestion relief is becoming an increasingly important issue. A recent FHWA study indicates that industrial logistics executives are identifying urban congestion as one of their principal problems. They estimate that congestion has been responsible for a 15 to 20 percent increase in trucking costs, and will be an even larger problem in coming years. (FHWA 1994, p. 81)

Investments, other than IVHS, to relieve congestion include capital investments such as lane widening and highway resurfacing, and other measures designed to reduce peak hour travel by single occupancy vehicles. Under ISTEA, 44 congestion relief projects have been funded, many of which involve the Interstate Highway System. Total funding for 1993 is $967 million.

Congestion mitigation is also tied to air quality improvement, as required by the Clean Air Act Amendments (CAAA) of 1990. The CAAA require active contribution by transportation investment programs to the improvement of air quality, and does not leave vehicular emissions reduction solely with the auto manufacturers. Traffic Control Measures or TCMs, are an example of how a relatively small transportation investment might facilitate two broader national goals, economic expansion and air quality improvement.

Congestion Management, or Traffic Control Measures, includes strategies such as high occupancy vehicles (HOV) lanes, ridesharing, and park-and-ride facilities to ensure that the Interstate Highway System can continue to function as originally intended, i.e. as a high-speed system. Investment in these types of strategies is significantly less capital-intensive than highway widening or reconstruction. However, much of the cost of TCM's is falling on companies employing more than 100 people, who are required to develop Employee Trip Reduction Plans. A 1994 study by Jacqueline Stewart estimated that each one-way trip eliminated costs a company an average of $397. (Stewart, p. 168) Using this factor (while recognizing the present tenuous nature of identifying the costs and benefits of TCMs), a reduction of 2,000 peak hour trips would cost about $800,000.

- **Refinements to the Interstate Highway System**. New interchanges, realignments, or connectors, targeted at well-defined economic objectives, are anticipated by ISTEA, which also mandated the identification of High Priority Corridors as part of the NHS. Twenty-one such corridors were identified in the 1991 legislation. The objectives of designating High Priority Corridors include further highway development in areas not now adequately served by the Interstate System, and promotion of economic development in such areas. While not specifically emphasizing the Interstate Highway System, this mandate requires consideration of interconnections of High Priority Corridors with the Interstate System. ISTEA also identified Rural and Urban Access Projects, many intended to provide connections to the Interstate Highway System. In addition, ISTEA identified 204 Innovative Projects, whose purpose is to demonstrate new highway construction and finance techniques, with the emphasis on cost-saving construction techniques. A number of these projects involve connections to the Interstate Highway System. Such cost saving techniques can increase the productivity of public sector highway programs.

III. Analysis and Methodology Used for Project Evaluation Prior to Investment Decision

No economic analysis of the overall benefits and costs, or of the economic impacts associated with construction of the Interstate System, is known to have been conducted as a basis for the decision to fund and construct the system. There was general agreement that the system was needed to meet the nation's economic and defense needs. Criteria for inclusion of links in the system were established, connecting major cities directly to the system, connections to every State, connections to defense installations, etc. In the landmark 1939 report *Toll Free and Free Roads*, the Bureau of Public Roads (BPR) concluded that a new nationwide limited access highway system should be concentrated in urban areas, where the heavy traffic was. This was not entirely agreeable to all parties, and the Roosevelt Administration sought a re-thinking of this assertion in favor of regional and rural interconnectivity. In 1941, the BPR wrote several papers which emphasized the necessity for planning the new national limited access highway system in tandem with complementary urban routes, "in order to avoid distorting urban form." (Gifford, p. 9). It should be noted that even if a more comprehensive economic analysis of the full benefits and costs of such a massive investment would have been attempted, there was not enough knowledge of likely impacts nor were methodologies sufficiently developed at the time to carry out such work at the national level.

Although no national analysis was conducted, project planning requirements were established under Federal law, including analysis of alternative routes in each corridor to determine the best highway alignment. Initially, operating cost savings, accident reduction, and time savings were the primary factors analyzed. As such, the analyses required only engineering, economic and cost considerations. Over the years, additional criteria were required to be considered by the States, including the requirements of a 3C process. In their route selection, States were eventually required to also consider such factors as neighborhood disruption and economic impact. Since 1969, Federal law has required the analysis of all environmental consequences of each proposed project, and the preparation of an Environmental Impact Statement. This is one of three major trends which will affect the way future investments in the Interstate Highway System will be evaluated. The other two are Cost-Benefit Studies and Management Systems.

A. National Environmental Policy Act of 1969

By 1969, when the National Environmental Policy Act (NEPA) was passed, about 30,000 miles of the Interstate System had been built. With NEPA, more complex methods of project evaluation have evolved to move a project past the planning and design feasibility stages to implementation. As public opposition mounted to specific projects, decision techniques involving multiple objectives, many of them noneconomic, were developed to set project priorities. Not only the direct, but also the indirect impacts to the environment were subject to investigation. A great deal more emphasis was placed on the evaluation of route and modal alternatives. In addition to potential socioeconomic impacts, the NEPA process necessitated consideration of a comprehensive range of environmental resources and complex trade-off negotiations with regulating agencies regarding such issues as wetlands, noise, water and air quality.

B. Cost-Benefit Studies

No comprehensive cost-benefit analysis is currently required as a basis to determine project feasibility for Interstate Highway investments. In the US, only water transportation infrastructure and navigation related projects must be justified based on a cost-benefit study.

In 1970 and 1974, FHWA carried out cost-benefit studies evaluating the Interstate Highway System, after the majority of the System had been built. These studies concluded that the monetary benefits of the System exceeded the total capital investment by ratios of between 1.5:1 (1970) and 1.8:1 (1974). The principal components of benefits included operating cost savings, accident cost savings, and commercial vehicle time savings. (FHWA 1970 and 1974) Some of the details of these FHWA studies are presented in Section IV.A. below.

Several methodologies are currently under development to address more specifically the economic benefits of highway investment in today's environment, such as the Transportation Research Board project NCHRP 2-17. These are fully applicable to the Interstate Highway System, as well as other major highway improvements.

In light of increased recent emphasis on economic productivity and international competitiveness, changes in transportation planning requirements under ISTEA, and the Clean Air Amendments, it may be appropriate to consider the type of economic analysis that should be conducted for highway project evaluation. As greater emphasis is placed on intermodal connections, multi-modal project evaluation, and system preservation, more comprehensive evaluation tools may be appropriate. These tools may incorporate both environmental, social, energy and economic considerations, and be based on the ISTEA performance management systems. This may eventually allow for more comprehensive trade-off evaluations between modal investments and network performance, and accounting for various spatial patterns associated with transport investment. Calculation of the full life-cycle costs associated with alternative investments may also provide additional information that can result in better investment decisions (see Small and Winston 1988). It is important to note that analytical tools require further development beyond what is available now. Furthermore, no such comprehensive economic analysis and project evaluation is appropriate for other than major new highway investments.

C. Management Systems

Since system preservation will require increased emphasis in the future, decision-making tools can be enhanced in the 1990s through further development of management systems similar to the bridge and pavement systems that are currently being utilized.

The information and decision-making tools of the 1990's will include the management systems required under ISTEA, which cover the following:

- highway pavement of federal-aid highways,
- bridges on and off federal-aid highways,
- highway safety,
- traffic congestion,
- public transportation facilities and equipment, and
- intermodal transportation facilities and systems.

One of the key elements of management systems will be the development of system monitoring and performance measures to assist decision-makers over time in selecting and evaluating transportation programs. This provision will encourage the development of data bases and analytical techniques for performance assessment. Economic criteria should logically be included in the performance assessment, although there is no specific mandate to do so. Maintenance program needs on a certain area of an Interstate Highway could be evaluated not only in terms of volume/capacity ratios and facility condition, but also in terms of impact for selected businesses in the service area. Using data

gathered from local businesses, such a measure could be translated directly into business cost savings. Similarly, a decision to rehabilitate a bridge should consider the need for and productivity benefits associated with a higher clearance to permit the passage of double-stacked rail cars. A key element in developing these new tools will be their use both before and after construction of a project, because of the need to continually measure project performance. Only by using analytic tools in this manner can we expect to gain a better grasp of the actual linkages between investments in the Interstate Highway System and economic expansion.

IV. Project Objectives Achieved and Results After Investment

A. The Economic and Development Effects of the Interstate Highway System

There is little doubt that the Interstate Highway system has had a significant impact upon the US economy and the pattern of development, although there are no available studies that quantitatively have established the number of jobs created, the increased productivity and/or the overall land development impact. The major categories of linkages between capital investment in the Interstate Highway System and economic growth are as follows:

- **Increased System Capacity, Reduced Transportation Costs and Increased Productivity**

Construction of the Interstate System represented a significant addition to the nation's highway capacity to transport the production of our nation's businesses. Although no analysis exists at the national level, it is clear that without such an increment in transportation capacity, the nation's production and/or export capacity would have been affected. Furthermore, there is no question that completion of a nationwide system to the same standards has some benefit that goes beyond the measurable impact of each individual project. However, it is much more difficult to reach conclusions as to the optimal time for construction of an individual link, whether some were built too early or too late, and whether a certain individual link is truly essential to network connectivity.

The most direct, and frequently the most fundamental way in which highway investments influence economic development, is by increasing traffic capacity and reducing the transportation costs to move people and goods between one location and another. The Interstate Highway System significantly reduced long-distance transportation time and costs and made possible the development of coast-to-coast trucking services as a competitor to rail, and thereby increasing the service options for businesses to move their freight. In their 1974 cost-benefit study, FHWA quantified the time savings. The average travel speed between cities increased from 35.8 mph in 1956 to 56.8 mph on Interstate highways. Approximately half of this 21 mph speed increase was directly attributed to the Interstate Highway System. Thus, FHWA estimated that a 365-mile trip which took 10 hours in 1956 was cut to 8 hours in 1970, a net savings of 20 percent. (FHWA 1974, p. 36)

The transportation cost reductions associated with the construction of the Interstate System also resulted in a reduction in the costs of consumer products and an increase in the productivity and competitiveness of American businesses. For individuals, it resulted in reductions in the cost for

long-distance vacation and other traveling. AAA statistics cited in the 1970 FHWA cost-benefit study indicated that the average length of a 16-day vacation trip had increased from 2,150 miles in 1959 to 2,480 miles in 1968. FHWA calculated that the 2,150-mile trip in 1959 would have taken nearly six days of driving time, compared with 5.5 days for the 2,480-mile trip in 1969. (FHWA 1970, p. 24)

The question of how transportation investments affect productivity was discussed in Volume I of this report. Briefly, it is generally agreed that there is a positive effect on productivity, although there is still disagreement as to the magnitude of the effect. The effect of investment in highway infrastructure has been separated out in some of the research. Since the Interstate Highway System was a major part of highway investment during the periods considered in these studies, the results can in general be applied to it. While none of these studies has shown a conclusive relationship between highway investment (and the Interstate Highway System) and economic growth and improved productivity, the weight of evidence supports the intuitive assertion that there is a linkage.

David Aschauer studied the effects of highway investment on economic growth, and found a significant positive correlation during the 1960-1985 period. He concluded that a "higher level and better quality of highway capacity expands transportation services and, in so doing, raises the marginal product of private capital. The higher marginal product of capital induces higher investment in physical capital and growing per capita incomes and output." (Aschauer 1991b)

Attaran and Auclair, in a 1990 study, conducted an econometric study of highway stock and productivity between 1950 and 1985, and concluded that there was a positive relationship. This relationship is illustrated in Figure B-4. Note the similarity of the left half of the Highway Stock curve on this figure to the growth of the Interstate Highway System shown in Figure B-1. Attaran and Auclair concluded that "for every 10 percent increase in the stock of highway and streets, private-sector output has grown by 2.26 percent." (Attaran and Auclair 1990)

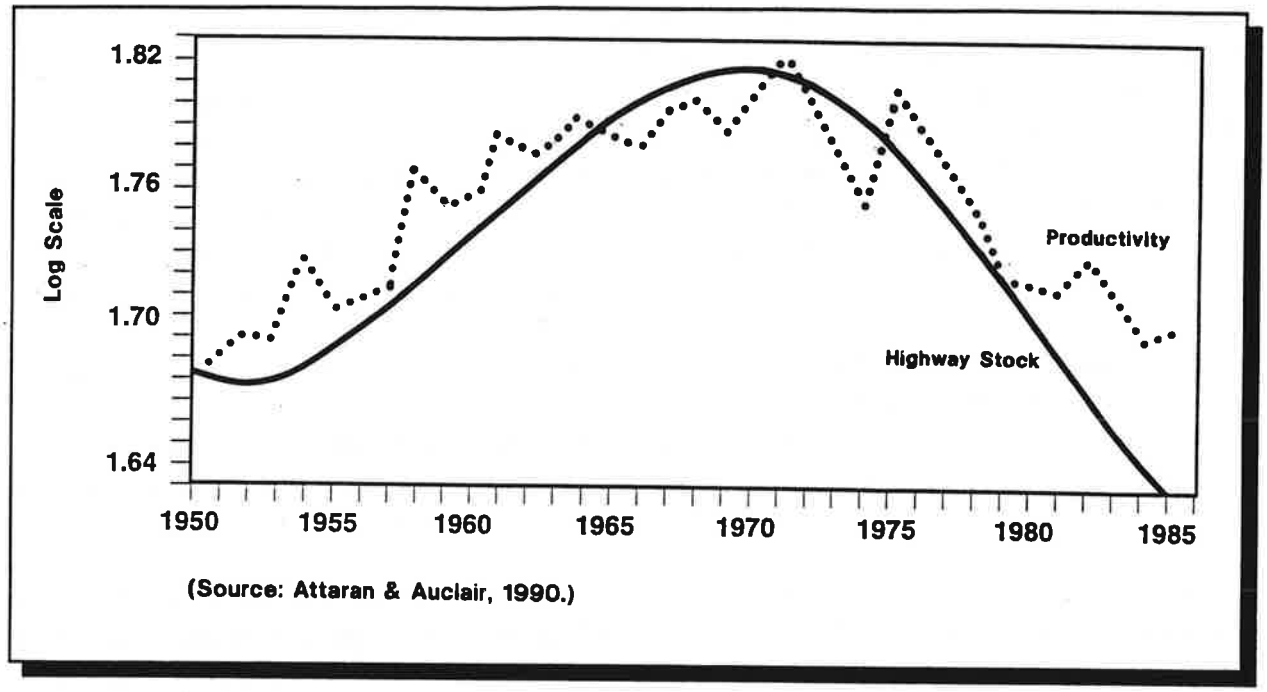
A 1992 FHWA study summarized the research on the relationship of transportation investment and productivity, and presented some research specific to highways. Highways were found generally to be among the most important components of infrastructure investments, in terms of the economic effect. However, specific results differed widely. FHWA concluded, "(n)one of the studies reviewed for this paper are detailed enough or designed to support aggressive public policy action based only on the research data." (FHWA 1992).

- **Changes in the Transportation Industry**

The Interstate Highway System dramatically increased the connectivity of regions and metropolitan areas of the United States, significantly shortened the times required to move among them and improved the overall reliability of transportation. These changes had a vast impact on the movement of cargo and the transportation industry. FHWA's 1970 cost-benefit study asserted that a travel-time related cost savings of 16 to 50 percent had occurred in 47 intercity travel corridors as a result of the Interstate Highway System. Furthermore, the removal of travel impediments such as steep grades,

Figure B-4

RELATIONSHIP OF VALUE OF HIGHWAY STOCK TO PRODUCTIVITY



traffic signals, traffic friction, and stop signs represented an annual savings of nearly $84,000 for a single 20-ton combination truck (assuming a reduction of 1,000 stops or slowdowns plus accelerations per year). (FHWA 1970, p. 9) FHWA has also pointed out that the construction of the Interstate Highway System has surmounted many transportation barriers such as major rivers, mountains, rail yards, etc., which had for years operated as "classic bottlenecks." (FHWA 1974, p. 40).

Data show there can be little doubt that the Interstate Highway System changed the dynamics of the trucking and rail industries. Between 1940 and 1989, the rail freight industry dropped in market share for intercity freight ton-miles from 61 percent to 37 percent. During the same period, trucking gained in market share from 10 percent to 25 percent. Rail revenues increased by only 7 percent during this period, while trucking revenues increased by 64 percent. (FHWA 1993, p. 7)

A recent FHWA study estimated that investment in highway infrastructure resulted in rates of return approaching 5 percent per year between 1960 and 1979 for the manufacturing sector's freight transportation operations. These rates of return represent direct savings in freight transportation costs and indirect savings in production costs. The rates of return between 1980 and 1986 fell to less than 0.5 percent per year. The variance of rates of return between the 1960-1979 period, when the

Interstate Highway System was being completed, and the 1980-86 period "accords with intuition that the interstate system had a very significant payoff and that marginal additions to the infrastructure have had a reduced payoff." (FHWA 1994, p. ES-9)

Several data sets can be used to illustrate the close relationship of trucking to the Interstate Highway System. Figure B-5 shows a juxtaposition of cumulative capital investment in the Interstate Highway System and the total number of trucks registered, clearly pointing out the upsurge in registrations after 1965. Truck registrations also increased as a percentage of total vehicle registrations during this same period, as shown on Figure B-6. This percentage was static in the 20 years following World War II, but increased rapidly after 1965.

The same type of trend is shown in the average annual miles driven per truck. This is illustrated in Figures B-7 and B-8. Figure B-7 is for all trucks, while Figure B-8 is for combination (truck-trailer) vehicles (data for these trucks was not separated out prior to 1965). A clear trend of stagnation in average miles driven per year is shown in the 15 years preceding the early 1960's, followed by an upsurge since then that has not ceased. There are, of course, many possible explanations for these trends, but the coincidence of rapid growth in demand for trucks with the completion of the Interstate Highway System stands out. (FHWA 1985)

Not only are there more trucks, driving longer distances, but they are also carrying larger loads. Figure B-9 shows the percent growth in average truck loadings, based on weight study data. Trucks with five axles or more represented only 8 percent of traffic on the rural Interstate System in 1970; by 1992, this percentage had doubled to 16 percent. (FHWA 1992c, pp. 224-225) Between 1977 and 1987, the average load per truck increased from 10.5 to 13.1 tons. (FHWA 1993, p. 28) In its 1970 cost-benefit study, FHWA cited research findings that a 10 percent increase in average shipping weight is associated with a 7 percent reduction in average shipping costs. (FHWA 1970, p. 14)

Not all the impacts of an increase in trucking at the expense of rail have been entirely positive. Bahar Norris has pointed out that in 1989, the railroads carried 1 trillion ton-miles of freight, as opposed to 700 billion ton-miles by the trucking industry. However, the trucking industry used 407 billion barrels of fuel for this period, while the railroads used only 79 million. (FHWA 1993, p. 7)

It is clear that the trucking industry gained a substantial amount of market share partly as a result of the Interstate Highway System. However, there are many other factors that have led to increased shipments by truck. Among the factors cited as reasons for changes in the trucking industry since 1980 are:

- deregulation,
- application of data processing and management techniques;
- shipper requirements and "just-in-time" inventory control methods;

FIGURE B-5: INTERSTATE HIGHWAY SYSTEM CAPITAL INVESTMENT & NO. OF TRUCKS

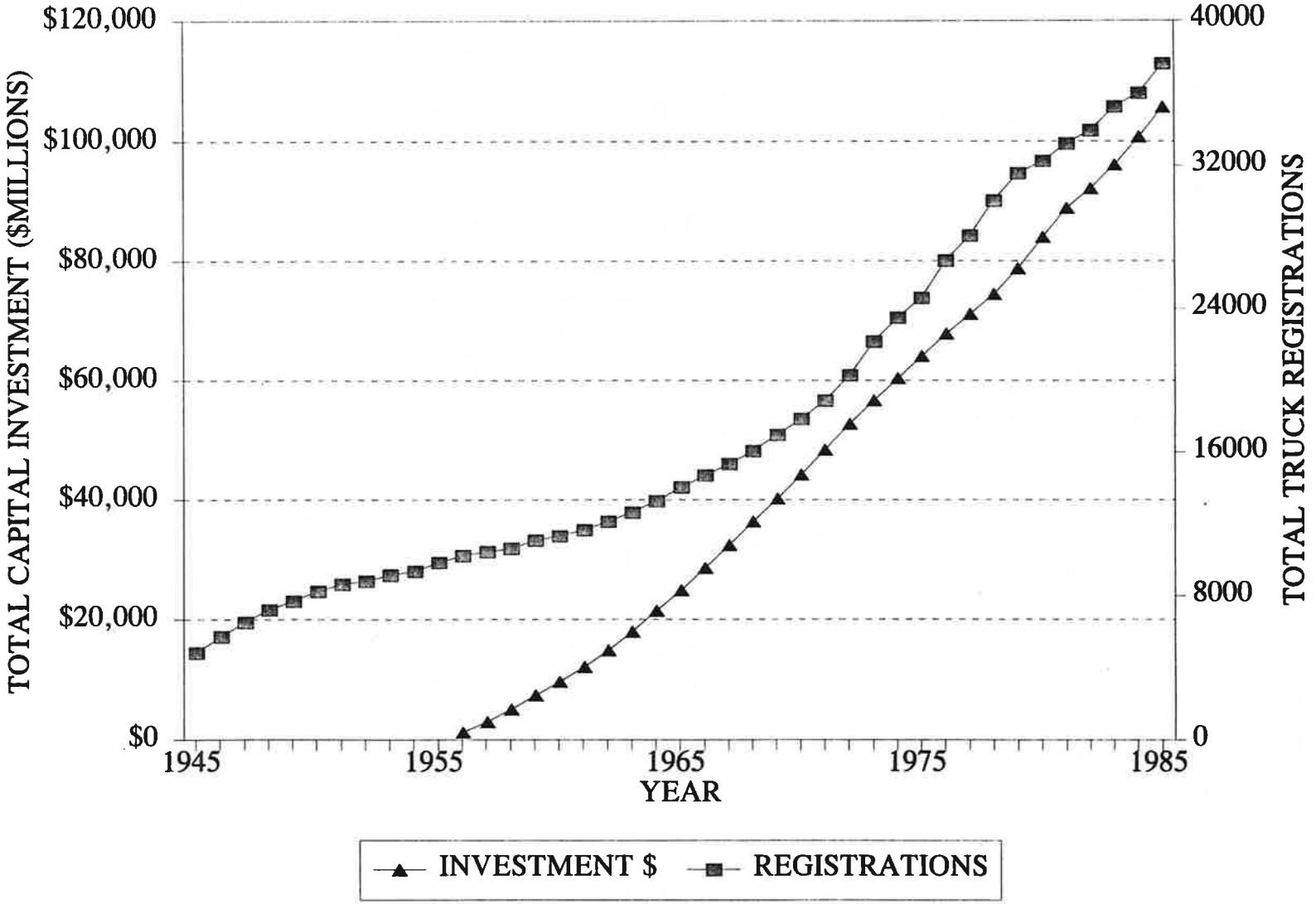


FIGURE B-6: INTERSTATE HIGHWAY SYSTEM TOTAL CAPITAL INVESTMENT AND TRUCKING

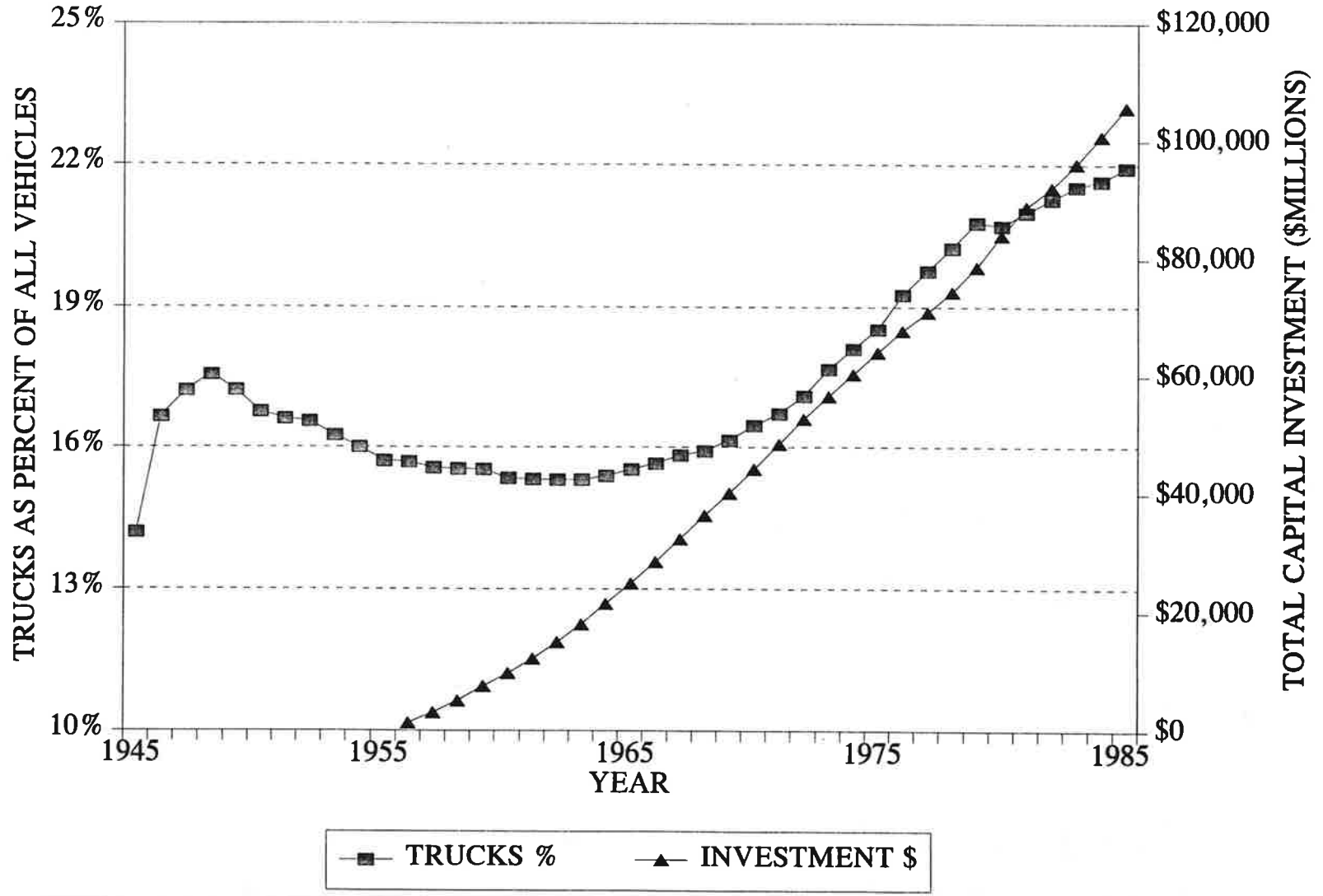


FIGURE B-7: INTERSTATE HIGHWAY SYSTEM COMPLETED MILES & AVE. TRUCK MILES/YR.

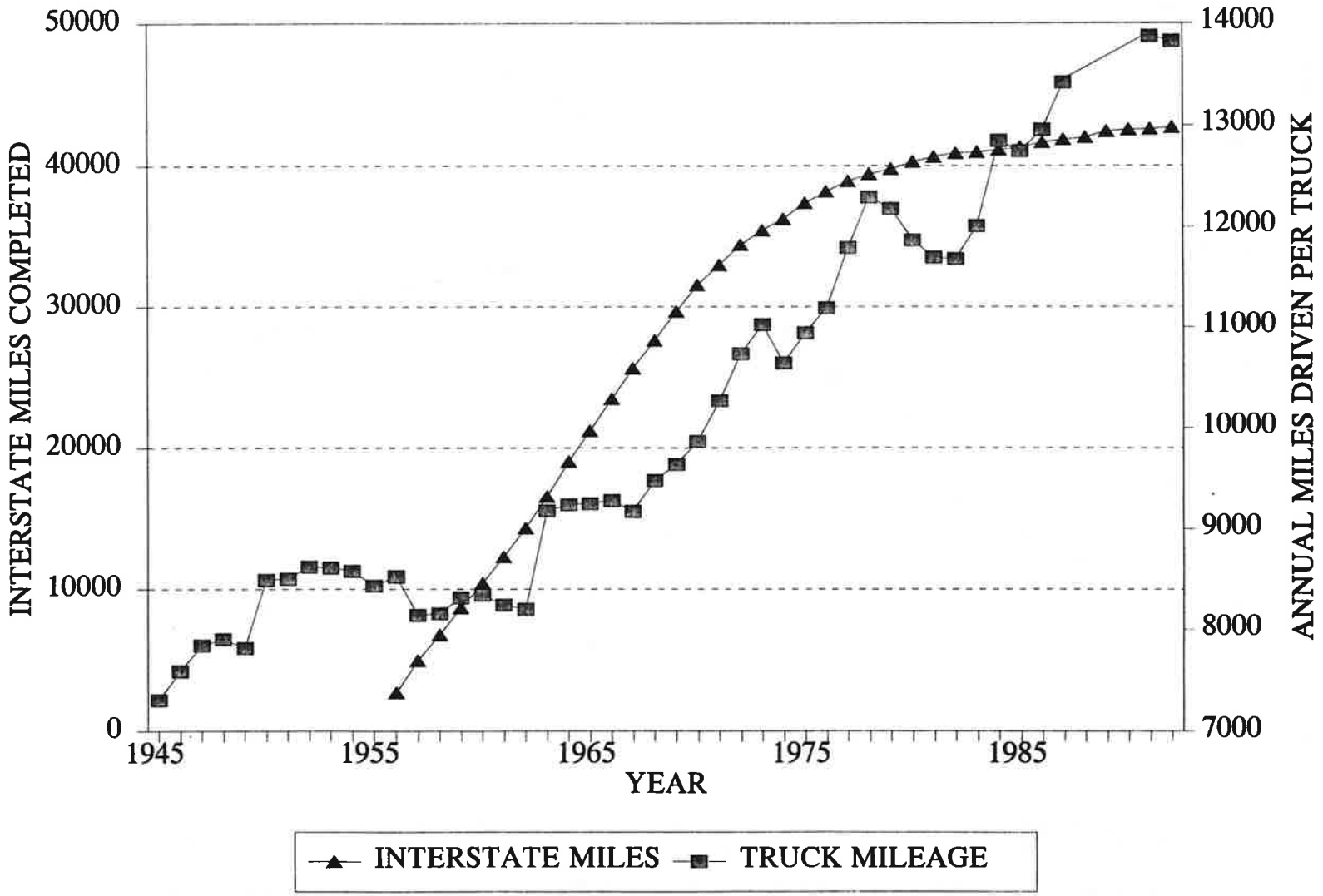


FIGURE B-8: INTERSTATE HIGHWAY SYSTEM COMPLETED MI. & AVE. LARGE TRUCK MI/YR

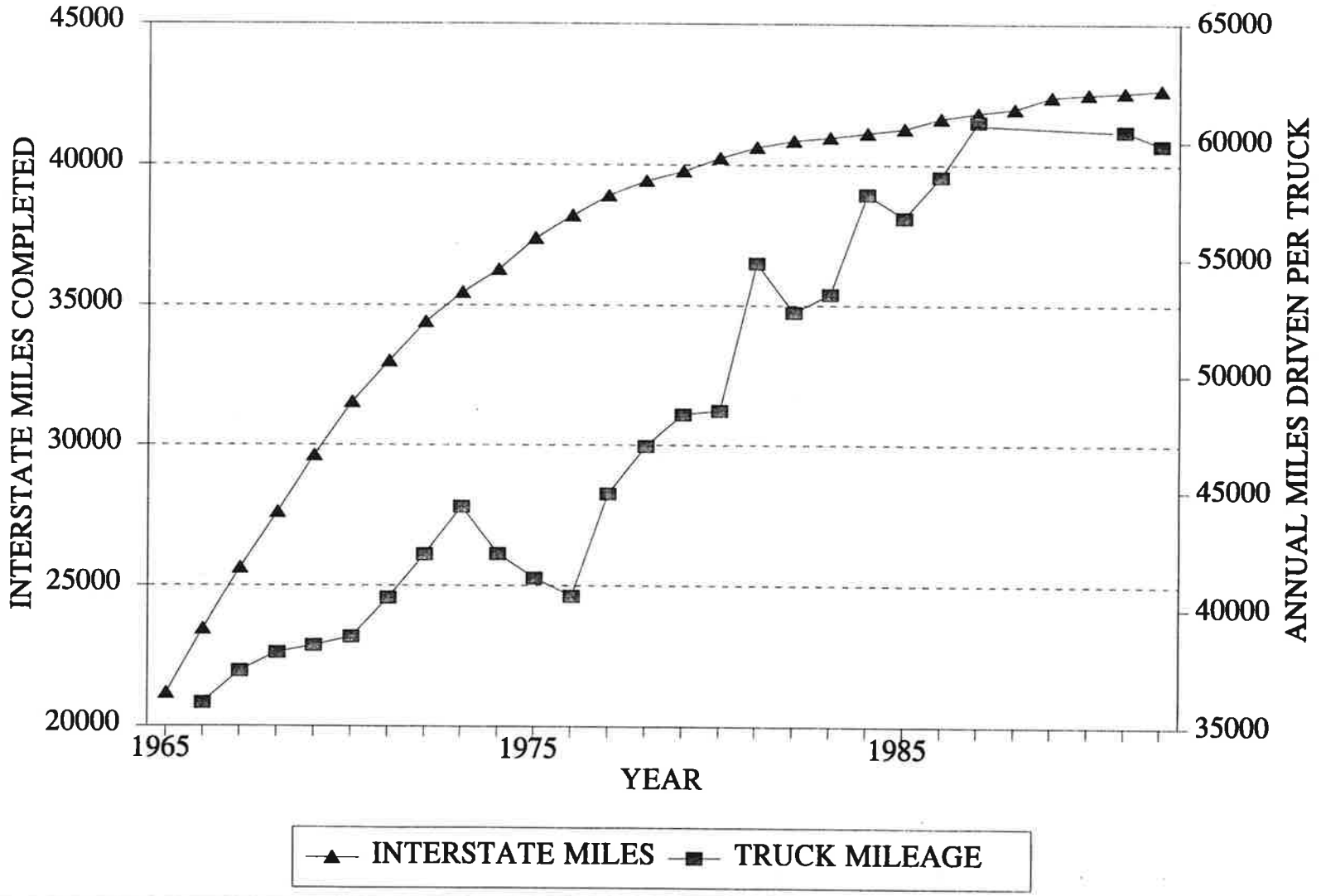
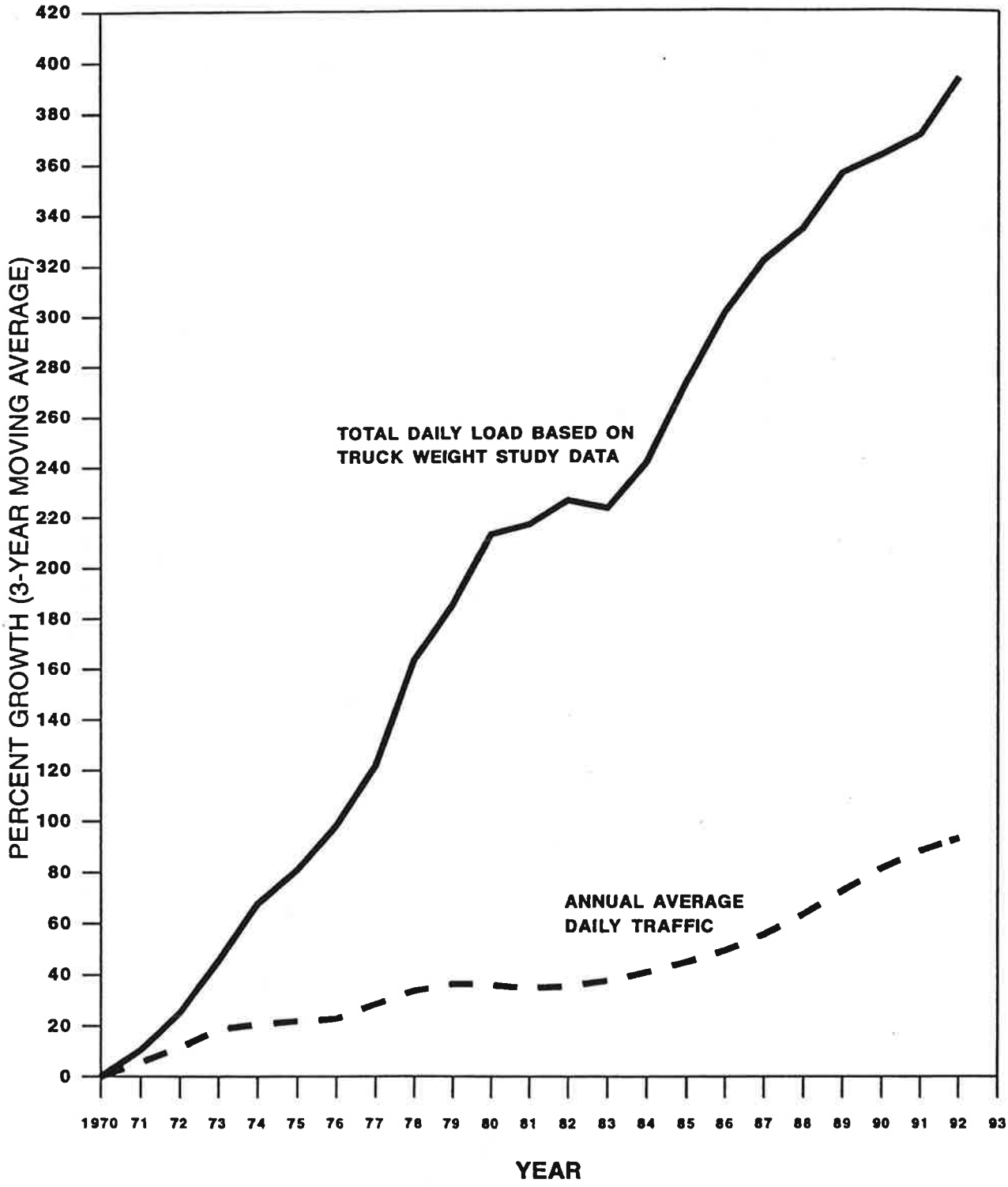


Figure B-9
COMPARISON OF GROWTH IN VOLUME AND LOADINGS ON THE RURAL INTERSTATE SYSTEM



- improved truck maintenance procedures;
- the use of double-trailer trucks;
- the growth of advanced truckload freight (ATLF) carriers, who concentrate on long-haul traffic in high-density corridors;
- the use of company drivers rather than independent carriers. (FHWA 1993)

One of the most important trends in manufacturing and trade is the emphasis of many businesses on "Just in Time" delivery. More and more manufacturers are carefully scheduling deliveries so that parts arrive when needed, not a day before or a day after. Through careful management of the transportation pipeline to the assembly plant, the inventory costs in storage and transit are kept to a minimum, thereby reducing warehouse and carrying costs. Just in Time (JIT) requires more frequent smaller shipments, emphasizing reliability. Another trend affecting transportation and distribution requirements is the importance that companies are placing in reducing "cycle time," i.e. the time that it takes for a company to respond to changes in the marketplace. For example in the garment industry, seasons and changing fashions demand quick turnaround if a company is to remain competitive.

Truck transportation (sometimes in combination with air) is the most flexible mode of transportation providing door-to-door service to every city, industry, and distribution warehouse in the country, and therefore, best able to meet the JIT and other shipper requirements for faster and more reliable service. Even though it is also the most expensive mode of transportation, (except air), truck is the preferred mode for small shipments, short-haul moves and time sensitive cargoes. For many industries and businesses located in small towns and cities throughout the U.S., trucking services are the only practical option to meet their freight transportation needs. Trucks compete only with rail (where both rail and highway corridors are available to serve moves over 500+ miles) and air services (for short-haul, small package delivery, perishables and high-value cargoes). With the exception of some bulk movements by rail, water and pipeline, trucks are typically used for pick-up and delivery of nearly all freight.

These factors and recent trends serve to illustrate the important role of Interstate Highways in improving economic productivity, but also how highway investment is a necessary, but not sufficient, condition for economic growth and increases in transportation industry productivity.

- **Improved Highway Safety**

Because of its limited access design, with grade separated interchanges, and its multiple wide driving lanes built to high-speed travel standards, the Interstate Highway System has become the safest component of America's roadway system. While many factors contribute to improved safety, such as reduced use of alcohol, reduced highway speeds, and improved police procedures, the data clearly

Table B-2
MOTOR VEHICLE TRAFFIC FATALITIES AND INJURIES - 1992
BY FUNCTIONAL SYSTEM AND FEDERAL-AID HIGHWAYS

(THE INTERIM NATIONAL HIGHWAY SYSTEM CONSISTS OF THE ENTIRE PRINCIPAL ARTERIAL SYSTEM 1 /)

HIGHWAY CATEGORIES	PUBLIC ROAD MILEAGE	ANNUAL VEHICLE-MILES (MILLIONS)	INJURY ACCIDENTS				PERSONS INJURED 2/				PEDESTRIANS INJURED			
			FATAL		NONFATAL		FATAL		NONFATAL		FATAL		NONFATAL	
			NUMBER 3 /	RATE 4 /	NUMBER	RATE 4 /	NUMBER 3 /	RATE 4 /	NUMBER	RATE 4 /	NUMBER 3 /	RATE 4 /	NUMBER	RATE 4 /
Functional System														
Rural														
Interstate	33,027	204,960	2,076	1.01	41,758	20.37	2,474	1.21	70,457	34.38	200	0.10	589	0.29
Other Principal Arterial	94,798	196,153	3,452	1.76	83,599	42.62	4,135	2.11	145,728	74.29	305	0.16	1,321	0.67
Minor Arterial	137,637	146,723	3,760	2.56	108,069	73.66	4,417	3.01	184,741	125.91	315	0.21	1,794	1.22
Major Collector	434,175	184,326	5,400	2.93	166,276	90.21	6,181	3.35	264,175	143.32	395	0.21	3,463	1.88
Minor Collector	284,706	49,945	1,437	2.88	55,885	111.89	1,579	3.16	84,098	168.38	107	0.21	1,196	2.39
Local	2,132,212	98,986	3,601	3.64	174,406	176.19	3,963	4.00	261,893	264.58	294	0.30	6,583	6.65
Subtotal -- Rural	3,116,555	881,093	19,726	2.24	629,993	71.50	22,749	2.58	1,011,092	114.75	1,616	0.18	14,946	1.70
Urban														
Interstate	12,466	302,091	1,670	0.55	118,050	39.08	1,865	0.62	186,103	61.60	375	0.12	1,643	0.54
Other Freeways & Expressways	8,465	137,959	1,039	0.75	88,374	64.06	1,165	0.84	139,496	101.11	215	0.16	2,336	1.69
Other Principal Arterial	52,165	344,195	5,246	1.52	488,228	141.85	5,671	1.65	781,631	227.09	1,502	0.44	27,492	7.99
Minor Arterial	80,368	260,507	2,895	1.11	366,879	140.83	3,146	1.21	570,952	219.17	750	0.29	23,843	9.15
Collector	82,657	115,631	1,023	0.88	141,143	122.06	1,086	0.94	206,721	178.78	234	0.20	13,079	11.31
Local	549,039	198,352	3,329	1.68	383,578	193.38	3,553	1.79	553,216	278.91	854	0.43	41,098	20.72
Subtotal -- Urban	785,160	1,358,735	15,202	1.12	1,586,252	116.74	16,486	1.21	2,438,119	179.44	3,930	0.29	109,491	8.06
Total	3,901,715	2,239,828	34,928	1.56	2,216,245	98.95	39,235	1.75	3,449,211	153.99	5,546	0.25	124,437	5.56
Federal-Aid Highways (Rural & Urban)														
Interstate System	45,493	507,051	3,746	0.74	159,808	31.52	4,339	0.86	256,560	50.60	575	0.11	2,232	0.44
Other National Highway System 5/	155,428	678,307	9,737	1.44	660,201	97.33	10,971	1.62	1,066,855	157.28	2,022	0.30	31,149	4.59
Total National Highway System	200,921	1,185,358	13,483	1.14	820,009	69.18	15,310	1.29	1,323,415	111.65	2,597	0.22	33,381	2.82
Other Federal-Aid Highways 6/	734,837	707,187	13,078	1.85	782,367	110.63	14,830	2.10	1,226,589	173.45	1,694	0.24	42,179	5.96
Total Federal-Aid Highways 7/	935,758	1,892,545	26,561	1.40	1,602,376	84.67	30,140	1.59	2,550,004	134.74	4,291	0.23	75,560	3.99
Total Nonfederal-Aid Highways 8/	2,965,957	347,283	8,367	2.41	613,869	176.76	9,095	2.62	899,207	258.93	1,255	0.36	48,877	14.07
Total	3,901,715	2,239,828	34,928	1.56	2,216,245	98.95	39,235	1.75	3,449,211	153.99	5,546	0.25	124,437	5.56

1 / The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 established the entire Principal Arterial System as the Interim National Highway System (NHS) until the U.S. Congress approves an official NHS.

2 / Pedestrians injured are included.

3 / Fatal accident and fatality numbers have been adjusted to agree with Fatal Accident Reporting System (FARS) totals. Estimates of nonfatal injury accidents and nonfatally injured persons and pedestrians were made by FHWA based on State reported 1991 data for Indiana, Iowa, Louisiana, Massachusetts, and 1990 data for Michigan, Ohio, and Tennessee.

4 / Per 100 million vehicle-miles of travel.

5 / All non-Interstate Principal Arterials.

6 / Urban Minor Arterial plus Collector and Rural Minor Arterial plus Major Collector functional Systems.

7 / The category, total Federal-Aid Highways, includes other Federal-Aid Highways and the National Highway System.

8 / Urban Local and Rural Minor Collector and Local Functional Systems.

(Source: U.S. DOT/FHWA Highway Statistics 1992.)

indicate that the Interstate Highway System has made a substantial contribution to improved motor vehicle safety.

Table B-2 shows safety data for all highway categories in 1992. In every category of accident and injury, and for each type of area (urban and rural), the Interstate Highway System is vastly superior in safety rates, often by a factor of two or more. (FHWA 1992b, p. 212) Moreover, the fatality rate on the Interstate System has decreased consistently since 1966. In 1966, there were 3.08 fatalities per 100 million vehicle miles. This rate had decreased more than threefold by 1992.

For the trucking industry, improved safety translates into improved reliability, which has been cited as one of the reasons for improved productivity in the trucking industry. (FHWA 1993, FHWA 1994) Reduced maintenance, insurance, and medical costs (as a result of reduced accidents and fatalities) have also been a contributor, not only to the trucking industry, but to the economy as a whole.

In terms of accidents and injuries avoided, a brief calculation serves to illustrate the effect of the improved safety of the Interstate Highway System. Using the data on Table B-2, there were 256,560 accidents involving injuries on the Interstate Highway System in 1992, a rate of 50.6 accidents per 100 million vehicle miles traveled. The average accident rate for other types of highways is twice this, which means that without the Interstate Highway System, there might have been over 250,000 more traffic accidents in 1992.

Table B-3 below, shows an estimate of the cost of traffic injuries, divided by the number of injury-causing accidents to obtain a per-accident figure.

TABLE B-3 COST OF TRAFFIC INJURIES, 1993

COST COMPONENT (EXAMPLES)	TOTAL COST ($Millions)	COST/INJURY
MEDICAL COSTS	$22,700	$6,581
ADMINISTRATIVE	$38,300	$11,104
MOTOR VEHICLE DAMAGE	$40,700	$11,800
EMPLOYER COSTS	$2,200	$638
TOTAL COST	$167,000	$48,417

Source: National Safety Council, 1994

Using the data from this table, the savings from a reduction in 250,000 traffic accidents, if the

same travel were to take place without Interstate Highways, can be valued at $12 billion annually. The National Highway Traffic Safety Administration estimated that in 1990, each traffic fatality in the US resulted in lifetime costs to society of over $702,000. (NHTSA) If the fatality rate of the Interstates had been equal to that of all roads combined, about 5,000 extra fatalities would have resulted, which, when multiplied by the cost to society, yields a sum of around $3.5 billion per year. Multiplied over a period of 30 years, the savings due to increased safety on the Interstate highways adds up to a very substantial sum, several times the total capital investment in the Interstate Highway System. From this perspective alone, then, the Interstate Highway System has at least paid for itself.

■ Increased Accessibility and Land Development Change

Intuitively, it seems clear that the Interstate Highway System has had a massive impact on driver accessibility and land development patterns. Construction of the Interstate Highway System resulted in increased accessibility to areas near the highways, and increased nationwide travel. Increased accessibility is typically measured by ease of access or a reduction in travel time between two points, so it is closely related to a reduction in transportation costs, and, hence, economic development and land development activities. Increased land accessibility then affects location decisions of individuals and businesses.

For individuals, the construction of the Interstate Highway System resulted in increased accessibility to job, shopping, leisure and vacation opportunities, thereby increasing personal choices and **quality of life**. Freeway construction around urban areas and in rural areas have made it possible for individuals to commute as much as 50 to 60 miles from their workplace, resulting in residential land development in areas that otherwise would not have been possible to develop. In addition, higher density suburban development was also made possible. Although additional traffic congestion, increased energy consumption and other impacts have been associated with this increased travel in some areas, the Interstate System has clearly expanded the choices for residential and business locations.

Similarly, businesses will consider accessibility, not simply transportation costs, when considering their plant and distribution site options. For businesses, the construction of the Interstate Highway System increased the **market reach** of products and services, due to faster access to more destinations for person travel and goods movement. Businesses were then able to consider sites along and near Interstate interchanges and urban highway bypasses. Furthermore, firms have been able to reduce their warehouse locations and production facilities, so they can now efficiently serve the entire US from one or two plant and/or warehouse locations.

To test these assertions, one can ask two questions: has the Interstate Highway System changed individuals' driving habits? If it has, then land use change would naturally follow. The second question is, has there been evidence of change in development patterns which can be attributed to the Interstate Highway System?

Changes in Driving Habits

The impact of the Interstate Highway System on the driving habits of individuals might be an important indicator of changes in land use patterns, because of the potential for associated changes in locational demands for services and employment. This suggestion can be assessed by referring to data sets which are indicators of changes of driving habits, and hence behavior: the average amount of mileage driven per car and person per year and the average distance driven, by trip type.

Figure B-10 shows the average vehicle miles traveled (VMT) in passenger cars per capita from 1945 through 1992. The VMT per capita trend is fairly uniform in its growth over this period. Some significant degree of change appears in the trend for four different time periods:

- the first five years following the end of World War II;
- the ten years following the early 1960s, coinciding with the period of greatest growth of the Interstate Highway System;
- the ten years following the onset of the oil crisis in 1973; and,
- the last ten years, during which gasoline has become cheaper.

These four periods are shown more clearly in Figure B-11, which is VMT per passenger car per year.The two figures combined help explain the major result from the construction of the Interstate System, i.e. the upward trend in personal travel or vehicle miles per capita (which reflects boh increased auto ownership and increased annual miles driven per car). While various other factors (such as increased energy prices) have reduced miles driven per car during some time periods, the overall trend towards increased personal travel has continued.

These figures suggest that the Interstate Highway System was probably one of the important factors to have affected personal driving habits during the last fifty years. They also show, how important other forces are, unrelated to the Interstate System, again reinforcing the idea that investment in transportation is a necessary, but not sufficient condition for economic growth. In general, however, the changes in personal travel did not vary significantly from the general upward trend, which suggests that other long-term unidentified factors were also important.

Table B-4 shows another indicator of change in personal driving habits, based on the FHWA Nationwide Personal Transportation Survey: average vehicle trip lengths.

This data tends to reflect the more recent major perturbations in driving habits over the 1969-1990 period: the oil crisis (declines in trip lengths in 1977), and the gradual reduction in gasoline prices during the 1980s (increases in trip lengths through the 1980s).

FIGURE B-10: INTERSTATE HIGHWAY SYSTEM COMPLETED MILES & VMT PER CAPITA

(Passenger and Nonpassenger)

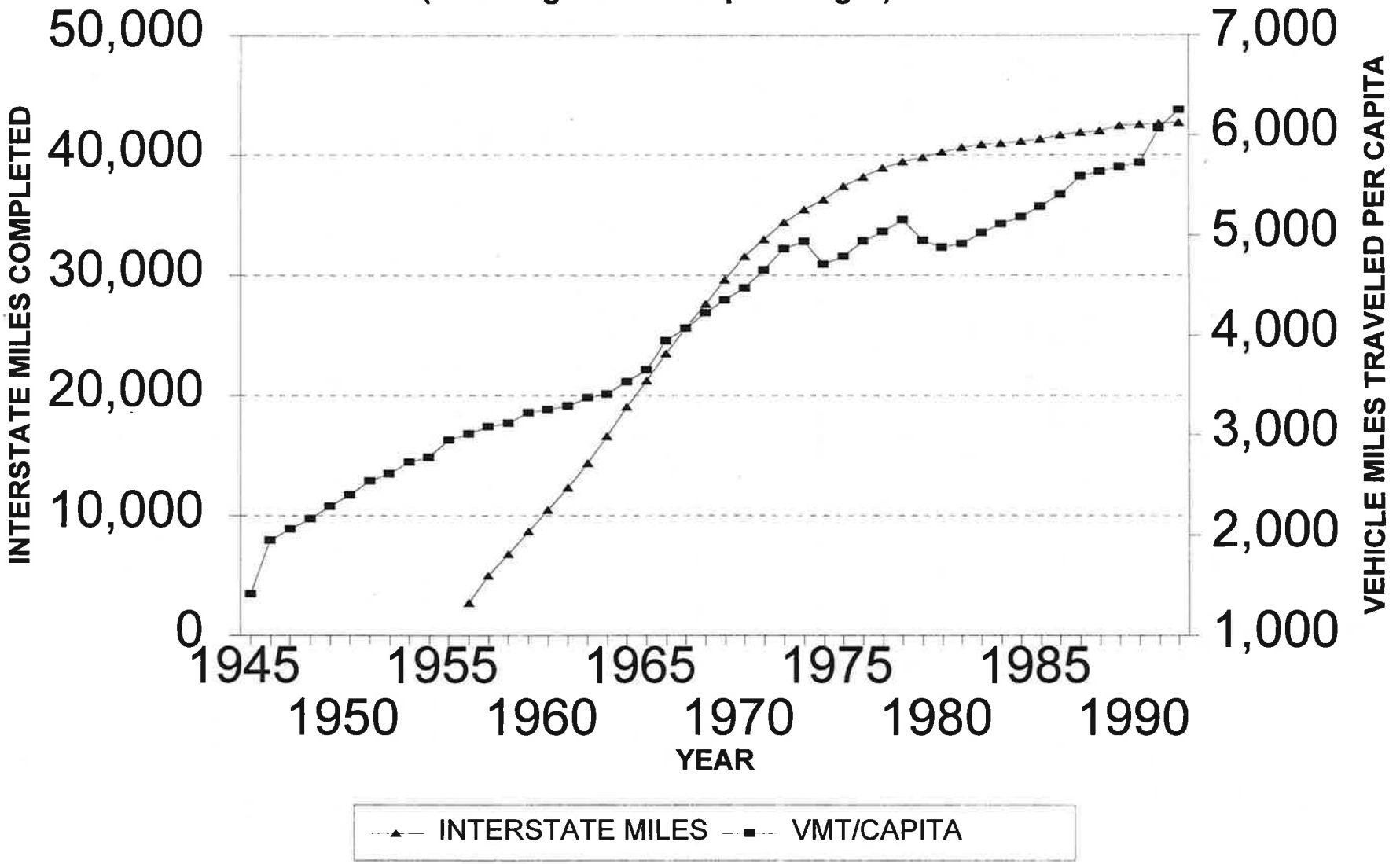


FIGURE B-11: INTERSTATE HIGHWAY SYSTEM
COMPLETED MILES & AVG. CAR MILES/YEAR

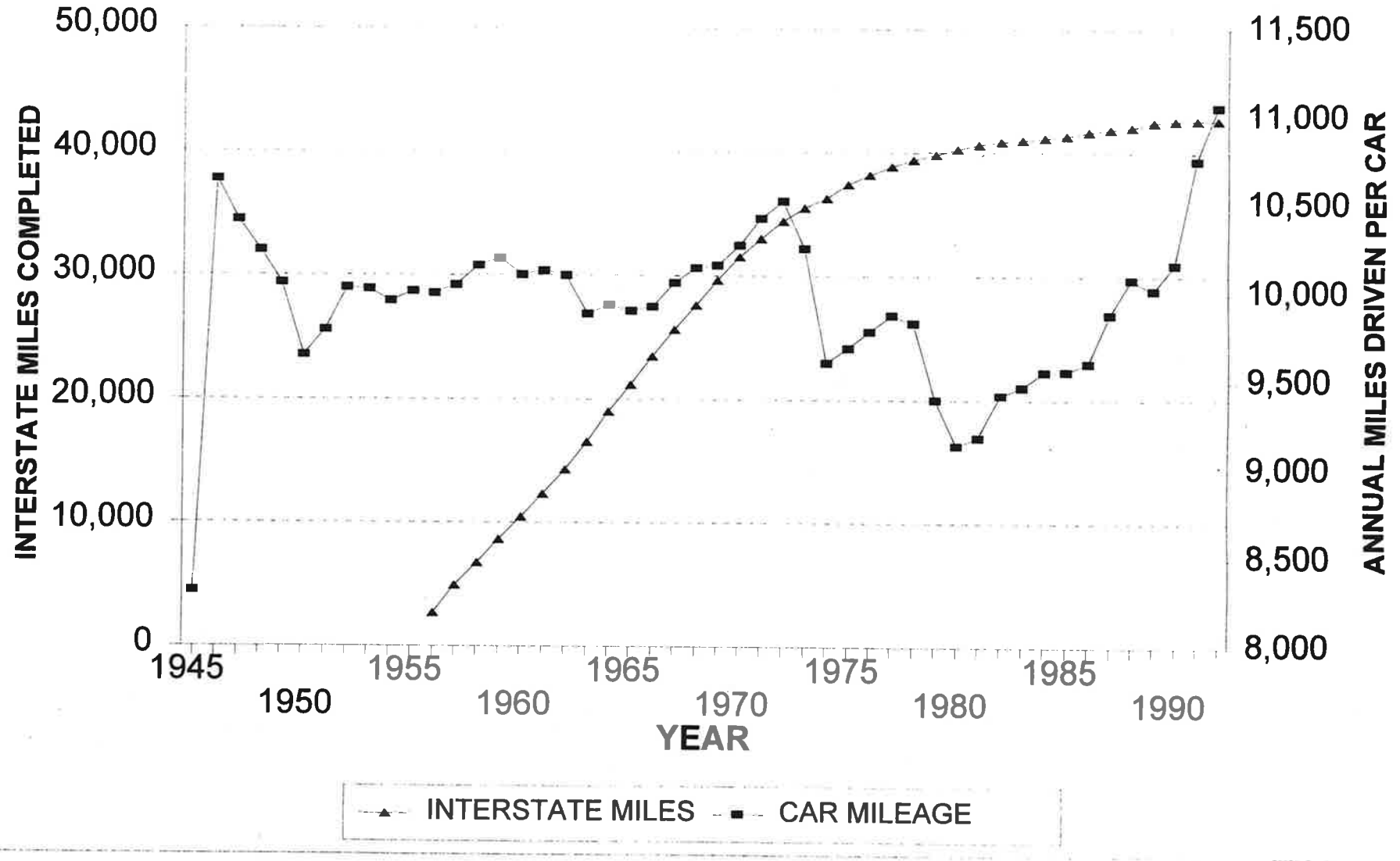


Table B-4: Average Passenger Vehicle Trip Length in Miles by Purpose, 1969-1990

Purpose	1969	1977	1983	1990
Work	9.4	9.1	8.5	11
Work-Related-Business	16.1	11.94	11.4	15.1
Shopping	4.4	5	5.3	5.1
School/Church	4.7	5.9	5.5	7.5
Doctor / Dentist	8.4	10.3	9.7	10.5
Other Personal Benefits	6.5	6.8	6.7	7.4
Vacation	160	77.9	113.9	114.9
Visit Friends/Relatives	12	10..9	10.8	11.8
Pleasure Driving	20	14.1	22.7	21.9
Other Social Recreational	11.4	9.3	8.7	10.5
Other	9.4	29.3	7.2	10.8
All Purposes	8.9	8.4	7.9	9.0

Source: U.S. DOT / FHWA, 1990 Nationwide Personal Transportation Survey (NPTS)

However, none of the changes in personal trip lengths are spectacular. Essentially, trip lengths have not varied significantly over the period under consideration. Without trip-length data prior to 1969, it cannot be stated that this was true during the period of Interstate Highway construction. However, the relative inelasticity of this data, in combination with the data shown in Figures B-10 and B-11, suggests that while the Interstate Highway System did have an effect on personal driving habits, it may not have been as significant as was the case in the transportation of freight, since large truck annual miles have increased by more than 50% (see Figures B7 and B8) and the average length of haul by truck has increased from 235 miles in 1950 to 389 miles in 1989 (as reported by the Eno Foundation in Transportation in America, 1991).

We do know that major changes in mode selection took place during the 1960s. During that period, private vehicle use for journeys to work increased from 69.5 percent of all commuting trips in 1960 to 80.6 percent in 1970. Private vehicle journey-to-work trips increased their modal share to 88 percent in the 1970-1990 period. Mass transit ridership for commuting declined by 16.6 percent in the 1960-1970 period, and then by only 9.5 percent in the following two decades. (FHWA 1993a, p. 2-2) The timing of this massive shift from transit to autos, the majority of which occurred during the 1960s, suggests a link with the construction of the Interstate Highway System. Clearly, the construction of the Interstate

System also affected urban congestion and the quality of life in urban areas as well as the attractiveness of public transportation (see Appendices F and I).

Changes in Development Patterns

While driving habits might not have undergone major change solely because of the Interstate Highway System, it does not necessarily follow that land use changes did not occur. Consistent driving habits might reflect peoples' tolerance for spending time inside automobiles, but not necessarily the locations in which they do the driving. In fact, it could be argued that providing greater choice of location to people with fixed driving habits might be a strong stimulant for land use change, because market forces will make land use development follow the people, and adjust to their driving habits.

The rationale for the Interstate System's effect on land development is clear. Just by looking at a map, one can see that construction of the Interstate Highway System probably had a major hand in changing the pattern of residential development in the US, resulting in suburbanization, and, more recently, exurban development. Commercial and industrial development patterns also have been significantly affected, with many corporate headquarters, shopping centers, and manufacturing plants moving away from urban areas to suburban and rural areas.

Urban planning experts have often asserted that the Interstate Highway System has had a major impact on land development patterns, both positive and negative. One of the strongest cases for this was made by George Sternlieb and James W. Hughes in a 1986 article in *Commentary*. They assert that the Interstate Highway System was one of three major factors which led to the prominence of suburban growth corridors throughout the United States (the other two being our economic evolution into a service-based economy, and federal deregulations and tax legislation). They argue that these developments have fostered intensive metropolitan service growth, massive office construction and overbuilt markets, and suburban growth corridors marked by concentrated office development along metropolitan ring roads. Sternlieb and Hughes state that this phenomenon "is so substantial that it ensures slower future development growth and preemption of alternative spatial development competition." They go so far as to state that "the sheer scale of suburban office construction is the equivalent of a preemptive strike, limiting the scale of future development," the effects of which will be felt through the 1990s. Now, we are faced with a situation in which "the growing potency of suburban gridlock will require massive expenditures" and more physical infrastructure support, at a time when funding is severely constrained. (Sternlieb and Hughes 1986)

Jonathan L. Gifford suggests that while the Interstate Highway System was never intended to be the backbone of local transportation systems, it has in effect become that because of the availability of huge amounts of 90 percent federal funding for the System, which led states to largely devote their funds to the Interstates, at the expense of local transportation systems. Gifford asserts that this underfunding of complementary local transportation systems has resulted in urban Interstate highways being overcrowded with traffic, with development

overwhelming suburban Interstate corridors. This change in urban form, says Gifford, was exactly what BPR officials had warned against over 50 years ago. (Gifford, pp. 19-20)

In their *Commentary* article, Sternlieb and Hughes pointed out another broad development-related impact of the Interstate Highway System: that it served to alter national patterns of regional connectivity. For example, "many parts of the South gained greater accessibility to the broader US economy, providing a major stimulus for the shifting regional fortunes of the 1970s. (Sternlieb and Hughes) This development of the South continues unabated in the 1990s. In 1993, a *Business Week* cover story featured the rapid development that has taken place along the I-85 corridor in North and South Carolina (see *Business Week*, September 27, 1993). This "rise of the South" has many other causes in addition to the Interstate Highway System, but there can be no doubt that the Interstates had a major impact in this national shift of economic strength, with all its subsequent cultural and political consequences.

Several studies have dealt with the land development consequences of highways in general, and Interstate Highways in particular. Many of these studies were conducted during the 1960s and 1970s, and are cited amply in previous NCHRP publications (NCHRP Report 193, 1978.) Some more recent studies are discussed below. In general, the more recent studies can be divided into categories, including metropolitan area development, site location decision-making, interchange effects, and other local land use impacts.

Stephanades (1990) studied the effects of highway expenditures on growth patterns in Minnesota counties, assuming a lag between the expenditure and the effect. His findings suggested that the areas most likely to benefit from highway expenditures were the suburban counties surrounding major cities, and natural resource-dependent counties. These findings were corroborated by Buffington and Burke (1991), who studied the effects of bypass, loop and radial highway improvements on employment and wages in Texas metropolitan areas. They found that all of these types of highway improvements had a demonstrable effect, in particular the radial highways. The radial highways had a significant affect because of the tendency of manufacturing firms to locate along them. By-pass highways appeared to be more attractive to retail and service employers needing access to suburban customers.

There have been numerous studies of the effects of bypass and beltway highways, one of which is presented as a Case Study in this report (Route 128 and I-495 around Boston - Appendix I). In 1980, the U. S. Department of Transportation sponsored a major study of the land use and urban development effects of beltways. They reviewed 27 large metropolitan areas, of which eight were studied in depth. They found that while these highways were a significant factor in the development of these areas, other economic and sociological factors, such as planning regulations, tax policies, and city and county leadership, were at least as important. One of their important conclusions was that beltways could have a profound impact on development as long as other factors, such as those mentioned, were present. It was not possible to quantitatively separate out the effects of the beltways. Mills, after an extensive analysis of 24 cities with and without beltways, concluded beltways had no statistically significant effect on central city vitality or on overall suburbanization of people and jobs.

Other factors, such as land use regulation, tax and mortgage policies, public actions, and market forces, outweighed the influence of beltways. (Mills 1981)

There have also been numerous studies regarding the importance of transportation in industrial site selection. All of these studies point out that transportation is one of several factors, but usually not the most important factor, in a decision to select a location for an industrial facility. Other factors include the nature of the local labor force, local educational facilities and amenities, tax policies, etc. (Hartgen 1990, Wilson 1981) However, there is general agreement that highways are an important component of industrial competitiveness. In 1994, FHWA interviewed industrial logistics executives and found that while they could not precisely estimate the effects of the Interstate Highway System on their operations, its importance to them was not in doubt. (FHWA 1994) AASHTO has documented numerous examples of situations where a company's competitive position was positively influenced by specific highway improvements. (AASHTO 1990b)

Land use impacts of the Interstate Highway System at rural interchanges has also been studied extensively. Cities and regions not located on the Interstate System have been at a competitive disadvantage in their efforts to attract and/or retain businesses. Some evidence exists that economic growth in rural areas near Interstate Highways has been higher than in other similar areas which do not have Interstate Highways (Briggs, 1981; Eyerly, 1987). In a study of non-urban interchanges in Pennsylvania between 1970 and 1980, Eyerly (1987), found that towns and counties near these interchanges grew more rapidly than other areas of the state. This was true for population, housing, employment, income, and commercial and industrial development (Eyerly 1987). Twark (1979), in studying the same areas, showed that not all interchange areas have the same potential for economic development. Other factors must be present, including a high enough volume of crossing traffic, and growth trends in nearby communities (Twark 1979). Hartgen (1991), studied 103 interchanges in North and South Carolina in 1990, and found that the same factors Twark mentioned had an important impact on development. Hartgen identified other factors as well, such as water and sewer service availability and other specific site characteristics. Hartgen's studies showed that motels, gas stations, and fast-food restaurants tended to develop together at interchanges if other conditions were suitable, while interchanges were strongly negatively associated with residential development. (Hartgen 1991)

Other local land use effects of Interstate Highways have been studied. The impact of vehicular noise on property values near Interstate Highways has been studied extensively. In general, these studies have identified a negative statistical relationship between noise and property values (see Allen 1981), but they also identify the important effects of other housing value variables, such as condition, size and appearance of the residence, as being of equal or greater importance. Steptoe and Thornton studied the effects of Interstate Highways on minority communities. They found that these communities derived little benefit from the highways; rather, highways appear to have reinforced negative trends that were already in evidence. (Steptoe 1986)

In sum, there is a good deal of evidence to suggest that the Interstate Highway System has had a major impact on development patterns. There have been no conclusive statistical studies which can relate the System to land use development. However, the general consensus among analysts is that the Interstate System has been one of several major factors, but not the only important factor, to have influenced development patterns in postwar America.

- **Creation of jobs during construction as economic stimulus**

The construction of such a large system over nearly 4 decades obviously has created jobs in the various local project areas. Job creation during construction, however, by definition is a temporary impact and cannot be viewed as an important linkage to national economic expansion.

During the Interstate System construction period, various efforts were made to vary the pace of expenditures as a counter-cyclical economic policy tool, i.e. to stimulate economic activity during recessions and to reduce activity during inflationary periods. It takes a long time to carry on pre-construction activities for major projects or to reduce expenditure levels once projects have been started. When additional funding is made available unexpectedly with the requirement that it be quickly spent, it is likely to result in the acceleration of those projects that are easier to implement, rather than the most economically sound investments. Such efforts can result in some limited near-term economic impact, but in general, there is little indication that they can be a significant factor in long-term economic expansion.

B. Economic Effects of Future Investment in the Interstate Highway System

Because most of the emphasis in the past has been on the impacts of new highway construction projects, the economic development impacts of other current investment choices related to the Interstate System such as maintenance and congestion management, have until recently received little attention. It is important to assess the potential impacts of the policy alternatives currently before the transportation community, which is discussed in the following two paragraphs, i.e. System Maintenance/Management and Congestion Management.

- **System Maintenance/Management**

FHWA financial and Highway Performance Monitoring System data for the years 1984-1990 show that highway maintenance expenditures by state transportation agencies increased by close to 40 percent in current dollars, from $7,395 per mile to $10,305 per mile. In 1990, the total cost of maintenance was close to $8 billion, up from $5.8 billion in 1984. Highway performance was measured with data for the same years on Volume/Capacity (V/C) ratios and pavement condition Present Serviceability Ratings (PSR). These data show that the increased expenditures have been rewarded with better performance on the Interstate Highway System. V/C ratios on urban Interstate Highways improved by close to 40 percent, and PSRs improved by over 30 percent. On rural Interstate Highways, PSRs improved by nearly 20 percent. Fatal accident rates were reduced by nearly 20 percent on all highways. (Hartgen 1992, p. 10).

The additional step of relating these data to improved travel times and lower operating costs, and relating such factors to economic expansion, is much more difficult. It is reasonable to note that if the Interstate Highway System is not adequately maintained and efficiently operated, the economic implications could be severe. In the short-term, a major snow storm that closes the Interstate facilities in an area can significantly affect economic production. Over the longer-term, it is well known that lack of maintenance can impact business location decisions and reduce competitiveness.

Few people would argue that maintenance does not pay for itself. The important question becomes, how much maintenance is needed, and how much is too much? Without careful analysis of the data, and evaluation of the opportunity costs, these questions cannot be answered. It can be said with some degree of certainty that maintenance costs will rise even if the goal is only to keep the system from deteriorating (rather than improving it) because of the size of the Interstate Highway System and the fact that a large portion of the system is aging.

The use of life-cycle costing has been suggested as a means to reduce long-term maintenance costs. A 1988 study by Small and Winston has questioned the original estimates of highway durability that were used during construction of the Interstate Highway System. Claiming that the highway thickness standards set in the 1950's were 1 to 3 inches less than optimum, they suggest that use of the higher standard for highway replacement and resurfacing could produce a net saving of 40 percent of the present value of maintenance outlays. (Small and Winston 1988)

Management of the use of highway facilities, particularly high volume links such as the Interstate System has become an important area for possible transportation investment since the passage of ISTEA. At this time, there is no track record for evaluating the economic impact of these investments, although clearly their objectives are reducing congestion, lowering travel time and increasing reliability, objectives of major importance for our economic competitiveness.

- **Congestion Management**

Traditionally, investments to reduce or manage congestion have included facility modernization, traffic control systems, and new roadway construction. Current thinking has added other important tools: Intelligent Vehicle Highway Systems (IVHS), using new high-technology to more efficiently move traffic; and Traffic Control Measures designed to reduce congestion by reducing demand for peak hour travel. In the future, Congestion Pricing, which is closely tied to IVHS, will be an increasingly important element of congestion management.

It has long been recognized that traffic congestion negatively affects economic performance. Obviously, if no action is taken to reduce congestion, an area's growth potential is limited. The need to reduce congestion was one of the important arguments behind the Federal Aid Highway Act of 1956, which funded the Interstate Highway System. However, the specific,

quantitative linkages between congestion and economic well-being have not been identified rigorously, other than attempts to estimate the cost of congestion.

A recent study undertaken by Hanks and Lomax in 1991 estimates the costs of congestion. They prepared an estimate of the cost of traffic congestion in 39 urban areas, using measures including travel delay, increased fuel consumption, and increased automobile insurance premiums. Except for the last, these are traditional transportation economics measures. The total annual cost of congestion for 1988 was estimated to be $34 billion in the 39 cities studied, with ten of the cities estimated to have annual congestion costs exceeding $1 billion. Delay accounted for two-thirds of the cost, and increased insurance premiums about 25 percent. The cost of delay and fuel consumption added up to between $250 and $900 per registered vehicle. The Hanks study did not evaluate the indirect or induced economic impacts of these costs, or of their reduction. This is obviously neither an easy nor straightforward question. The value of personal time savings is difficult to estimate. Hanks and Lomax placed it at $8.80 per person-hour. The consensus estimate for the value of time is about two-thirds of the prevailing wage rate (Texas Transportation Institute 1990). There is little guidance concerning exactly how this value is to be translated into economic expansion, for we do not really know how people utilize saved time.

The development of IVHS (and its companion strategy, congestion pricing) will be a significant new element in congestion management for Interstate Highways and other roadways. However, the economic implications of IVHS go beyond time savings, reduction of business costs, and improved productivity. One of the important expectations for IVHS is for a new high-technology industry to evolve. The development of this industry could have significant ramifications for America's international competitive position, in addition to the stimulation of new domestic jobs and the beneficial impacts of technological spin-offs which are applicable to other industries. ISTEA requires that IVHS be incorporated by planning agencies into transportation management systems, and it has designated several pilot projects to start the process. Operational tests of IVHS user services will be the source for direct measurement of costs and benefits, that can then be used in analyzing the value of similar technology applications in other sites.

V. Lessons From Case Study

A major investment such as the Interstate Highway System, involving the development of a new national system with a high level of service to reduce transportation costs and travel times, can have profound implications for land and economic development, as well as economic productivity. Although there is no simple way to measure the linkage between the investment and economic well being, productivity and development, several points can be made with a reasonable degree of confidence:

- There is little doubt that the Interstate Highway System has had an overall profound impact upon national U. S. economic expansion. The most direct, most readily measurable, and frequently the most fundamental way in which

highway investments influence economic development is by reducing the transportation costs of moving people and goods between one location and another. The Interstate Highway System significantly reduced long-distance transportation costs (including travel time and delay costs), made possible the development of coast-to-coast trucking services as a competitor to rail, and thereby increased the service options for businesses to move their freight. The transportation cost reductions associated with the construction of the Interstate System also resulted in a reduction in the costs of consumer products and an increase in the productivity and competitiveness of American businesses. For individuals, it resulted in reductions in the cost for long-distance vacation and other traveling. Although the linkages have not been precisely defined, studies have fairly consistently identified a relationship between Interstate Highway investment and the key factors that affect improved productivity (lower unit operating costs and reduced travel times).

- The safety benefits of the Interstate Highway System are readily apparent in highway safety data. The System was designed for safe, limited access, high speed travel, and its accident and fatality rates per million VMT are less than half those of other types of highways. A credible argument can be made that based solely on the economic savings from reduced accidents, injuries, and fatalities over a 30-year period, the Interstate Highway System has paid for itself. Decreased accident rates have also contributed substantially to the trucking industry's productivity and its ability to deliver products reliably and on time.

- The local and regional impacts of the Interstate Highway System on land development have been significant. There is substantial evidence of the impact that limited access highways, including the Interstate Highways, have in shaping urban development. Some urban planners argue that the Interstates have contributed to a vast re-shaping of urban land uses and overbuilding along Interstate corridors, which will limit future development options and increase infrastructure costs. Development in rural areas has also been affected, particularly in the area around interchanges and along bypasses around smaller cities.

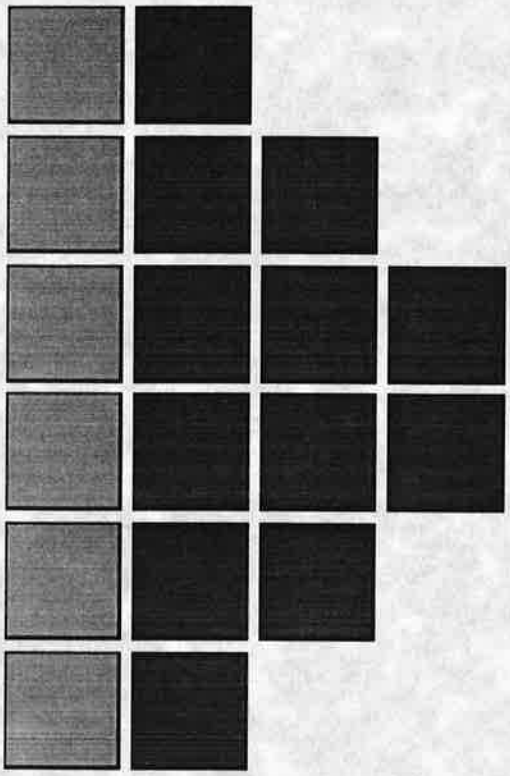
- Access to an Interstate Highway has become an important factor in business location decisions. As such, the Interstate Highway System has significantly affected the pattern of regional and State development. However, in order for development to take place near an Interstate Highway, other factors must be present. The economic base of the locality or region must possess the labor force, educational institutions, resources, public services, quality of life, and/or other advantages which can lead to the decisions by businesses to locate there.

- Traffic congestion costs large amounts of money, and it is reasonable to conclude that Interstate Highway improvements which alleviate congestion (primarily in urban areas and highly traveled links) will be good investments and will be positive factors in attracting or retaining businesses. However, definitive linkages of how such investments are related to economic expansion have not been established.

It is clear that future investment in the Interstate Highway System should include a considerably greater emphasis on facility management, as well as connections to other highway systems and modes, aimed at increased efficiency. Rather than focusing on new major construction projects, the Interstate System will need to emphasize better connections to other systems and modes.

Economic growth should continue to be an important objective in adding capacity on the Interstate System, as well as maintaining and preserving the existing facilities. This continuing need for investment will have to be balanced against competing priorities, such as air quality, particularly in non-attainment areas. States which are pressed by non-attainment air quality requirements will be emphasizing those measures which reduce congestion, while at the same time helping achieve air quality goals.

Finally, because the US already has an excellent transportation system, it will take new technological development and/or the development of a totally new system to higher design standards and offering a significantly improved level of service (in terms of reliability, cost, and speed) to achieve significant economic productivity gains and long-term impact on national economic expansion.



Appendix C

Case Study II:

National Airspace System

LOUIS BERGER INTERNATIONAL, INC.

APPENDIX C

CASE STUDY:

NATIONAL AIRSPACE SYSTEM

I. Investment Description

The National Airspace System (NAS) is the largest and most technologically advanced aviation infrastructure in the world. It is probably the most complex, but one of the least visible elements of the nation's transportation infrastructure. Its purpose is to control air traffic, and provide information and communications links to pilots. It is also the only element of the nation's transportation network that is solely a Federal government responsibility. The current major air traffic control facilities are shown in Table C-1.

Table C-1: Current Major Air Traffic Control Facilities

Air Route Traffic Control Centers	21
Airport Traffic Control Towers	462
Automated Radar Terminal Systems	181
Flight Service Stations	174
Airport Surveillance Radars - Terminal	211
Air Route Surveillance Radars - En Route	115
Remote Center Air-Ground Facilities	655
Remote Communications Outlets	1,718
Direction Finder Equipment	229

(Source: 1993 Aviation System Capital Investment Plan, Final Draft, Federal Aviation Administration, US Department of Transportation, May, 1993.)

The National Airspace System Plan was selected as a case study of a transportation investment at the Federal level involving:

- automation and the deployment of new technology,
- the expansion, relocation, and/or consolidation of existing facilities, and
- the rehabilitation or replacement of existing structures or obsolete equipment.

This case study also requires private user investment to achieve the intended improved efficiency, since use of the new technologies are also dependent on aircraft based equipment. The case study reviews the FAA National Airspace System Plan in terms of how a national transportation investment can influence transportation productivity and economic development.[1]

In 1981, the Federal Aviation Administration (FAA) published the first National Airspace System Plan (NAS Plan). The plan involved a comprehensive strategy for improving the safety, capacity, and productivity of the air traffic control system. The Congressional Budget Office (CBO) estimated the total cost of the plan to be approximately $10.7 billion[2]; the investment would begin in 1982 and would continue over two decades. At the time, this investment represented roughly 36 times the previous capital expenditures for air traffic control, and one of the largest federal public works investment ever undertaken.

In recognition of the need to modernize the system, funding for the first five years was authorized by Congress under the Airport and Airway System Development Act of 1982. By 1991, more than 40% of the original NAS Plan projects had been completed, with most of the remainder in the implementation phase.

It should be pointed out that this case study is based solely on historical information available at the time it was prepared. The NAS Plan is an evolutionary document, and as such, has not and will not remain static. Changes and alterations to the original Plan have occurred, most notably in the present emphasis on the Global Positioning System (GPS) technology instead of the Microwave Landing System (MLS) approach and the present approach to achieve a more limited consolidation instead of the larger consolidation envisioned when the original version of the plan appeared. It should be understood that many of the proposals and the analysis presented in this Case Study are out of date, and many of the supporting documentation for the conclusions of the economic analysis, which were true in 1982 when the original NAS plan was developed, are no longer correct, since changes that are being implemented have significantly changed the NAS Plan.

The FAA proposed the original National Airspace System Plan in 1981, partially in response to increases in demand for aviation services and forecasted increases in air traffic and facilities operations costs over the next 20 years. These two factors, in addition to ensuring a safe aviation system, led to the proposed system plan. It evolved into a continual, annually revised, planning process for the facilities, equipment and associated development required to operate and maintain the National Airspace System. By 1990, the National Airspace System Plan had been replaced by the Aviation System Capital Investment Plan (CIP). Though the overall objective of the plan has not changed, the CIP has several major changes from its predecessor. These changes largely reflected the recognition that support and modernization of the almost 25,000 NAS facilities is a continual process and not a single, final end system.

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[1] The original plan is discussed in the report entitled "Improving the Air Traffic Control System: An Assessment of the National Airspace System Plan," published by the Congressional Budget Office, August 1983.

[2] All dollar values used from the CBO report will be in terms of 1982 dollars.

Much of the $10.7 billion price tag of the original plan, over 70%, represented direct federal investment in purchasing new technologies including the advanced automation system, terminal radar program, general support, system engineering and integration, and the Microwave Landing System (MLS) (see latest estimates in Capital Investment Plan, June 1993). The rest of the funds would originate from private sources, representing private investment expenses for the airline industry and general aviation users. Some of that investment would go toward equipment for aircraft owners and operators, particularly for new radar transponders for improved route planning, weather information service, collision avoidance, and signal receivers to operate the MLS.

It should be noted that since the original NAS Plan was prepared, development and implementation of the MLS program has been hampered by difficulties and full deployment may not be realized. The FAA has determined that GPS will be used for CAT I approaches and there is a high probability that GPS will supplant MLS for CAT II/III approaches also. GPS will also provide en route navigation and is being evaluated to provide capabilities in air traffic management that are beyond MLS's capacity. For instance, research is being conducted to make GPS an integral part of an air traffic management system that will provide surveillance capabilities in oceanic areas for the first time. Therefore, even if an MLS system is more fully deployed, it will be extremely limited and not provide the benefits originally foreseen in the NAS Plan.

The FAA plan is being financed by taxes on aviation users paid into the Airports and Airways Trust Fund, as is the case with other federally financed aviation projects. The trust fund's most significant tax is the one on commercial airline tickets. In addition, other system users make significant contributions through the trust fund in the form of aviation fuel taxes, domestic air cargo waybill taxes, etc.

The original FAA National Airspace System Plan was designed to automate and consolidate the air traffic control system by deploying new technology, reducing the number of facilities and improving labor productivity. The $10.7 billion plan represented a significant investment in the airspace system to increase capacity. The increase would result largely through the replacement of outdated technologies, consolidation of facilities, and staff reductions. Investments were categorized into six different areas, according to the part of the air traffic control system that they were designed to improve:

- terminal and en route air traffic control,
- flight service stations and weather services,
- ground - to - air services,
- interfacility communications,
- auxiliary services (maintenance and operations), and
- related projects (research and development).

At the time, new technologies were emerging, creating opportunities to facilitate greater automation and improved efficiencies within the air traffic control system. As stated, the FAA was particularly interested in implementing the MLS technology as it provided a radio signal that allowed multiple-

curved approaches and different glide slope angles when aircraft were appropriately equipped. More importantly, it would greatly improve air traffic capacity and use of airspace and airport resources.

II. Investment Objective and Decision-Making Process

The 1981 FAA plan specifically identified four broad goals:

- Reduce the cost of operating the traffic control system.
- Accommodate anticipated growth in air traffic.
- Improve the safety of air travel.
- Upgrade the quality of flight services.

The FAA's investment objective was largely to reduce the cost of operations and accommodate future air traffic growth as efficiently and safely as possible. Greater automation within the system would facilitate further system efficiency gains. For example, controllers managed their workload on the basis of flight plan data coded on paper strips torn by hand from teleprinters. Automating such functions would decrease requirements for facilities and personnel while simultaneously addressing the reliability problems inherent in labor-intensive mechanical operations.

The resulting improvements in labor productivity from the new technologies would allow increased facilities consolidation, staff reductions, and provide for future air transportation needs. Originally, it was felt that consolidation would lead to a reduction from the 25 en route navigation centers and 188 airport approach facilities into approximately 30 air traffic control facilities by the year 2000. The original plan called for a number of large Terminal Radar Approach Control Facilities (TRACON) to be consolidated into the current Air Route Traffic Control Centers (ARTCC), with some of the ARTCCs being consolidated as well.

However, as the NAS Plan evolved, the FAA has modified its approach to consolidating airport approach facilities. Since then, the FAA has opted for a policy of a more limited consolidation. Under limited consolidation, the 21 ARTCCs will remain while some of the larger TRACONs are scheduled to be merged together. The remaining "stand-alone" TRACONs will undergo an equipment modernization program. This consolidation plan would allow a reduction in staff, including controllers and maintenance personnel, and permit controllers to handle a greater number of landings and take-offs per year. This should permit significant cost savings.

Without sufficient investment to modernize the air traffic control system, significant costs in the form of higher future operating costs and insufficient capacity would result. The NAS Plan investment relied on new technologies to facilitate substantial labor productivity gains and increased capacity. These productivity gains would be exacted from automation and consolidation programs and would result in substantial gains in terms of number of operations per employee. The improvements in technology and labor productivity would result in other important benefits including:

- increased airways capacity,
- shortened travel time due to the availability of more direct flying routes,
- reduced costs of airways operations,
- reduced risks of mid-air collisions,
- continued high standard of safety, and
- reduced air and noise pollution.

Even though economic development was not an explicit objective of the NAS Plan per se, the investment was intended to result in real savings - primarily time savings and operating cost savings - and would contribute significantly to economic development by decreasing the cost of individual, business, and freight transportation.

The decision-making process involved evaluating projects based on their rate of return. The plan relied heavily on Congressional approval for facility consolidation and staff reductions, both of which were vital to achieving a feasible rate of return. This approach is still intact but has evolved based on changes to the proposed technology and the policy of limited consolidation. The latest program calls for the 21 ARTCCs to remain in operation, while some of the larger TRACONs will be merged together and others permitted to stand-alone but with improved equipment.

III. Analysis and Methodology

The FAA used a benefit-cost analysis to evaluate the National Airspace System investment. In the early 1980's, the CBO reviewed the FAA analysis and determined the total cost of implementing the plan to be $10.7 billion to be spent over a period of approximately 20 years. The annual rate of return for the duration of the investment was calculated to be 24.3% with a Net Present Value to exceed $9.1 billion. The $9.1 billion denotes actual value-added to the national economy resulting from increases in productivity and realized by both airway users and non-users. In the context of benefit-cost analysis, the NAS plan represented a very good public transportation investment and a very efficient use of funds. The following results of the economic analysis are taken from the original analysis although, as noted previously, the investment program has evolved and the analysis has been updated regularly to reflect such changes.

A. Costs

The costs for NAS plan were largely classified into two groups: federal investments and special equipment for avionics users. Table C-2 displays the breakdown of expenses by billions of dollars and percentages of total costs. As may be observed, the largest portion of the investment is borne by the Federal Government through the Airports and Airways Trust Fund although private investment is also significant.

B. Benefits

The benefits are reflected in three major categories:

- FAA operating cost savings,
- fuel savings,
- user cost savings from the Microwave Landing System,

User cost savings are largely the result of time saved by freight, passengers, pilots and others, because of the increased reliability, reduced restrictions and increased safety. The savings to the FAA result in reduced user costs to the extent that it is eventually reflected in lower taxes and/or user fees.

Table C-2: Prospective Cost Estimates for NAS Plan, 1983 - 2005[3]

	Total Costs[a]	
Sources of Costs	**Dollars[b]**	**% of Total**
Federal Investments	7.65	71.7
Avionics User Costs		
Transponders & TCAS[c]	2.42	22.7
Microwave Landing System	0.59	5.6
Total	**10.7**	**100%**

Table Notes:

a. All costs are given in 1982 dollars.
b. All values are expressed in terms of billions of dollars.
c. Traffic Alert and Collision Avoidance System.

Table C-3 shows the expected benefits, in billions of dollars and percentages of total benefits. Clearly, the largest portion of the savings, 62%, is associated with FAA operations. For example, the improved NAS and new landing system was projected to increase the average number of operations per controller from approximately 2,400 in 1981, to 4,200 in 1990, and to more than double by the year 2000. This would represent a 75% increase in operations handled within the first decade and a 100% increase over the whole twenty year period.

Resource savings in terms of fuel used by commercial air carriers and general aviation account for about 27%; non fuel-related savings are associated with the MLS.

C. Annual FAA Updates

The FAA produces an annual Capital Investment Plan that updates the status of the various investments, the expected benefits based on projects completed to date, and anticipated future

[3] The prospective cost estimates for NAS Plan were taken from the CBO evaluation of the FAA benefit-cost study based on FAA data.

benefits after completion of the entire plan. The full impact of benefits to be produced by the 1993 plan are not anticipated to be realized by users until the year 2025.

IV. Project Objectives Achieved and Results after Investment

At the conclusion of 1991, after more than 40% of the original NAS plan projects were completed, benefits accruing since 1981 amounted to approximately $24 billion,[4] according to the FAA. These savings will continue to accrue from the completion of these projects in the form of reductions in FAA operations and maintenance costs, productivity increases, and reduced delays and disruptions to air traffic

Table C-3: Prospective Benefit Estimates for NAS Plan, 1983 - 2005[5]

	Total Benefits[a]	
Sources of Benefits	**Dollars[b]**	**% of Total**
Savings in FAA Operating Costs from Increased Productivity	37. 09	62.2
Savings in Fuel		
Air Carriers	11.29	8.9
General Aviation	5.07	8.5
Savings from Microwave Landing System		
Improved Safety	0.28	0.5
Reduced Disruptions	2.52	4.2
Reduced Outages	0.24	0.4
Reduced Ground & Air Restrictions	1.99	3.3
Reduced Path Length	1.12	1.9
Total	**10.7**	**100%**

Table Notes:

a. All costs are given in 1982 dollars.

b. All dollars are expressed in terms of billions.

operations that would otherwise have occurred due to congestion and equipment down-time. The top investments in terms of long-term benefits to both the FAA and the users is the advanced automation program.

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[4] The 1991 Capital Investment Plan identifies the $24 billion, in 1991 constant dollars, resulting from completed projects, stand-alone systems of ongoing projects funded by the FAA Facilities and Equipment account.

[5] The prospective benefit estimates for NAS Plan were also taken from the CBO evaluation of the FAA benefit-cost study.

Over the years since the first NAS plan was prepared, FAA objectives have been expanded to reflect new opportunities for cost reductions, new technologies, and new industry requirements. For example, the more recent versions of the plan place increased emphasis on increasing user-preferred routes and altitudes that minimize aircraft operating costs.

Tables C-4 and C-5, show a summary of National Airspace System activity as projected in the 1981 NAS plan compared to the projections in the 1991 plan. Nearly all indicators of activity experienced significant growth, although at a slower pace than originally projected. Interestingly, the nation's air carrier aircraft fleet grew even faster than projected in 1981, reflecting airline expansion and introduction of quieter and more fuel-efficient airplanes.

Table C-4: 1981 Total National Airspace System Activity

	1980	1985	1990	2000	% Growth 1980 - 2000
NAS Airports	3,163	3,637	3,631	4,000	`26.5%
Airport Operations (mil)					
Aircraft Operations	134.1	179.7	212.7	290.0	116%
Itinerant Operations[b]	74.0	98.8	117.3	159.5	115.5%
Instruments Operations[c]	38.2	48.1	54.2	65.6	71.7%
Domestic Enplanements[d]					
Air Carrier (mil)	278.1	380.8	454.0	589.8	112.1%
Commuter (mil)	13.1	21.8	30.6	42.0	220.6%
Aircraft Fleet (000s)					
Air Carrier	2.4	2.7	2.9	3.4	42%
Commuter	1.6	2.4	3.2	4.5	175%
General Aviation	210.3	254.5	298.1	408.5	94%

(Source: National Airspace System Plan: Facilities, Equipment and Associated Development, Federal Aviation Administration, US Department of Transportation, December 1981.)

Table Notes:

a. Aircraft operations include takeoffs and landings at all towered and non-towered airports.
b. Itinerant operations refer to those aircrafts departing or arriving from an area outside an airports local operating area.
c. Instrument operations represent a separation service provided to aircraft while conducting flight.
d. Domestic enplanements include all enplanements regardless of the airport type.

Although delays are less than would have been the case without the investment in the NAS plan, FAA computes that total passenger delay costs for all air carriers actually more than doubled from 1976 to 1986, increasing by 131% from $1.4 billion to $3.3 billion. Without the NAS plan improvements, airline passengers would have experienced increased even more delays waiting for takeoff or landing slots at airports, and aircraft operating costs would have been even higher due to such delays and increased fuel costs.

To date, no information has been obtained as to the anticipated benefits from FAA consolidations and staff reductions. As mentioned earlier, the FAA has shifted its approach to facility consolidation. Rather than reducing the 25 en route navigation centers and 188 airport approach facilities into approximately 30 air traffic control facilities by the year 2000, 21 ARTCCs will remain, with some TRACONs being merged and others retrofitted with modern equipment to function as stand-alone units.

Table C-5: 1991 Total National Airspace System Activity

	1991	1996	2001	2005	% Growth 1991 - 2005
NPIAS Airports [a]	3,370	3,610	3,860	4,100	21.7%
Airport Operations (mil)					
Aircraft Operations	148.1	168.8	187.4	201.7	36.2%
Itinerant Operations	87.5	101.5	113.7	123.2	40.8%
Instruments Operations	45.1	51.2	56.6	60.5	34.1%
Domestic Enplanements (mil)					
Air Carrier	413.3	496.5	596.7	685.1	65.8%
Commuter	38.4	54.1	73.0	89.9	134.1%
Aircraft Fleet (000s)					
Air Carrier	4.3	5.0	5.7	6.1	41.9%
Commuter	1.9	2.1	2.3	2.4	26.3%
General Aviation	212.2	215.8	222.9	226.9	6.9%

(Source: Aviation System Capital Investment Plan, Federal Aviation Administration, US Department of Transportation, December 1991.)

Table Notes:

a. Aircraft operations forecasts are based on the existing airports included in the National Plan of Integrated Airport Systems (NPIAS).

V. Lessons From Case Study

The NAS plan is based mostly on technology development and achieving higher productivity in the operation of the airspace system. Economic development was not and is not directly articulated by the FAA as an investment objective for the original NAS plan. It is clear, though, that the investment in new technology and NAS improvements results in increased productivity (i.e. aircraft operations or flights per air traffic controller) and savings for both users and non users of the airways system. The NAS plan investment programs also contribute to US technological leadership in an area of great potential to increase the nation's exports and thereby reduce our balance of payments deficit.

The NAS plan has been based from the outset on a rigorous analysis of economic benefits as compared to costs. The relationship between airways system benefits and the nation's economic

expansion, however, is not easily understood. Figure C-1 on the following page, provides a simplified overview of the relationship between airway investment, the ensuing increase in productivity, and economic development. Basically, the investment results in

- increased capacity to meet demand for more flights to move passengers and cargo as the economy expands;

- decreased travel time and reduced congestion, also increasing reliability for time-sensitive freight and resulting in more productive use of time for individuals on business or personal trips;

- reduced airway operating costs, which should be reflected in lower taxes or fees for passengers, air carriers, and other system users; and

- reduced aircraft and airline operating costs (through lower fuel use and less flying time), which should be reflected in lower airline fares or air cargo rates.

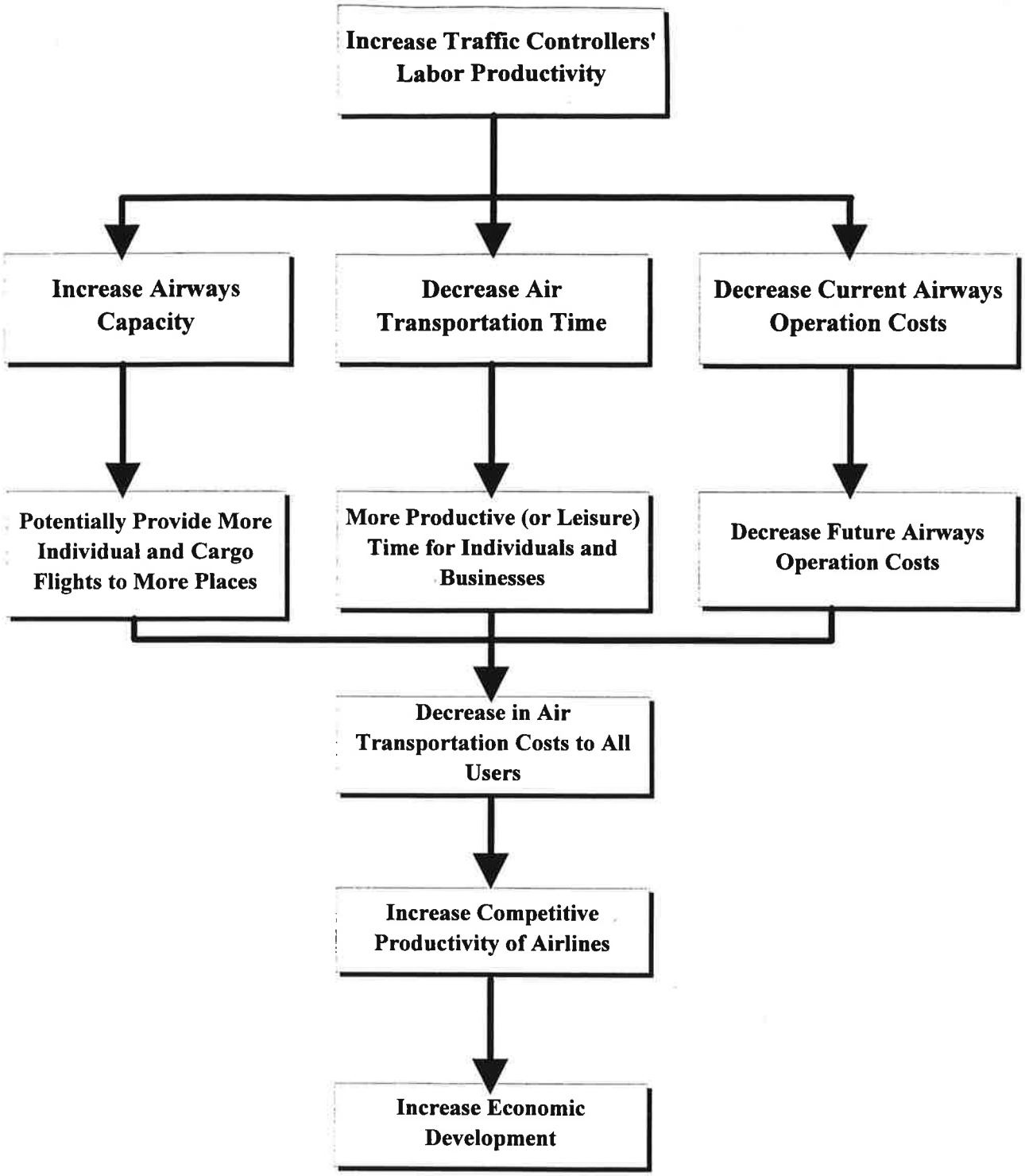
The NAS investment then decreases air transportation costs and increases the potential service levels that air carriers can offer, thereby expanding the market reach of the nation's products and services. At the same time, it increases the competitiveness of the US in the global marketplace, both through technology development and through the additional air service links that NAS investments make possible.

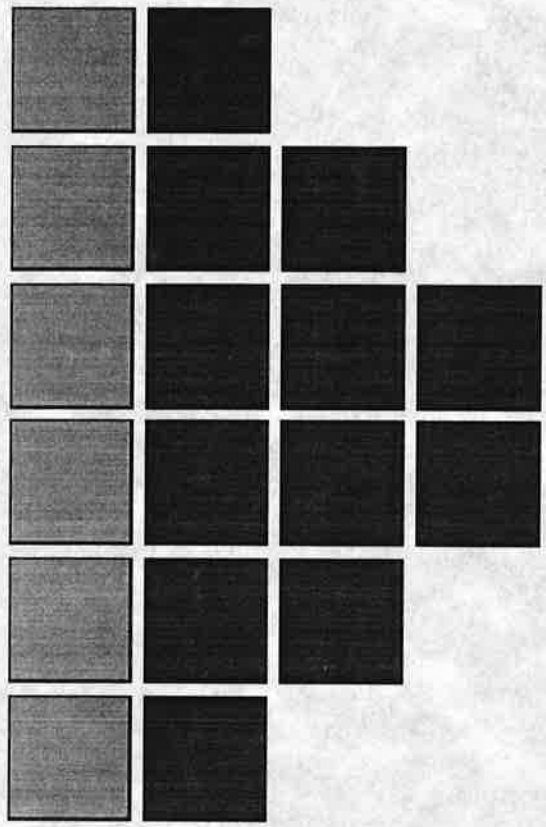
The investment directly contributes to economic development through increased air traffic controller productivity and decreased air transportation costs. These benefits accrue not only to persons and businesses that use the airways but to many others as well. Lower air transportation costs may be passed on to consumers as lower prices for consumer goods that move by air, to workers as higher wages, or to owners of businesses and aircraft equipment as higher net income.

The productivity increase generated by the NAS investment, works its way through the economy generating indirect benefits. Some of the more indirect benefits include an increase in productive time for businesses and individuals, and a decrease in air and noise pollution. These benefits accrue to both airway users and non-users, and although intuitive and easily identifiable, can be far more difficult to assess. Time savings for business travelers and shippers, for example, may mean more hours of productive work, faster deliveries to factories and thus more output per hour. Additionally, businesses can use air transportation to reduce their inventory requirements, rely on inputs from higher quality or lower cost suppliers located farther away, thereby resulting in higher production levels and/or lower unit costs. For example, implementing just-in-time (JIT) purchasing strategies to reduce inventory costs, or using different intermodal transportation combinations to facilitate greater access could both further accelerate cost reductions or output increases.

The National Airspace System plan offers an excellent case of how transportation investment can enhance the nation's future economic development and competitiveness in a global economy. It further highlights the role capital investment can play in improving labor productivity through capital investment. Finally, it is an excellent case study of how the economic analysis or benefit-cost methodology can be used to evaluate and justify transportation investments in the public sector.

Figure C-1: Illustration of the Linkage between Productivity and Economic Development





Appendix D

Case Study III:

Pennsylvania Railroad Clearance Projects

LOUIS BERGER INTERNATIONAL, INC.

APPENDIX D

CASE STUDY:

PENNSYLVANIA RAILROAD CLEARANCE PROJECTS

I. Investment Description

Public sector transportation investment can result in economic expansion primarily through the increase in productivity that is achieved by private sector transportation carriers and/or users of their services. The US is probably the only country in the world where the railroad system was developed and is mostly operated by private enterprise. Since deregulation in the early 1980s, the industry has significantly improved its productivity, see Table D-1. The primary increases in productivity occurred because of reductions in the labor force, increases in equipment utilization, network downsizing, and use of higher capacity railcars. Between 1975 and 1991, output per hour for all railroad employees (Class I line-haul railroads and switching terminal companies) increased three fold.

Table D-1: Indexes of Output per Hour for All Employees for 1975 to 1991

	1975	1980	1985	1988	1989	1990	1991
Railroad Transport (Revenue Traffic)	77.3	92.6	139.7	195.3	207.4	218.1	236.2

(Source: US Department of Commerce, Statistical Abstract of the US, 1993, Table No 633.)

Although mostly privately operated[1], rail service and costs can have a significant impact on a state's economic expansion. The state of Pennsylvania and other eastern states faced such a situation when the rail industry (initially at the initiative of steamship lines) began to use double stack railcars for intermodal services in the mid-1980s. Double stack railcars can result in significant line-haul cost savings (over 40% compared to conventional intermodal cars). Double-stack services first started mainly to move international cargo inland from West Coast ports. Because the efficiencies made possible by the new railcar technology expand when the equipment is more fully utilized, railroads and other operators of the double-stack service (steamship lines) quickly began to use available capacity to fill slots with domestic cargo as well. The double-stack network has expanded rapidly and is one of the main reasons why rail intermodal services have grown rapidly in recent years, even to the point of attracting truckload carriers.

[1] The exception is the short-line railroads which receive government financial assistance, that have been operating mostly along lines abandoned by the Class I railroads.

The double stack railcar for containers requires a higher vertical clearance (over 20 ft.) compared to the approximately 18 ft. clearance required by conventional intermodal railcars. Other specialized railcars, such as the fully enclosed trilevel automobile railcars also require higher clearances than exist in many eastern states. With the technology in use nationwide and railroads rapidly expanding their double stack and trilevel rail services, Pennsylvania and other eastern states are at a competitive disadvantage, since its ports and businesses are not able to obtain the lower rates that are made possible by such services.

In April 1993, the Pennsylvania State Legislature gave its approval to invest approximately $35 million to increase clearances on two major rail corridors, in cooperation with Conrail and the Canadian Pacific Railroad. Work on a third corridor, the CSX rail corridor, is currently being delayed pending formal commitment by CSX and the State of Maryland to raise clearances on the southern portion of that corridor (see Figure D-1). Total direct investment for those three corridors was estimated at $72.4 million (in 1992 dollars) with the State of Pennsylvania financing 30% of that total with the remainder to be financed by the railroads operating the selected lines (Conrail, CSX and Canadian Pacific).[2]

The high clearance rail project in Pennsylvania was selected as a case study of joint public-private sector transportation investment to improve privately owned infrastructure in order to increase the competitiveness of private businesses and port facilities located in the State. This case study will also discuss the impact of the investment on transportation and logistics costs of Pennsylvania based-industry.

Overall, the high clearance investment is part of a broader state economic development policy whose goal is to offer, by the turn of the century, a completely seamless intermodal transport infrastructure to shippers.

In April 1993, following the approval of the project by the state legislature, overhead clearance improvement work started. The project schedule calls for completion of all the clearance work by December 1995 for the Conrail Mainline and the Canadian Pacific line. Since the initial cost estimates were published, the cost of the project has gone up significantly, with total investment for the Conrail Mainline and the Canadian Pacific line now estimated at $80 million versus $64 million previously (+25%).

Preliminary studies on a "high profile rail clearance" project in the state of Pennsylvania were first conducted in the late eighties. Financed by railway operators, those studies looked primarily at existing limitations in terms of rail car height along the railway corridors serving Pennsylvania.

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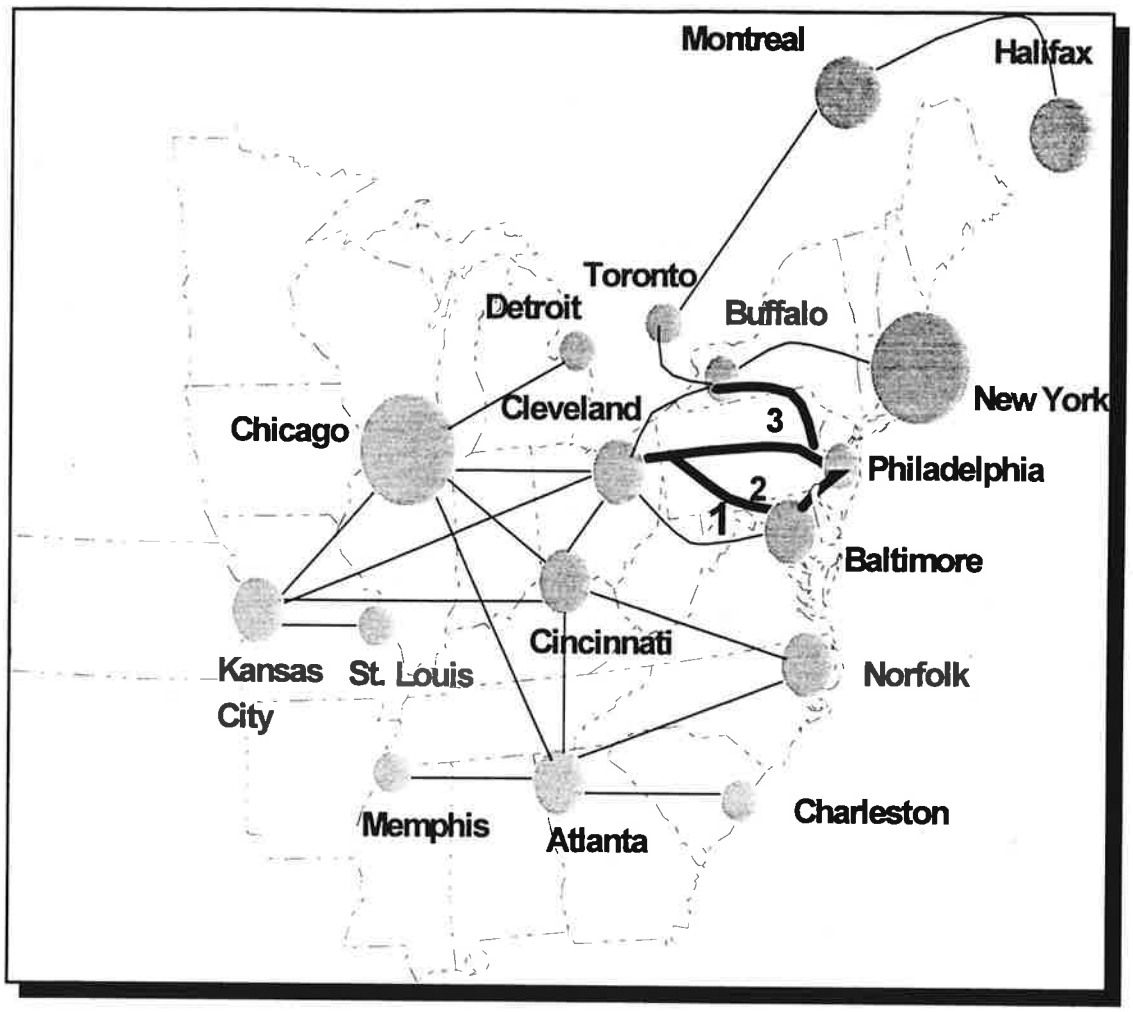
[2] A 1992 report entitled "**High Profile Rail Clearances in the State of Pennsylvania**" was prepared by Transmode Consultants and Apogee Research for the Pennsylvania Department of Transportation. The analysis documented in this case study is based on that report.

Figure D-1: High Profile Clearance Rail Corridors



1. CSX Via Baltimore

2. Conrail Mainline

3. Canadian Pacific via Binghamton

On the three rail corridors targeted for overhead clearance investment, it was found that maximum authorized height for rail cars varied between 17 ft. 6 inches and 19 ft. 3 inches, which fell short of the 20 ft. 8 inches necessary to accommodate the third generation of double-stack cars[3]. The combined effect of the increasing number of third generation double-stack cars in use and the growth in intermodal transportation[4] was likely to further impact the competitive disadvantage that Pennsylvania faced due to the clearance issue, if no corrective action was taken by the state and the Railroads (see Table D-2).

Table D-2: Third Generation Double-Stack Car Capacity For Class I Railways

Year	1986	1987	1988	1989	1990	1991	1992
No. of Slots	17,000	23,000	31,000	35,000	55,000	65,000	77,000
As % of Total Intermodal Equipment Capacity	14.4%	20.0%	26.5%	31.8%	44.0%	50.0%	57.1%

(Source: "High-Profile Rail Clearances in the State of Pennsylvania", Report 3. Transmode Consultants, October 1992.)

Additional investment costs related to complementary network improvements within and beyond the Pennsylvania state borders[5] represent a major part of this project. Compared with the total direct investment for the three rail corridors within the state, the sum required to be spent on complementary network improvements is rather large, totaling between $64 and $69 million[6]. Of that sum, about $24 million are to be invested in intermodal terminals by the railroads, while $40 to $45 million are required investments by the railroads or neighboring states for overhead clearance per se.

As noted earlier, financing of the direct investment costs for overhead clearance work on the three rail corridors is shared between the state of Pennsylvania and the railroads. Overall, the state is to

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[3] The height of the latest generation of double-stack car is 20 feet and 2 inches. This means that, for safety reasons, a minimum rail overhead clearance of 20 feet 8 inches is required on tracks used by those double-stack cars.

[4] In its 1990 "National Transportation Strategic Planning Study", the US Department of Transportation reported that the average growth of intermodal traffic during the last decade had reached 8% per annum.

[5] Complementary network improvements include all overhead clearance work to be performed in Ohio for the Conrail Mainline and in Maryland for the CSX line, as well as the upgrade and the construction of intermodal terminals within the State.

[6] Figures obtained from the "High-Profile Rail Clearances in the State of Pennsylvania" report published by Transmode Consultants and Apogee Research, October 1992.

finance 100% of the cost of the overhead clearance work to be done on common or shared rail lines and 30% of the same cost to be executed on tracks used only by one railroad.

However, the state contribution to the project is subject to two main conditions:

1. The financial involvement of the Commonwealth in the project is limited to a maximum of $34.4 million for the Conrail and Canadian Pacific rail corridors. Any additional funding for the overhead clearance work would have to be financed exclusively by the railroads.

2. State financing of the CSX line will only occur when a clear commitment to proceed with overhead clearance on the Maryland portion of the track is obtained from CSX and the State of Maryland.

II. Investment Objective and Decision-Making Process

It is clear that the state and the railroads have very different investment objectives. For the state of Pennsylvania, the objectives of this investment are, not surprisingly, broader in scope than for the railroads. They include the following :

- **Provide high productivity, low cost transportation to manufacturers and distributors who operate from Pennsylvania** - This goal is part of the state's more fundamental goal to expand the competitive market reach of Pennsylvania-based export manufacturers.

- **Develop high productivity rail services which serve multiple interregional markets, with Pennsylvania at the hub of a comprehensive containerized freight service network** - This objective relates to both the domestic and international container service network and includes the development of the container activity of the Port of Philadelphia.

- **Encourage innovative intermodal services from terminals in Pennsylvania** - By working with the three majors railroads, the state investment can ensure that intermodal services will be provided throughout Pennsylvania and that competition between railroads is preserved.

- **Foster the diversion of "overhead" motor carrier traffic from Pennsylvania highways to railways** - By diverting through traffic (i.e. traffic which does not originate nor terminate within the state borders) from highways to railways, the cost burden associated with freight traffic that does not directly generate economic development for the Commonwealth could be lowered.

- **Attract additional business through the relocation of central distribution and warehousing services, wholesale distribution, and integrated retail firms operating throughout the northeast region** - Build the infrastructure needed to make Pennsylvania the distribution base of these types of firms for the northeast region.

- **Encourage economic development** - Even when shippers do not need high clearances, they may be inclined, when making a site selection, to consider possible future needs. Thus, clearance constraints is an important factor which tends to affect industrial site selection directly.

- **Make the project financially attractive for the railroads** - By sharing the burden of the investment with the rail operators, the state greatly enhances the internal rate of return (IRR) of the project for these investors as well as contributing to lower risk.

The railroad's perspective is somewhat diferent. Each railroad faces a somewhat different competitive position. All three railroads will obviously benefit from achieving higher clearances on their lines. For the railroads, this project has two main objectives:

- **Develop new markets for established customers and increase their customer base, particularly for automobile services** - At the present time, clearance constraints limit rail carrier's ability to haul oversized cargo. For this reason, the railways serving Pennsylvania have limited access to the market for oversized freight. They also cannot compete as aggressively in hauling automobiles and domestic and international containers in certain markets.

- **Increase intermodal competitiveness** - The increased productivity of intermodal services and the cost of providing intermodal services are both directly related to rail clearances. The lifting of rail clearance constraints will allow the companies operating the three rail corridors to compete more efficiently in the growing intermodal market.

The investment objectives show that economic development is the primary reason behind the investment from the State's perspective. The market strategy upon which this project was developed calls for the creation "of a competitive advantage for Pennsylvania-Based shippers/receivers through a progressively developed service network centered in the state."[7] The major result expected from such a strategy is clearly economic development through an increase in the state shipping and production activity. As stated in the report published by Transmode Consultants, "traffic growth is the clear and unmistakable signal that economic value has been created and that public funds have been productively invested."[8]

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[7] Ibid.

[8] Ibid.

III. Analysis and Methodology Used for the Project Evaluation

In November 1992, Transmode Consultants and Apogee Research submitted to the Pennsylvania Department of Transportation (PaDOT) a series of studies regarding the financial and technical feasibility of increasing several rail corridors' overhead clearances within the state .

Among the five rail corridors considered, three were selected based on the following criteria:

- linkage with other state infrastructure projects,
- increased competitiveness,
- collateral network benefits,
- cost of improvements,
- railroad commitment,
- local economic development benefits.

The initial analysis consisted of a review of a set of criteria that the consultant felt were essential to the success of the project. Different degrees of importance were attributed to each criterion. Among all criteria reviewed, **local economic development benefits** received the highest ranking, giving a clear indication of the main focus of the rail corridor evaluation process. The second most important of the six criteria, railroad commitment and/or interest in the clearance project, was also a significant factor in the selection of the three corridors.

The project evaluation consisted of a cost/benefit analysis to determine the merits of carrying out the clearance work in each of the three corridors. The cost/benefit analysis looked at the economic impact of the investment in terms of

- increased freight traffic,
- direct and indirect jobs to be created by the construction activity generated by the project,
- direct employment in industry generated by lower transportation costs, and
- increased state and local tax receipts.

Future freight traffic volume was forecasted over a five year period for the rail and the truck modes. Four different categories of freight were considered in the analysis:

1. autorack freight,
2. international intermodal freight,
3. domestic intermodal freight, and
4. high and wide load freight.

Shipper surveys were conducted to identify industries that were losing business to competitors due to the clearance restrictions. These surveys provided a clear indication of the importance of higher clearance to the shippers in the state.

For each rail corridor chosen, the expected traffic impact of the overhead clearance investment was translated into transportation cost savings. It was estimated that construction of all three projects would result in $53 million of savings in transportation and logistics costs by Pennsylvania industry in 1995, rising to $114 million by the year 2000.

This, in turn, made possible a comparison between the Net Present Value (NPV) of estimated investment costs and benefits. Table D-3 presents the results of this analysis which shows that the NPV of benefits exceeds by about $300 million the NPV of costs.

In terms of jobs created by the construction effort, it was found that, over the 1993-1995 period, 920 direct jobs and 2,330 indirect jobs would be created.[9] The study also observed that if any public share of the construction costs represented funds diverted from other state programs, the jobs would represent transfers rather than net additions (i.e. implying a transfer of jobs rather than a creation of jobs). More importantly, it was estimated that by 1995, about 2700 jobs would become available in basic and directly affected industries as a result of the transportation and logistics costs associated with the project, with an additional 6,400 jobs in secondary activities. By 2000, it was estimated that the growing savings in transportation and logistics costs would lead to 6,000 new jobs and 16,000 secondary and support jobs.

The cost/benefit analysis also looked at the long-term impact that lower logistics costs would have on shippers profitability and, in turn, on shippers future economic activity. Based on studies which have examined shifts in employment and measures of profitability,[10] it was concluded that, by the year 2000, between 5,200 and 7,000 new jobs would be generated as a direct result of this project. Of this total, about two-thirds would represent indirect and induced jobs linked to the effect of the expected increase in industrial activity. The economic sector which was identified as the one likely to gain most from the investment was, as expected, the transport intensive manufacturing sector. Interestingly, though, the trucking industry was also found to benefit from the investment, with more than 50% of the new jobs to be created in this sector linked to intermodal traffic.

The impact of the project on tax revenues was also computed to assess the impact of the project on the Pennsylvania economy. Increased economic activity due to improved rail transportation was expected to provide a significant boost in tax revenues of almost $50 million in net present terms.

IV. Lessons from the Case Study

Although the project is still in its implementation stage, some lessons in terms of how investment in transportation can impact the economic development of a region or a state can be drawn:

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[9] This figure is based on the assumption that all three selected rail corridors would be under reconstruction during this period.

[10] For example, see Conaughton and Madsen (1990).

Table D-3

Net Present Value of Costs and Benefits (in Millions of 1992 Dollars)

	1993	1994	1995	1996	1997	1998	1999	2000	Total
	Net Present Value of Cost								
Conrail Mainline	$26.6	$15.0	$9.4	$0.0	$0.0	$0.0	$0.0	$0.0	$51.0
CSX via Baltimore	$4.6	$2.2	$1.6	$0.0	$0.0	$0.0	$0.0	$0.0	$8.4
Canadian Pacific Line	$6.8	$3.9	$2.4	$0.0	$0.0	$0.0	$0.0	$0.0	$13.1
Total	$38.0	$21.1	$13.4	$0.0	$0.0	$0.0	$0.0	$0.0	**$72.5**
	Net Present Value of Benefits								
Conrail Mainline	$0.0	$0.0	$25.2	$34.2	$39.1	$40.6	$40.4	$39.5	$219.0
CSX via Baltimore	$0.0	$0.0	$15.3	$20.4	$23.1	$23.8	$23.6	$23.0	$129.2
Canadian Pacific Line	$0.0	$0.0	$2.7	$3.8	$4.5	$4.7	$4.6	$4.5	$24.8
Total	$0.0	$0.0	$43.2	$58.4	$66.7	$69.1	$68.6	$67.0	**$373.0**

- A public-private partnership may be an appropriate way to achieve needed transportation improvements when

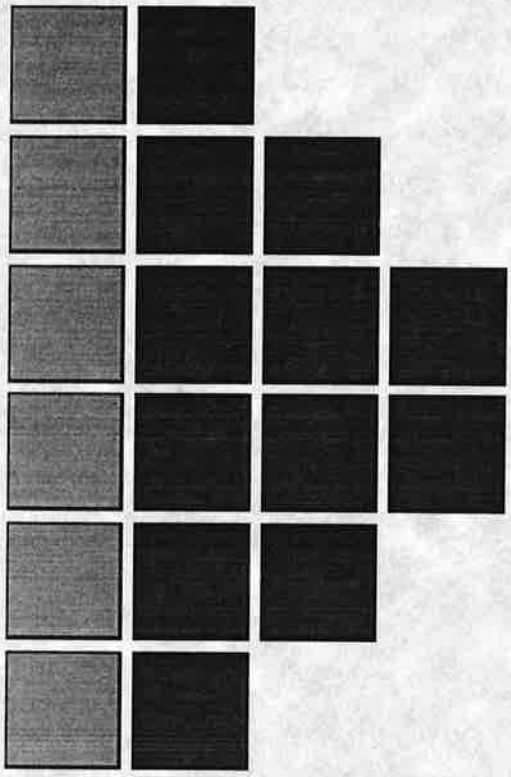
  1. no private carriers are willing to make their own commitments,
  2. there is some question as to the role that public sector investment should play.

  In the Pennsylvania case, the state served as the catalyst to get the railroads interested. It is not known whether the railroads would have eventually made the investment on their own. No consideration was given to the financial benefits to be derived by the railroads from this investment.

- Transportation service availability (such as double-stack container service or tri-level autorack service) can be a significant competitive factor for industry site selection and retention of existing businesses.

- Pennsylvania's transportation investment, including the spending of public funds on privately own assets, reflects the importance the state placed on maintaining a competitive transportation service to attract and retain industry.

- The investment was originally considered to improve the competitive position of the Port of Philadelphia for international cargo. The analysis concluded that the largest benefits would actually accrue to domestic shippers due to transportation cost savings, making it possible for the state to participate in the rapidly growing long-haul domestic container markets, with profound implications for Pennsylvania-based manufacturing and distribution industries.



Appendix E

Case Study IV:

State Transportation Economic Development Programs

LOUIS BERGER INTERNATIONAL, INC.

APPENDIX E

CASE STUDY:

STATE TRANSPORTATION ECONOMIC DEVELOPMENT PROGRAMS

I. Case Study Description

State and local economic development officials have long recognized the importance of transportation infrastructure among the factors considered by businesses in their site selection process. In recent years, nearly half of the states have established transportation investment programs to address the specific need for new or upgraded highways and/or rail access to attract or retain businesses or industries. These state transportation programs are closely tied to broader state economic development programs.

Depending on the state, this type of investment may involve near-term targeted projects to benefit specific private developments, and/or longer-term regional transportation projects that are anticipated to foster the prerequisite conditions for economic development.

In either case, through these transportation investments, the state seeks to enhance private economic activity and improve the statewide economy. These programs are part of the competitive efforts of the states to attract development within their boundaries, thereby generating or retaining employment and an expanded tax base. Implementation of these programs requires that decision-makers be responsive to competitive pressures within the states, sometimes involving competing projects from different areas in the state.

In considering the allocation of scarce fiscal resources with the specific objective of economic expansion, these transportation programs must balance competing claims for funds and consider

- transportation need,
- regional economic development benefits, and
- the implications on the beneficiary target industry.

In determining whether a project should be funded, states must consider these issues and reach a conclusion as to the likelihood that the investment will result in a real net positive impact on the economy. Some investments will only result in a larger tax burden at the expense of the overall area's competitiveness if the requesting industry would have remained on site or moved to the area in any case.

This case study explores several examples of state transportation investment programs that have been undertaken recently with the specific goal to promote economic expansion. The **Michigan** and **Wisconsin** programs are briefly described as examples of programs involving relatively small near-term investments. These programs provide an opportunity to explore how transportation

infrastructure and service levels affect business location decisions from the state and local perspectives. Other programs include more ambitious longer-term goals, involving transportation investments without targeting specific companies or industries. The **Pennsylvania, Minnesota,** and **Georgia** programs, as well as another **Wisconsin** program are presented as examples of long-term state highway investment with a focus on economic development objectives.

Although not discussed in this case study, Iowa's RISE program (Revitalize Iowa's Sound Economy) is another example of a state's transportation investment program with an economic development focus. The RISE program was created in 1985 to promote economic development through road investments. The $33 million annual authorization was targeted at projects in three categories: immediate opportunities, local development, and regional development projects. The RISE program has been extensively studied (see Forkenbrock, Pogue, and Finnegan, 1990).

II. Near-Term Programs to Attract or Retain Jobs

A. Michigan Transportation Economic Development Fund

The Michigan Transportation Economic Development Fund is a statewide program dedicated to targeting transportation investment for economic development purposes. The program is divided into several funding categories to distribute capital for transportation improvements throughout the state's urban and rural regions and to ensure that funds are available to promote job-creating business activity.

1. Investment Description

The fund was initiated by the Michigan legislature in December 1987. One precipitating factor that led to the creation of the fund was the state's experience competing with other states to attract a Mazda automobile manufacturing plant. Despite being the traditional home of U.S. automobile manufacturing, the state was confronted with the need to offer incentives to compete with other states in attracting this new Japanese entrant. During this period, Michigan officials also began to pursue a diversification policy to reduce the state's dependency on the automotive sector. In addition to bringing potential new jobs to Michigan, the fund was also established to preserve the state's substantial job and manufacturing base in a period of rapid economic change. The state's general funds and license fees are the primary sources of annual funding for the Transportation Economic Development Fund (TEDF). The state's general fund provides approximately $37 million to the transportation fund, and license fees provide another $10-$12 million annually for the program.

The fund is administered through the state's Office of Economic Development (OED) in accordance with Michigan Transportation Commission policy. Eligible applicants are limited to Michigan highway, road, and street agencies; specifically, the Michigan Department of Transportation, all county road commissions, and all cities and villages. Private firms must work with one or more of the eligible applicants to access the fund.

The first cycle of project solicitation, selection, and funding was completed in October 1988. Since then, the program cycle has been conducted on an annual basis. Since its inception the demand for funds has far exceeded the funding capacity of the program. The program has been viewed as a success by the state legislature, which recently extended the life of the program for another 5-year period with only minor alterations in program category funding. Since the creation of the fund, over $388 million has been awarded in grants through the six funding categories of the TEDF, which include the following:

Category	Description of Categories
A	Target Industry Development - grants for road improvements to enhance opportunities in agriculture, food processing, tourism, forestry, high technology research, mining, manufacturing or major office development.
B	State Trunkline Service - grants to upgrade roads to allow state take-over of selected county roads and city streets, in order to provide adequate service for long-distance travel (repealed by Michigan Legislature in 1994).
C	Urban Congestion Relief - grants to allow intersection improvements, addition of lanes, and advanced traffic management systems.
D	Rural Counties - establish an all-season road network.
E	Forest Roads - for essential projects to transport forest products.
F	Cities in Rural Counties - improvements in small cities to complement the rural all-season road network.

The Target Industry Development category has accounted for over 40 percent of the dollars awarded since the TEDF's inception. Of the several categories funded under the TEDF, the Target Industry Development is the most focused aimed at capturing immediate opportunities for economic development from transportation investment. Other funding categories aimed at longer-term economic development objectives have often been used in association with the Target Industry Development category to leverage additional public funds for immediate projects.

2. Investment Objective and Decision-Making

Each program category has dedicated funds reflecting a broad variety of statewide transportation objectives and eligibility criteria.

Projects eligible for Category A grants are road and street projects to enhance economic development opportunities in agriculture, food processing, tourism, forestry, high technology research, mining, manufacturing, or eligible office centers. Approximately $20 million is set aside statewide for Category A programs, of which $6 to $8 million is used to service debt repayments for bonds previously issued.

The Office of Economic Development evaluates applications against the eligibility requirements. Minimum eligibility criteria are established to screen out projects, as listed below:

- The proposed economic development program must create or retain permanent jobs in Michigan. To avoid intrastate competition, the program does not credit job transfers within the state from one site to another. To gain credit for a "retained" job, the OED requires proof from the applicant that were the improvement not undertaken the job would be lost, either by being transferred outside Michigan, being laid off, or through closure of the company.

- A transportation need must exist in one of the following categories: capacity, condition, safety or accessibility.

- The transportation improvement must relate to immediate, rather than long-term or speculative needs.

- The economic development project must demonstrate the presence or commitment to provide essential nontransportation infrastructure and support services including fire protection, water, sewer, drainage, and heating.

- If the project applicant is a local unit of government, the economic development project must increase the tax base of the local area.

- The application must demonstrate that negotiations are ongoing between the appropriate agency and developers regarding a site location or retention decision. A resolution of support from an appropriate unit of government is required.

- Matching funds are generally sought from the local beneficiary. Non-category A funding, including private and other public sector funding for the transportation improvement, must account for at least 20 percent of the eligible costs of the transportation improvement.

- The program should avoid subsidies for projects with a "non-basic" or service orientation that would likely be undertaken without public monies. Therefore, an eligible economic development project must target one or more of the following industries:

    - agriculture or food processing,
    - tourism,
    - forestry,

- high technology research,
- manufacturing,
- mining, or
- office centers of not less than 50,000 square feet.

Following recommendations from the Office of Economic Development, the Commission then selects projects to be funded, as well as the appropriate level of funding, and forwards this list to the Transportation Subcommittees of the Appropriations Committees of both houses of the Legislature for their review.

3. Analysis and Methodology Used for Project Evaluation

To ensure that scarce funds are effectively and equitably expended, substantial effort is made to evaluate and select projects. Criteria regarding transportation service, engineering and economic development are examined within a weighted project evaluation approach which considers the following factors:

- total cost of the project,
- requested grant monies,
- the number of jobs created and jobs preserved,
- average annual salary of jobs,
- taxes (income, property, single business),
- the cost per job,
- grant dollars per job,
- the relative impact upon the community's economic base,
- the private and public investment monies leveraged,
- transportation user costs,
- the relative transportation need (i.e., level of service (LOS), capacity, condition, safety), and
- the criticality of the project to economic development.

Since inception, demand for program funds has far exceeded TEDF's total capacity. In the implementation of the program, legislators and officials have made job creation and preservation its primary objectives. However, program officials are sensitive to the fact that limiting project selection to this objective would have the practical effect of concentrating most of the economic development funds in major population centers in southern Michigan. Therefore, several other factors are considered in order to achieve an equitable program balance. These factors include wide geographic distribution, target industries that are resource-oriented (i.e., agriculture, tourism, forestry), the potential for industry growth, local wage rates, the type of firm, and local unemployment rates. In devising a recommended package of improvements, program officials consider the relative impact upon the affected community, recognizing that relatively small expenditures of program dollars can have "critical" impacts for smaller, and more rural communities.

4. Objectives Achieved and Results After Investment

Since the program's inception, the Target Industry Development category has provided support for 310 projects in 158 communities. With over $165 million in grants approved, Michigan DOT has estimated 60,000 jobs have been created or retained with the program. Another $4.4 billion in private investment has been expended in association with the public funds.

In assessing the program's overall contribution to the economy, several other impacts to the region's economy are identified. Most notably, program advocates cite additional indirect and induced benefits to the public in form of increased purchasing power of employees (retained or new) for retail, housing, and recreation. Another factor cited is the large amount of private capital leveraged for every public dollar expended. This ratio of private and non-TEDF funds to TEDF funds has been estimated to exceed 20 by program officials.

The Target Industry Development category includes several "success" stories, where road investments have promoted economic activity, job growth and retention. These are described in the paragraphs that follow. Reflecting on the purpose of the TEDF, annual reports extol the importance of an efficient transportation network to firms' siting decisions. TEDF annual reports note how congestion negatively affects productivity, employee travel-time, fuel costs, and wear and tear on vehicles. Similarly, the Target Industry Development category is believed to reduce delays in delivery times which can impair final sales and production of finished goods particularly for firms that have adopted "just-in-time" inventory and delivery practices.

- Fayette Tubular Products

The Reading, Michigan Division of Fayette Tubular Products employed 291 persons as a supplier of air conditioning and heater hose assemblies for Chrysler and Ford. The state trunk line, M-49, in Hillsdale County was restricted to 96-inch trailers. Chrysler Corporation, as well as other suppliers, currently utilize wider, 102-inch tractor trailers. In contract negotiations with Chrysler, it became apparent that their contract would be in jeopardy without widening and resurfacing to facilitate use of larger trucks. Fayette Tubular indicated that without widening in this corridor, production would need to be relocated to its parent plant in Fayette, Ohio. Fayette Tubular pledged an increase of 33 new employees in addition to the retained jobs in return for the requisite road improvements.

Approved in February 1992, the transportation improvements included the widening of two 10-foot lanes to 11-foot with three foot paved shoulders. The stretch of M-49 from US-12 to the Fayette Tubular Products Plant was also to be resurfaced. The total estimated cost of these improvements was $1.2 million, including $900,000 from the TEDF. The TEDF cost was approximately $2,800 per job.

- American Seating Company

Located in the city of Grand Rapids, an older urban area, American Seating Company manufactures

seating products for public transportation, amusements and educational facilities as well as office furniture. The company wanted to expand its operations, but could not continue to rely upon an inadequate local traffic network. The firm had considered building a new facility outside of Michigan, but decided to reinvest $13 million in the existing plants and retain the existing 750 person work force should necessary infrastructure improvements be made.

The TEDF provided $1.1 million in funds for a $1.48 million new construction project consisting of a four lane roadway along an abandoned railroad right-of-way. The new route diverted truck traffic from residential neighborhoods and provides a safer, more direct access to the company's plants. The program cost approximately $1,500 per job.

- Crystal Mountain Resort

While many of the selected projects are intended to improve access or safety for manufacturing facilities, the target industry program has been successfully used to support smaller projects benefitting tourism, another type of "export" industry. Used in the summertime for golf and in the winter for skiing, the Crystal Mountain resort attracts approximately 164,000 visitors annually. In March 1991, $111,000 in state transportation funds were used to improve immediate access and visibility to the resort facility.

Combined with $7.6 million in private investment, the project was expected to support 42 jobs including all direct, indirect and induced impacts. As a "basic" industry capable of attracting expenditures from outside the region, project evaluation methods specifically consider tourism's indirect benefits, which would include the effect of tourism expenditures to stimulate secondary business activity such as rentals, automotive services, hotels/motels, restaurants, and crafts.

- Four Winns/Cogeneration Michigan, Inc.

Four Winns is a manufacturer of recreational motor boat cruisers that grew from 24 employees to 1,136 since 1980. Four Winns wanted to expand with a $2.2 million engineering research and development plant, adding 150 new jobs. Cogeneration Michigan, Inc. is a combined mill and electric generation operation which wanted to build a manufacturing plant nearby that was expected to create 350 jobs. All-season truck access to both sites directly from M-55 was sought which would bypass the city of Cadillac.

The proposed transportation resurfacing and widening improvements included the reconstruction of two roads from M-55 to the Vanderlaight Industrial Park. The $875,000 total cost of the improvements included $600,000 in funds from the TEDF. The program costs approximately $1,200 per job.

- Great Lakes Technology Center

The TEDF has been utilized to adapt and reconstruct traffic infrastructure in association with revitalization projects. Michigan has faced major plant closures including the old Fisher One Assembly Plant in Flint. The Great Lakes Technology Center involves the partial demolition and adaptive reuse of the vacant GM Fisher Body plant. The 1.2 million square foot Center was expected to house the Flint Automotive Division Engineering and Development Center with over 1,650 employees, mostly transfers within Michigan, as well as 345 new jobs. The remainder of the space was intended to be leased to other high-tech and office activities.

The City of Flint and Michigan DOT applied for grants through the TEDF in 1988-89. Total grants issued included $255,000 to the City of Flint to reconstruct turning lanes on Atherton street and $794,000 was awarded to Michigan DOT for widening improvements to Saginaw street from 57 to 59 feet to allow for center turn lane improvements. Both roads needed rehabilitation to accommodate truck and employee traffic that would result from the renovated Center.

The revitalized infrastructure is intended to one day encourage nearby quality development, although not presented as a justification for the transportation investment.

B. Wisconsin Program

Wisconsin has established a comparable, although lesser funded program, the Transportation Economic Assistance Program (TEA), which invests in rail and aviation as well as road improvements. The TEA similarly applies exclusionary criteria to assure that selected projects are definite, non-retail, acceptable to local government, and without competitive bidding between areas of the state. In an effort to prevent the funding of speculative projects, local government is required to sign a guarantee that the jobs will be created and that they will be subject to a grant pay-back penalty provision should the forecasted jobs not occur.

The TEA will fund up to 50 percent of the costs of a transportation improvement. Essential evaluation criteria include the cost to the state per job (it may not exceed $5,000), demonstrative transportation benefits relative to its costs, the unemployment rate in the subject county, value of increased wages, and the income and tax benefits to the state's economy. Similar to the Michigan program, benefits such as reductions in accidents, travel-time and operating costs are compared against improvement and maintenance cost. Also, indirect job, income and tax benefits are quantified utilizing a statewide regional model.

Since the program's inception in 1987, Wisconsin has spent $21.6 million on 85 projects, claiming the creation and retention of 10,600 direct jobs. Utilizing a regional econometric model, indirect job benefits of 14,600 have been estimated. The average size of grant funds has been $250,000; the average cost per direct job $2,040. A variety of rail spur, access road, signalization, and intersection improvements have been funded benefitting mostly manufacturing projects.

III. Other Longer-Term State Highway Investment with Economic Development Focus

Numerous states including Pennsylvania, Wisconsin, Minnesota and Georgia have developed or are developing highway programs that place higher priorities for investment on the basis of links in the statewide network that serve key economic activities and population centers.

A. Pennsylvania

In 1982, Pennsylvania defined a 12,000 mile Priority Commercial Network (PCN) of state highways comprised of the state's most important commercial routes for the movement of raw materials and manufacturing products. Defined in cooperation with county and regional planning agencies, Pennsylvania DOT (PaDOT) developed criteria based on truck and traffic volumes and key economic resources. Subsequently, PaDOT determined an Agri-Access Network and an Industrial-Commercial Access Network to further define the PCN as well as focus its economic development highway system more intensively on investment supportive of agribusiness and industrial parks.

B. Wisconsin -- Corridors 2020

Prepared in 1989, the Wisconsin transportation improvement program, Corridors 2020, is a plan to create a network of highways statewide to foster economic development and meet intercity mobility needs. Proposed is a 3,200 mile network comprised of two elements: a multilane backbone system and a two-lane and four-lane connector system. The backbone system is a 1,650-mile network of multilane divided highways interconnecting all regions and major population and employment centers in the state, with connectivity to the national transportation network.

The implementation schedule set forth would add 900 miles to the backbone and connectors by 2005. At the time of the plan's preparation, it was estimated that an additional $627 million would be required to complete the network as specified.

Central arguments for transportation investment set forth in the Corridors 2020 document were that transportation investment is a critical link in economic growth and that 19 other states had established similar multilane highway networks to meet economic development needs. Specifically the plan noted programs to support rural or economically depressed areas in Georgia, Kentucky, and Florida. Pennsylvania and Michigan were also singled out as examples of states with highway improvement programs sensitive to commercial and industrial access in the selection of priorities for funding. A deficiency in the states's total interstate and multilane mileage per 1,000 residents in comparison to states of comparable size and density was also cited in support of the program.

The document also concluded, that the maintenance and enhancement of a high-quality highway network were essential to attaining a more competitive position in the national and global economy. Improving market access would require better connectivity with the national multilane highway network.

Seven criteria were used in a composite fashion to select highways to be included in the backbone system:

- Capacity improvements - This category includes those highway segments with traffic volumes projected to require additional lanes by 2020.

- Efficient capacity improvements - Highway segments where the benefits of the prospective improvements would exceed the construction costs were given additional weight. The benefits included travel time savings, accident prevention, and changes in vehicle operating costs.

- Service to population centers - Included were highways interconnecting population centers with more than 50,000 people (projected to 2020).

- Service to trade centers - Those highways connecting the most significant trade centers (based on population, employment, full property valuation, retail and wholesale sales, and select service sales) became candidates for the backbone system.

- Service to manufacturing centers - Three factors were used to determine the most important manufacturing centers: number of manufacturing businesses, number of manufacturing employees, and valued-added by manufacturing.

- Service to recreation/tourism centers - Ten factors were used to determine the most important recreation/tourism centers: the number of recreation/tourism-related businesses, recreation/tourism-related employees, lodging establishments, lodging rooms, campgrounds, campsites, seasonal dwellings, private tourist and state park attractions, downhill ski runs, and cities with sports teams of statewide significance.

The connector system is intended to tie the next level of economic and tourism centers to the backbone system and similar criteria were applied in the evaluation of candidates for connector routes.

Prior to the selection of an appropriate level of highway improvements (i.e., mixture of two- or four-lane at-grade versus full freeway configuration), Wisconsin has also subjected parts of the system to more detailed cost-benefit analysis incorporating economic development objectives in the project evaluation. For example, between Green Bay and Minneapolis-St. Paul, the cost-benefit study incorporated both traditional transportation user benefits as well as other regional economic benefits.

Regional economic benefits were defined as

- business expansion,
- business attraction, and
- tourism benefits.

Business expansion included an identification of the direct user benefit savings for area businesses (i.e., operating cost savings, accident reductions, and travel-time savings). Utilizing a regional econometric model, the indirect and induced effects of business travel-time and operating cost savings were calculated. The subsequent influence of the highway investment on improving accessibility and thereby attracting new businesses and increasing tourism were also considered.

In calculating the total regional economic benefits, it was argued that the total benefits of the highway investment cannot be limited to traditional user benefits but, with due attention given to avoid double-counting, should include the role that more efficient transportation systems play in affecting business costs and therefore, the developmental conditions for business growth, tourism travel, and the attractiveness of a particular location or region from among competitor areas (Seskin, 1990: 33).

C. Minnesota - Market Artery System

Larger trucks offer larger payloads, reducing trips for shippers and providing cost savings for producer and consumers. As larger and heavier tractor semi-trailer combination trucks became more prevalent in the 1980s after passage of the Surface Transportation Assistance Act of 1982, the state of Minnesota developed a highway investment program intended to take advantage of the productivity improvements embodied in larger trucks by eliminating obstacles to their use as well as focusing public investments on improving the supporting highway infrastructure.

Minnesota sought to maintain its regional competitiveness in part by focusing its highway investment on the elimination of spring weight restrictions. In the spring, moisture in subgrade soils from thawing frost and rainfall reduces the strength and stability of highway pavements. Heavy trucks accelerate deterioration and pavement breakups. To protect the state's highways, spring weight restrictions were established (despite the impact on shippers and producers) to ensure use of smaller trucks and/or less than full loads during that period. While the maximum gross vehicle weight permitted for five-axle, tractor-semi-trailer truck combinations on state highways was 10 tons per single axle or 80,000 pounds, only about 18 percent of the state's trunk highway system was open year round to such trucks. Funding the entire cost of upgrading the network was prohibitive; eliminating restrictions without infrastructure upgrading would have been very costly and inefficient in the long-term.

In 1986, inspired in part by programs in Michigan, Iowa, and Pennsylvania, Minnesota authorized the establishment of a statewide market artery system to eliminate spring weight restrictions on highways most important to economic and shipping activities. The market artery system study was the Minnesota Department of Transportation's (MnDOT) first attempt to base statewide truck weight management decisions on economic considerations rather than solely on pavement or strength testing data.

MnDOT has since established a trunk highway market artery system representing the most important highways in the state for trucking. Market arteries connect significant centers of population and commerce utilizing the following criteria:

- population of 5,000 people,
- $50 million or more in annual wholesale and retail sales,
- 450 or more manufacturing employees,
- access to transportation terminals, and
- temporary emergency service to particular shipping or receiving points on market arteries.

MnDOT has identified about 4,800 miles of trunk highway routes that connect 149 significant centers in Minnesota representing the vast majority of the state's demographic and economic base. Highway investment priorities have been adjusted to ensure that load carrying capacity deficiencies were given special consideration.

Subsequently, Minnesota also established designated commercial access routes to connect other important commercial places to the market artery system. The commercial places are areas with one or more of the following characteristics:

- businesses with 100 or more manufacturing employees,
- major dairy processing,
- large grain elevators, or
- major timber processing sites.

MnDOT has identified nearly 2,800 miles of trunk highway commercial access routes that connect 160 commercial places to the market artery system.

A third tier of the system are local and regional access routes which serve individual land holdings such as farms, residences and pulp cutting sites. Because of limited financial resources these routes do not get as high investment priority for improvement dollars.

In addition to the productivity improvements and the efficient allocation of investment dollars, MnDOT has also justified its market artery program as a lifeline that links farms and cities and connects products with markets. The system is intended to increase the state's competitive advantage in the national and global marketplace. While program monies have only been expended recently, MnDOT has reported a substantial increase in the 10-ton per axle state mileage open year-round.

D. Georgia Road Improvement Program

1. Investment Description

The Georgia program involves the construction of a 2,600-mile 4-lane arterial road network with the objective of connecting towns of more than 5,000 residents. The Georgia Department of Transportation (GaDOT) has been spending $100 million per year since 1983 on this program. One-

third of the 2,600 miles of arterial roadway has opened to traffic. The other two-thirds are estimated to cost $2 billion and are expected to be constructed over the next 20 years.

Utilizing the rationale of economic development, GaDOT adopted this highway construction program without targeting particular companies or industries. The scale of overall program funding and investment greatly exceeds the levels of funding set aside by other states for road improvement offering targeted industry assistance as well as for multilane highway construction projects.

Historically, GaDOT has devoted most of its highway investment funds to upgrading the state's roadways and especially the Interstate Highway System. GaDOT does not allocate money for targeted transportation investment; rather, it follows a long-term economic development strategy involving the construction of more multilane highways and bringing the entire state up to standards.

Since the 1940s, GaDOT had focused its highway transportation funds more on the interstate highway system and less on the arterial roadway system. Its investment focus did not change significantly between the 1940s and early 1980s. In the early 1980s, GaDOT attempted to resolve problems associated with oversized trucks using the narrow and sometimes winding arterial roadways. GaDOT started its improvements of the arterial roadways by correcting the geometries of the roadways and adding a great deal of multilane capacity. But problems with accommodating the trucks became more pressing when an act creating a nationwide oversize network for larger trucks was approved. Many of Georgia's arterial roadways could not handle these types of oversized trucks.

2. Investment Objective and Decision-Making Process

In the 1980s, GaDOT concluded that its multi-lane arterial mileage was not as developed as that of other southeastern states while its funding base was smaller. (Floyd 1985, pp. 40-41). In terms of access, defined as being located within approximately ten miles of a four-lane divided highway connected to a system, 45 percent of Georgia communities with populations of over 2,500 were found not to have access to a four-lane highway in 1984. This was significantly higher than eight other southeastern states including Alabama (29 percent), Florida (4 percent), Kentucky (20 percent), Mississippi (35 percent), North Carolina (15 percent), South Carolina (17 percent), Tennessee (31 percent), and Virginia (3 percent). When the same communities were evaluated in terms of their access to the interstate system, however, Georgia was comparable to other southeastern states. (Floyd 1985, pp.46-47).

GaDOT also concluded that it was investing less compared to other states, the lowest level of funding in the southeast. The two main sources of funding for GaDOT were the motor fuels tax and federal-aid funds. The arterial highway construction is financed through the state's general fund with specific appropriations each year rather than through the gasoline tax, where most of the other state transportation funding is derived.

Several transportation need and economic development arguments were put forth for greater funding of multilane highway construction. One argument pointed to the need to improve Georgia's competitive position vis-a-vis other states in the southeast in terms of the percentage of four-lane primary road mileage. Another pointed out that Georgia counties along arterial corridors were found to have had higher growth levels for key economic indicators (i.e., population, employment, income and taxable sales) than noncorridor counties. Other contributions of construction that were cited were lower transportation costs for farmers, industries, and travelers; improved tourism; and greater probability of industry siting. Finally, construction would result in the removal of restrictions on truck access and thus improve the economic potential of affected regions.

Two specific arterial projects were selected by the Georgia Governor's Office for priority funding under a program titled Georgia Rebound: The first, the Fall Line Freeway, will be one of the only east-west freeways in Georgia and will connect Columbus, Macon, and Augusta, three major urban areas with populations of over 200,000. In screening alternative alignments for the Fall Line Freeway project, potential economic impacts were scrutinized. Models of accessibility and economic impact were prepared measuring each alignment's perceived impact upon future growth, labor force, tourism, fiscal resources, industrial development capacity and quality of life. The second project is U.S. Route 27 in southwest Georgia and is designed to provide a connection between Tallahassee, Florida and Columbus, Georgia. This high speed connection through the rural/agricultural area is expected to provide some economic stimulus to an area which has been in economic decline for some time.

Since the inception of the improved highways program, the funding priorities are set by the GaDOT and are subject to approval by the state Transportation Board and the Georgia General Assembly.

3. Analysis and Methodology Used for Project Evaluation Prior to Investment Decision

While the overall objective of investing in the arterial roadway system is to encourage economic development, the criteria for selecting which highway projects are funded earliest is based primarily on safety and capacity. The routes with the highest traffic demand levels and the greatest safety problems receive priority funding.

4. Project Objectives Achieved and Results After Investment

There have been a number of studies regarding the impact of transportation investment on economic development in Georgia. Three were reviewed for this case study: a report by Floyd that recommended a Developmental Highway System for Georgia, a report by Hammer, Siler, George Associates (HSGA), that considered the probable impacts of different alignments for the Fall Line Freeway, and a report by the GaDOT on the impacts of the Columbus to Brunswick highway or Corridor Z.

The Floyd study compared growth rates in various parts of the state and concluded that few Georgia communities off the Interstate are served by highways that enable them to be competitive. The

study showed that non-metropolitan counties served by multi-lane highways grew more rapidly than other non-metropolitan areas. The study also concluded that Georgia's multi-lane highway system was inadequate, compared to other states in the southeast. (Floyd 1989, pp.67-69).

The HSGA study considered accessibility, economics, alignment exposure, and employment growth of eight proposed alignments for the Fall Line Freeway. It ranked them for each of the criteria, and identified those with higher scores for each criteria and a weighted score. (Hammer, Siler, George, associates, 1985).

GaDOT studies prepared in the 1980s considered the economic impact of the Corridor "Z," a $161 million multilane highway extending from Columbus southeast to Brunswick, approximately 248 miles. Parts of Corridor Z had been under construction or been completed for more than 12 years when studied. (GaDOT Plan Development Bureau, 1989).

A survey of firms along the corridor was conducted to determine whether Corridor Z had contributed to the economic development and industrial growth of cities and counties within a twenty-five mile area surrounding the corridor. The survey indicated several automotive and retail-oriented firms as well as manufacturing operations that were influenced in their location decisions by the highway, but the main conclusion was that the highway had not been open to traffic long enough to measure any meaningful impacts. There was also a general finding that completion of Z would enhance county recruitment of companies seeking to expand in the western and southeastern portions of the state.

IV. Lessons From Case Study

The state programs described in this case study are aimed specifically at transportation investments that can improve the economic development and competitiveness of an area. To achieve its objectives a project must result in a net increase in state income. Applying this criterion, it is too early to tell whether these state programs have achieved the intended results.

However, these programs must be considered from the perspective of the overall economic development process in the US, involving competition between states, regions and local areas. States view these programs from the perspective of their need to retain and attract jobs, thereby maintaining or increasing their tax base. Based on the stated goals that program officials and legislators adopt, goals emphasizing job creation and preservation, most of the programs targeted at specific industries or intended to promote specific business location decisions, are viewed by the states as valuable in their competition with other states. Broader longer-term programs emphasizing economic development and commercial needs in prioritizing state highway investments are also viewed as important in increasing the state's competitiveness and assisting rural areas where development has lagged.

A. Near-Term Targeted Assistance to Provide Business Incentives Regarding Location Decisions

In the case of near-term targeted assistance providing incentives to businesses facing a location decision or a specific transportation problem, the following conclusions can be reached:

- The main criteria used by the states are attracting or retaining jobs and increasing or maintaining their tax base (compared to the required state investment).

- Typically, these programs involve situations where state government is putting together an incentive package to assure that a business does not move out-of-state or to attract a new business to locate in the state.

- Programs typically attempt to discourage intrastate competition and the funding of projects that only transfer jobs within the state. In many cases, this may be a difficult decision, as an industry may threaten to move out of state if it does not obtain assistance to relocate. Another difficult situation occurs when several cities within a state compete for out-of-state private investment, particularly when the selected site requires public sector transportation investment that competitor sites did not require.

- Some programs focus on attracting "basic" industries (such as manufacturing), rather than service jobs, and may assume that service industries can adequately finance their own unique transportation investment requirements. Emphasis is placed in export-producing industries in some states (including tourism), which can result in additional indirect and induced economic activity. Other programs are not targeted to specific industries.

- Typically, a private commitment is required in cases where projects may not result in jobs remaining for a sufficiently long-term to justify public expenditure. It is important to avoid a situation where a firm reconsiders its location after the state has made an investment to retain them when more favorable conditions arise at another location.

- For nearly all these projects, it is difficult to consider the equity of the investment, i.e. whether the net benefit to state taxpayers is sufficiently high relative to the public expenditure which is paid by all taxpayers. In most cases, the benefits accrue mainly to small numbers or to one individual firm, which might be profitable even without the investment.

- In some cases, the state also requires that there be a demonstrable preexisting transportation need, in addition to meeting the more specific criteria of attracting or retaining jobs.

- State programs also sometimes require that funding be balanced among diverse industries, communities and regions, and that such funds be used for revitalization as well as new development. This requirement is typically a function of practical political considerations, but it may come at the expense of meeting the economic development and/or job attraction objectives.

Despite the best efforts of program officials, and even considering the emphasis on transportation improvements intended to reduce business costs, typically it is not possible to conclude unqualifiedly whether a transportation investment in fact leads to a business location decision or job preservation that otherwise would not have occurred. To ensure nonspeculative economic development projects, considerable private funds and/or planning and time are generally required, but there is always the question of the necessity of the public sector contribution to finalize the private sector decision. Even when private businesses assert that their decision depends on the transportation infrastructure investment, there will be instances when the public monies would not have been necessary or private investment could have substituted. These investments are state economic development decisions, which should be guided by the overall state economic development strategy. In many respects, the decision is not very different than the common decision that any private business must make as to whether to reduce prices (or subsidize) an initial sale in order to get repeat business.

B. Longer-term state Highway Programs with an Economic Development Focus

Regarding long-term state highway programs aimed at transportation investment with a focus on overall regional or state economic development, the following conclusions can be reached:

- Some state highway investment programs focus on **laggard economic centers**, where it is felt the greatest economic growth potential may exist if transportation access is improved. It is generally agreed that transportation investment does not ensure economic expansion, unless other prerequisites also exist such as natural resources, competitive labor, business climate, etc.

- Other programs emphasize access to population and employment centers, seeking to ensure **connectivity** with regional and national markets, which in today's global economy can be a significant factor in attracting or retaining business. To the extent that such investments facilitate trucking productivity, improve access to raw materials, tourist destinations and other export industries, as well as increase the market reach of key industries in the state, such programs are likely to impact positively the state's economic long-term growth objectives. However, in today's environment, business location decisions are affected by many factors, so it is not possible to easily quantify such impacts.

- Some investment programs are aimed specifically at providing a statewide system of 4-lane arterials (such as Georgia), based on the assumption that multilane arterial development is related to higher density land uses and increased economic activity

levels. In fact, the economic development process also involves establishing a positive business image and climate. To the extent that the state has been perceived as having a less efficient highway system, such a program can assist state economic development efforts. However, properly designed 2-lane highways with adequate shoulders, access control, and similar design speeds, can provide as efficient transportation service as 4-lane arterials. Such trade-offs should be carefully considered in designing statewide highway programs aimed at economic expansion, since it is widely acknowledged that transportation investment alone will not satisfy the prerequisites for development (i.e. other available infrastructure, labor, education, etc.).

- Programs aimed at specific network deficiencies affecting trucking productivity, such as bridge postings, seasonal truck restrictions, network-wide or specific locations with weight and/or size restrictions that affect truck routings and productivity, are most likely to result in transportation cost reductions to businesses located in the state.

Justification for these statewide programs center on **the competitive economic development efforts of nearby states and the need to reduce transportation costs and enhance productivity**. To the extent that the state's residents are not unduly burdened by taxes vis-a-vis other states, that the state's basic transport network is underdeveloped, and that the traditional transportation benefits stemming from construction (travel-time savings, lower transport costs, accident reductions) are sufficient to justify the investments, these programs are likely to be economically attractive.

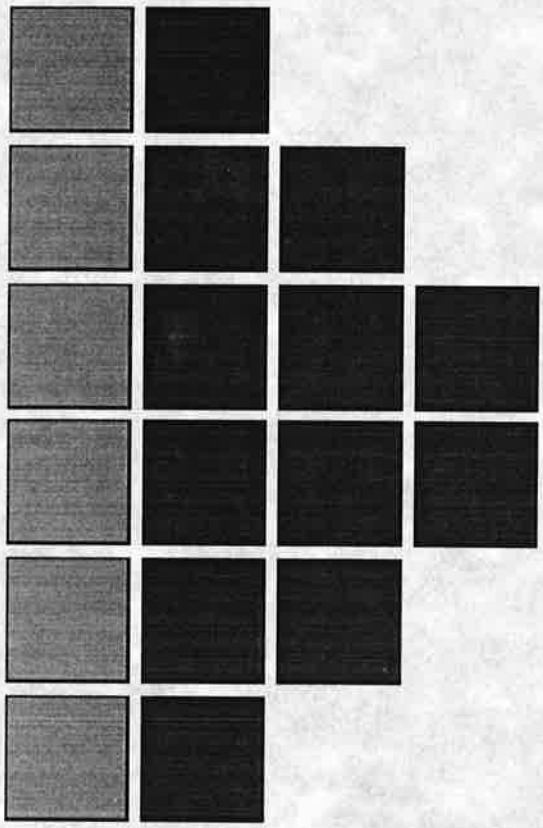
C. Overall Conclusions

There has been some criticism that state transportation programs aimed at economic expansion do not generate a net gain in income or output, but simply affect the pattern of development. The economic development or growth benefits of highway improvements in terms of increased output, income or productivity, are difficult if not impossible to measure precisely. However, **properly targeted** state highway investments to reduce transportation costs increase the productivity of firms located in an area, attract new business, and **can** be a valuable tool to increase the competitiveness of a state or local area, increasing its economic activity over the long-term.

As the individual states focus on how to attract economic development, they pay close attention to the factors that influence business location decisions, increase tourism and reduce business costs. As such, the state's are engaged in essential behavior to compete in the context of regional, national and global markets. By focusing on issues such as improved multistate connectivity and lowering business transportation costs, the state is assessing its basic industries and natural resources, seeking improved access to distant markets, and eliminating congestion and obstacles that may reduce industry competitiveness.

Other factors that will affect the competition for jobs between states and local areas and the priorities of state transportation investment in the future are the requirements of the 1990 Clean Air Act Amendments (CAAA) and the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). For many states and urban areas, economic development will remain an important objective, but it will have to be balanced against other competing objectives. While some states will continue to follow a strategy of highway capacity expansion and targeted roadway investments for improving competitiveness, other states and regions, pressed by their non-attainment status, may determine that air quality conformity with the state's Implementation Plan will have to be an equal or higher priority. This latter objective will require more attention to such approaches as highway preservation, management and maintenance to reduce congestion; identification of modal and intermodal efficiencies; demand management and land use controls.

The influence of air quality attainment status on business location decisions; transportation investment type, scale, mode, and need; and relative economic expansion potential of different regions is difficult to assess. It is likely to alter the spatial patterns of development among metropolitan regions, between urban core and suburban-rural hinterlands, and perhaps, nationally. Similarly, the new regulatory regime may impact the efficiencies of moving goods and individuals, which may affect the relative competitiveness of industries within and between regions. As these implications continue to emerge within a context of global competition, states will want to continue to explore the economic development implications of their transportation investment decisions.



Appendix F

Case Study V:

Rapid Transit Development

LOUIS BERGER INTERNATIONAL, INC.

APPENDIX F

CASE STUDY:

RAPID TRANSIT DEVELOPMENT

I. Investment Description

Historically, urban mass transit systems influenced the shape and size of large older cities. These systems made possible the high density development of urban areas like New York and Chicago. With increased reliance on automobile travel and the resultant decentralized development and suburbanization that has characterized urban growth patterns since World War II, the importance of access to urban mass transit systems has diminished as a factor influencing development and individual and business location decisions.

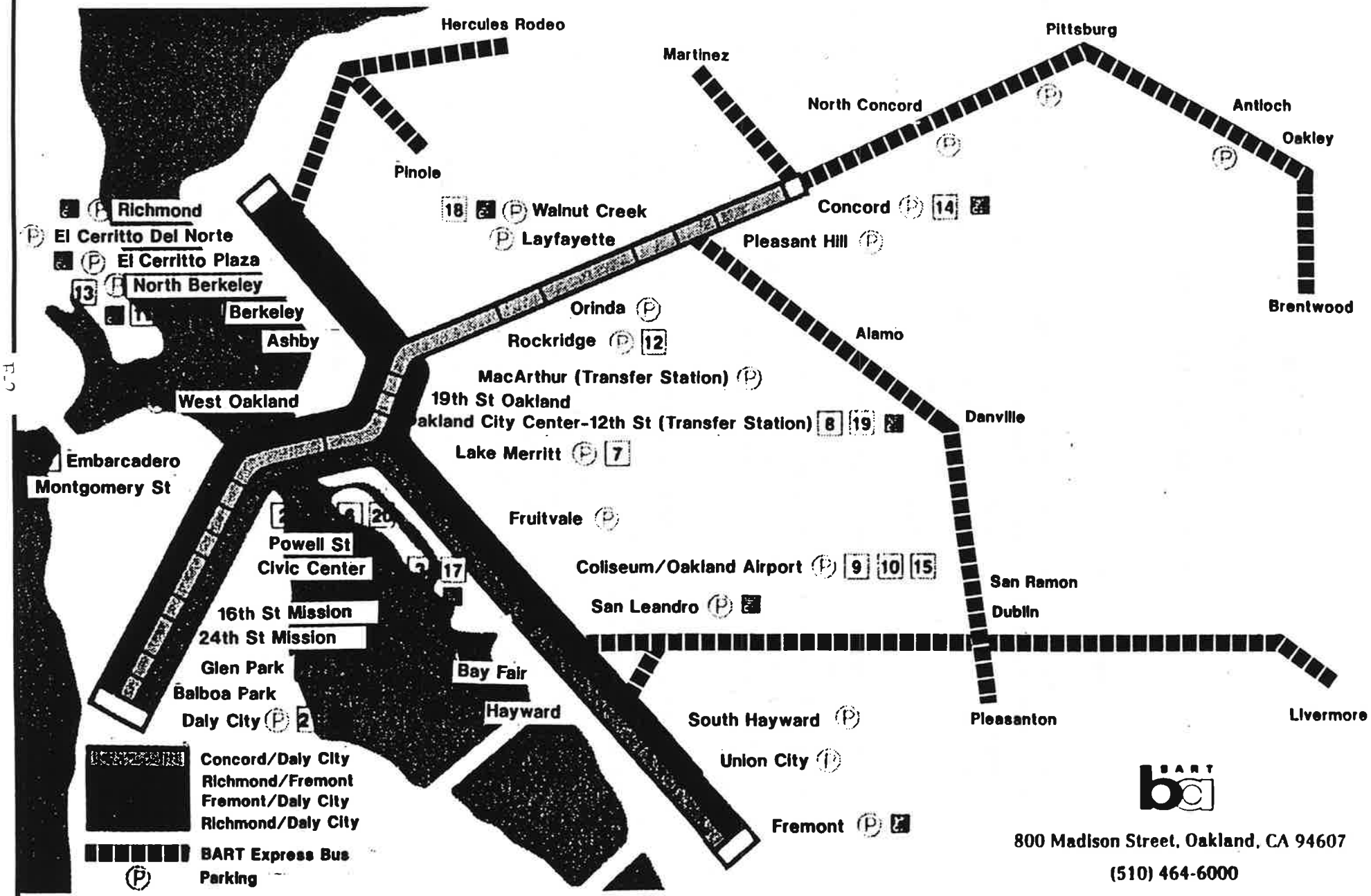
Mass transit investments today are necessary to rehabilitate and maintain the aging central areas of older cities. These systems are viewed as an essential public service. Without this service, the economies of the urban cores would function less effectively, leading to the loss of businesses and jobs. In addition, development of new mass transit systems has been pursued by many metropolitan areas with the objective of stimulating growth and channeling development along the new transit corridor.

This case study discusses the economic development impacts of four urban mass transit systems, three of which are modern (constructed within the last 20 years), and an older, established system in need of major rehabilitation. All modes of mass transit are considered, including rail (commuter trains and subways), buses, and light rail (trolleys), but the emphasis is on rail, since as the highest capacity technology, it is viewed as the mass transit system with greatest influence on development patterns and also requires a larger investment commitment. The economic development influence of the following mass transit system investments will be described:

- **BART (Bay Area Rapid Transit), San Francisco-Oakland, California.** BART is one of three rail mass transit systems in the San Francisco Bay Area (the others being Cal-Train and Santa Clara Light Rail). It serves three counties with a total population of over three million persons with 71 miles of rail, 34 stations, and 27,000 parking spaces. (See Figure F-1). Unlike most other urban mass transit systems, BART does not include buses or other modes besides rail. Planning for urban mass transit in the Bay Area began in 1949, and the BART District was organized in 1957. BART's original capital estimate, published in 1962, was $994 million (Metropolitan Transportation Commission 1979, p. 7). The system was constructed for a total of $1.6 billion between 1972 and 1977. Eighty percent of the capital funding for BART

Figure F-1

BART SYSTEM



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(510) 464-6000

came from local sources. Fare revenues cover 38 percent of the total operating cost of the system, with 90 percent of the deficit financed through local sales and property taxes.

- **MARTA (Metropolitan Atlanta Rapid Transit Authority), Atlanta, Georgia.** MARTA serves the two largest counties in the Atlanta metropolitan area with a total population of 2.8 million persons. The system currently has 38.6 miles of rail and 1500 miles of bus routes. There are 33 rail stations with 33,000 parking spaces, and 150 bus stops. (See Figure F-2.) Buses account for about 58 percent of MARTA's ridership. The first proposal for rail transit in Atlanta was developed in 1960, and MARTA was established in 1965 to be responsible for existing bus transit and the planned rail system. Construction of MARTA's rail system began in 1975. The planned system includes a total of 60 miles and 45 stations. Most of the additional rail mileage has been approved for funding by the Federal Transit Administration (FTA). The total capital cost of the MARTA rail system through mid-1993 has been $2.7 billion, of which 47 percent was funded locally. Passenger revenues cover slightly over 36 percent of the operating budget. Local sales and use taxes pay for close to 90 percent of the operating loss.

- **SEPTA (Southeastern Pennsylvania Transportation Authority), Philadelphia, Pennsylvania.** SEPTA serves four counties and the City of Philadelphia with five modes of mass transportation on a total of more than 1,800 miles of routes. The service area population is more than 3.7 million persons. The modes include commuter rail, subway/elevated rail, light rail/streetcar, trackless trolley, and bus. Bus routes account for over three fourths of the route miles, and 50.8 percent of the ridership. Rapid rail transit (commuter trains and subways) include 307 route miles and 216 stations serving 34.4 percent of the ridership. (See Figure F-3.) Ridership has dropped on all modes over the past five years by close to 15 percent, a decline attributed mostly to problems with the Philadelphia regional economy. Mass transit in Philadelphia began in 1831 with stage coaches, and evolved through horse-drawn and steam trolleys before electric trolleys, subways, and buses were introduced in the early 1900s. The system has been extensive for many years, with 110 miles of rail operating since 1864 and 678 miles of rail operating as of 1911. SEPTA was founded in 1968 to assume responsibility for the entire system. SEPTA has launched into a twelve-year rebuilding program, priced at $4.5 billion. Operating revenues on the system are derived from passenger revenues (about 53.5 percent), state subsidy (one-third), and federal (4.5%) and local (9%) subsidies.

- **WMATA (Washington Metropolitan Area Transit Authority), Washington, DC.** WMATA is the agency responsible for the Washington "Metro" rail mass transit system. The system serves the District of Columbia and the seven surrounding suburban jurisdictions in Maryland and Virginia, which have a total population of 3.2

Figure F-2
MARTA RAIL SYSTEM

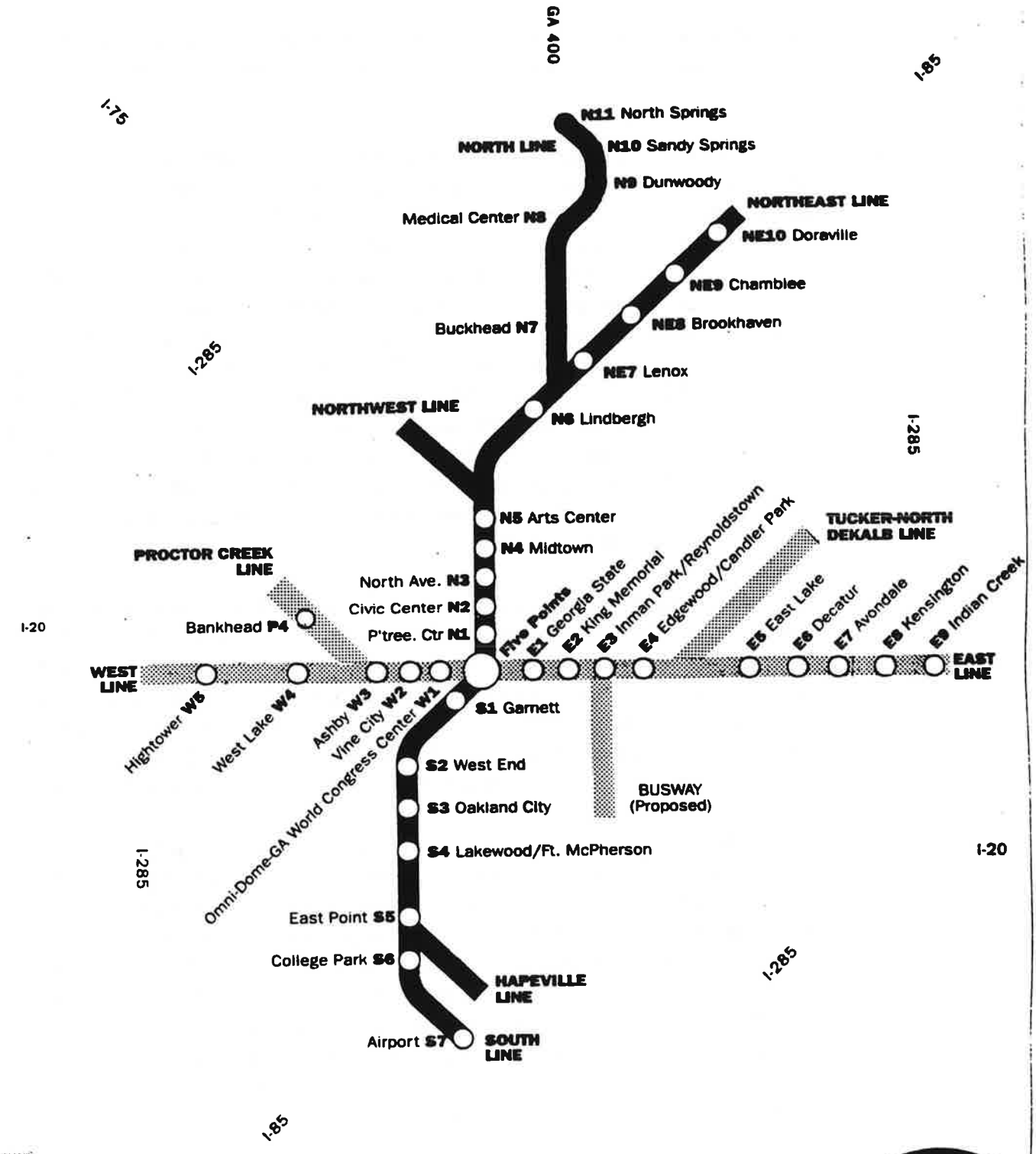
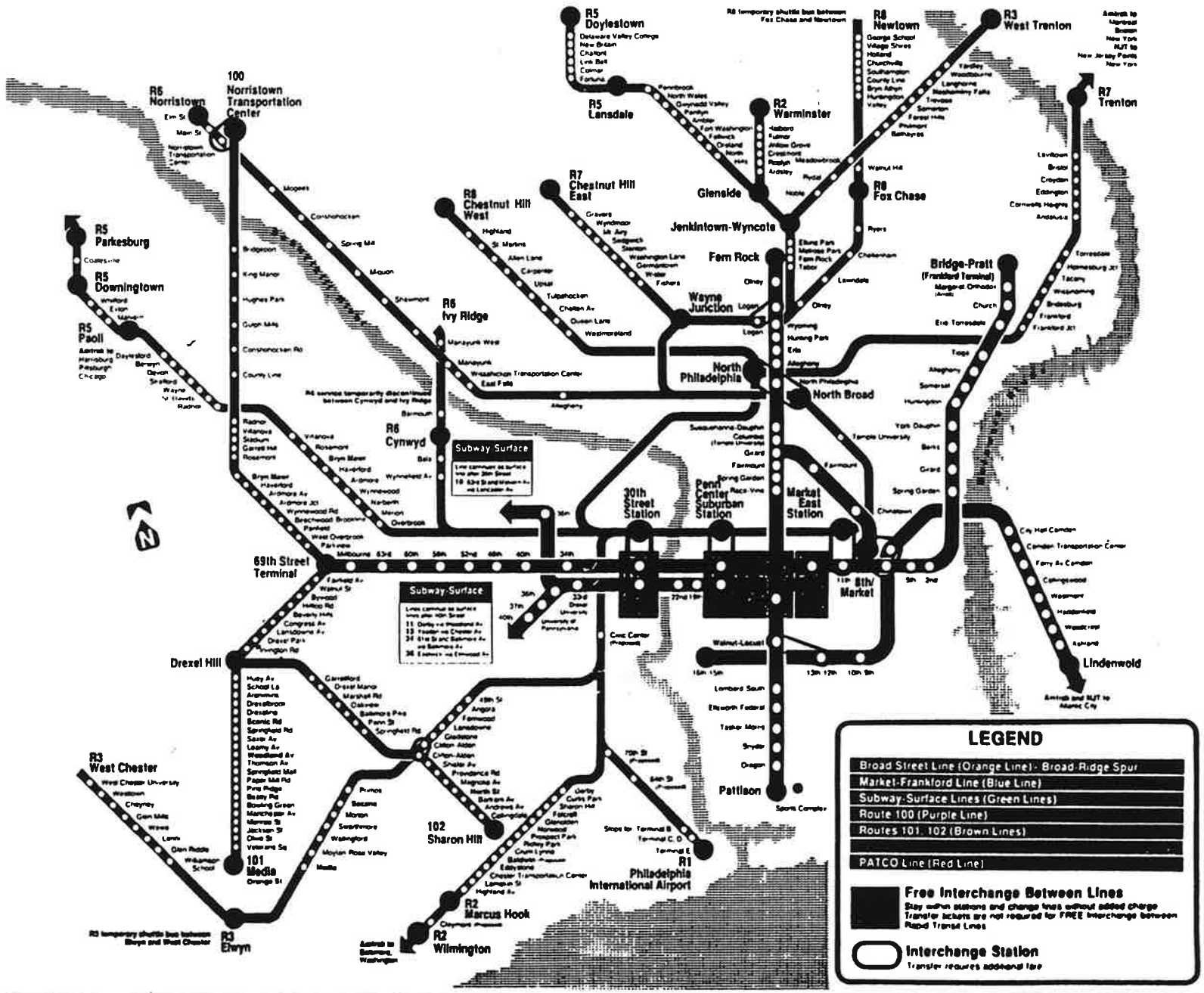


Figure F-3
SEPTA RAIL SYSTEM



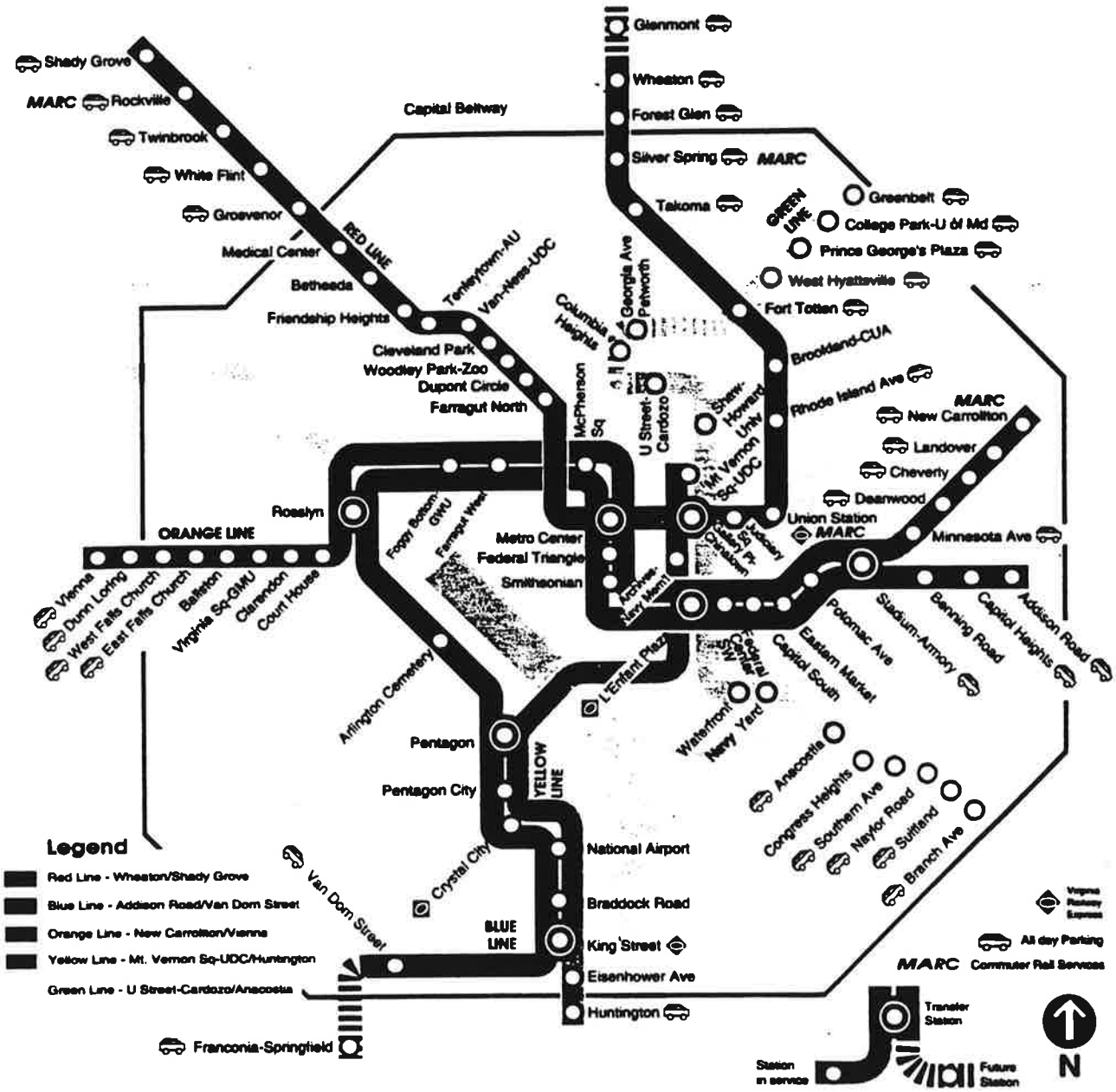
million people. WMATA includes the area's largest bus system as well. The rail system currently has 89 miles with 74 stations, out of a planned 103 miles and 83 stations. (See Figure F-4.) The WMATA bus system ("Metrobus") serves 13,000 stops with 1,467 buses. Ridership is about 60 percent rail and 40 percent bus. The first formal proposal for rail transit in the Washington area appeared in 1959, and the National Capital Transportation Agency was created in 1960 to plan the system. WMATA succeeded this agency in 1967. In 1973, WMATA purchased four private bus transportation companies for a total of $53.4 million. A capital cost of $2.42 billion was projected for the Metro (Deiter 1985, p. 29). Construction on the rail system started in 1969, with the first segment opening in 1976. By 1980, 37 miles of line were open. The total capital investment in the Metro to date has been $7.5 billion. Another $2 billion is projected before system completion in 2001. Nearly 75% of the capital investment is from the federal government. Passenger revenue accounts for 49 percent of operating costs on the combined bus-rail system, while on the rail system alone, passenger revenues cover 67% of operating expenses. Federal subsidies for operation are small, less than 3 percent of the total system.

There are some important parallels among the investments in the modern systems. First, rail transit has become extremely expensive. The capital investment for the Washington Metro and MARTA's rail system totals almost $70 million per mile. Secondly, each of the modern rail systems were constructed in metropolitan areas whose populations are now close to or greater than three million persons. This suggests that an investment of this magnitude can only be undertaken by a few large, densely populated metropolitan areas. Third, none of the modern systems cover more than half of its operating expenses with passenger revenues. It is critical to note, however, that cost recovery factors for these rail systems may be higher than stated figures because bus and rail financial figures may be combined. For example, WMATA's rail passenger fare revenues cover 67 percent of its operating cost while its bus system covers only 34 percent. Total system costs, rail and bus combined, is 54%. Moreover, total revenues from advertising and joint development ventures can increase coverage of operating expenses. In WMATA's case, these revenues plus passenger revenues cover 72 percent of rail operating costs. Finally, the modern systems have been implemented with attention to intermodal transfer. BART, MARTA and WMATA have each constructed large numbers of "Park 'N' Ride" facilities. WMATA and MARTA are both involved in continuing efforts to improve bus route connections with rail stations. MARTA offers a free transfer for rides linking rail and bus.

Older mass transit systems such as SEPTA face a different set of investment needs revolving primarily around facility obsolescence, rising maintenance costs, and declining ridership. However, in spite of fierce debate, the older systems remain an important service to the region's population and businesses, and have ambitious plans for service restoration and expansion.

Figure F-4

WMATA METRO RAIL SYSTEM



II. Investment Objective and Decision-Making Process

Besides the transportation objective of efficiently moving large numbers of people and reducing congestion, new urban mass transit system investments are generally pursued to achieve the following three land and economic development objectives (Neuwirth, 1990: 143):

- Sustain and maintain dense development and growth in the downtown core,
- Manage the shape of land use development, and
- Create and stimulate economic growth and employment opportunities.

Mass transit systems have influenced urban land form, and rail transit is becoming a force in shaping suburban development as newer systems serve emerging "edge cities" developing on the periphery of older downtowns. An example is Silver Springs, Maryland which is served by WMATA.

Typical of the objectives of investment in a new mass transit system are the basic goals of BART:

> "[BART] was to be automated, fast, comfortable and attractive; a modern, space-age version of the rail transit systems in the leading cities of the world, and an appropriate symbol of the pride with which San Francisco Bay Area residents regard their metropolitan area. BART was expected to increase capacities in the major travel corridors; to encourage a city-centered type of growth; to preserve and enhance the vitality of the major cities and urban subcenters by forestalling an increase in traffic congestion; and to attract an increasing share of the nation's economic growth to the region (MTC 1979, p. 2)."

In San Francisco, Atlanta, and Washington, the need to develop and/or maintain a "world-class" image has been mentioned repeatedly in justifying rail mass transit investments. This goal is related to the three objectives identified above, but also adds a broader goal related to competitiveness with other cities and countries. In the words of Lyndon Johnson, the Washington Metro "should be designed so as to set an example for the nation, and to take its place among the most attractive in the world."[1] Rail mass transit then is intended to achieve broader goals in addition to creating jobs, higher incomes, and tax revenues.

City planning issues have been an integral part of the decision-making process for rail transit systems. City planners have long argued for urban core investment, often citing examples of older European cities who have maintained their vibrancy with high densities and a sensitivity to a

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[1] See "**America's Subway - Transit Design for the Ages,**" in M: The Magazine of Metro, Vol 1, No 3, Spring 1992, p. 18.

"human" scale. Achieving such objectives in twentieth-century American cities, surrounded by suburbanization and an automobile-oriented culture, is much more difficult.

For the modern mass transit systems discussed in this case study, construction of rail mass transit was also a region-building exercise with long-term implications for a region's economic health and status. Metropolitan areas which invested in mass transit perceived themselves as taking significant strides toward their place among a hierarchy of national and international cities. Clearly, economic expansion is an implied goal of rail mass transit investment; growth and development will come from becoming a "world class" city. MARTA is currently taking some of the credit for attracting the 1996 Olympic Games, which many believe will be accompanied by significant short- and long-term economic benefits. From this perspective, rail mass transit is typically intended to be an investment that consolidates a region's identity as a central place, which is viewed as a marketable quality. One local leader notes that "The Region's transportation system is critical to its global competitiveness (ARC 1993, p. 10)."

BART's original plan included a straightforward objective: the rapid transportation of people into downtown San Francisco. BART's routes were selected to accomplish this objective with a minimum of disruption, mostly within or next to existing highway or railroad rights-of-way (MTC 1979, p. 24). The needs of the downtown area therefore took precedence, a decision which would be of great benefit in developing San Francisco, but would provide little more in the near term than rapid train service to many other areas, and fewer development opportunities outside the city that might otherwise be the case (MTC 1979).

Rehabilitation and preservation of older mass transit systems is typically based on different objectives, which are exemplified by the SEPTA situation. Mass transit in Philadelphia has been in existence for over 160 years. During that time, technological change has made many of its facilities obsolete. The cost of upgrading the system, estimated at $4.5 billion, is massive. The SEPTA case is a good illustration of how dependent a region can become on mass transit. SEPTA estimates that 70 percent of all work trips to downtown Philadelphia are made on mass transit. Without mass transit service, the region would face significant negative economic impacts, and economic dislocation would be severe. This represents a powerful argument in favor of maintaining and upgrading an existing mass transit system to protect jobs and an area's economic health, just as it is important to preserve and maintain an area's highway, airport or other infrastructure.

Recently, some areas have articulated an additional objective of mass transit investment also closely related to land development and urban form, i.e. the improvement of air quality in nonattainment areas. With the passage of the Clean Air Act Amendments (CAAA) of 1990, the ability of mass transit to reduce automobile usage and assist in the management of congestion has become a key concern for many metropolitan areas that have to demonstrate conformity with CAAA requirements. Some investments for new mass transit systems, for example the Los Angeles system, rely heavily on achieving this objective.

III. Analysis and Methodology Used for Project Evaluation Prior to Investment Decision

Typically, the methodology used for project evaluation of mass transit systems has been based on a financial feasibility analysis and related ridership estimates. For example, the 1968 plan for the Washington Metro estimated that the system would be carrying 287 million passengers annually by 1990, and that operating revenues would amount to $77 million, while operating expenses and depreciation would be about $37 million, leaving net operating proceeds of about $40 million (Deiter 1985, p. 29). All of these projections have proven to be overly optimistic, and the system has required increasing operating subsidies. However, as noted in the previous section, financial return was not a major goal of the investment. Metrorail ridership has increased steadily, reaching an average of about 500,000 daily riders in 1990, or about half of the projected ridership, although portions of the system remain incomplete.

Besides financial feasibility, Federal assistance for mass transit systems has been based on a requirement for an alternatives analysis or cost-effectiveness analysis of various options to identify the option that will carry the most passengers per investment dollar. Such methodologies do consider potential development along the rapid transit line, by considering the impact of new development on ridership. Generally, the modeling process used to estimate urban travel demand considers the impact of transportation system alternatives on land development. In some cases, rapid transit routes have also been chosen to make possible joint-development opportunities. WMATA, for example, has a very successful joint development program.

Given the complexity of the urban development process, the extent to which mass transit investment can positively contribute to a region's overall economic expansion is difficult to isolate definitively. Typically, no analyses of an area's economic competitive advantage or of economic benefits compared to investment are carried out.

The social benefits, or positive "externalities," of select features of mass transit (e.g., city image-building, traffic congestion avoidance, or service to disadvantaged populations) are not easy to measure. Therefore, quantitative analyses are usually in the form of capital investment, ridership or revenue projections, and these other factors are discussed qualitatively, or simplified estimates of effects are included in planning documents.

In the case of investments to rehabilitate an existing transit system, SEPTA presents an example of the type of analysis that has been used to estimate the economic impacts of various alternatives. An existing, functioning mass transit system is an essential part of the economic fabric of a city, and disruption or elimination of service significantly affects economic activity. In the case of older existing systems, such as SEPTA, the debate over the level of investment spending revolves around the cost of rehabilitation versus the economic impacts of terminating service. In 1991, the Delaware Valley Regional Planning Commission (DVRPC) undertook a study of "The Economic Impacts of SEPTA on the Regional and State Economy".

The focus of this effort was to identify the economic consequences of four basic scenarios (DVRPC, 1991):

- rehabilitation of SEPTA (at a cost of $4.5 billion);
- 50 percent reduction of SEPTA services, with rehabilitation of the remainder of the system;
- A gradual shutdown of all SEPTA services within ten years; and,
- An immediate and permanent shutdown of all SEPTA services.

The study evaluated the impacts of each alternative on transportation cost, traffic, loss of mobility, and the regional economy. The analysis included assessments of road capacity and service levels, impacts on transportation costs, economic impact modeling, fiscal impact modeling, estimates of energy consumption and air pollution impacts, as well as interviews with businesses, economic development professionals, and representatives of affected population groups. The overall cost of complete system rehabilitation was judged to be the least expensive alternative by a significant margin, because of the dislocations that would result from changes in transportation patterns as a result of any of the other options.

Based on an analysis to the year 2020, annualized costs of the alternatives as follows were:

- $450 million to completely rehabilitate the system,
- $1.2 billion to carry on 50 percent of the rehabilitation,
- $3.5 billion for gradual shutdown of service; and
- $4 billion for immediate shutdown.

The projected costs were divided into seven categories, each of which was quantified for the metropolitan region and the state as a whole. They are listed below (DVRPC 1991, p. 6):

- increased cost of doing business,
- reduced business access to labor markets,
- increased cost of living,
- reduced "quality of life",
- loss of SEPTA jobs,
- shifts in personal spending patterns, and
- reduced attraction of visitors.

Reduced business sales would be the major component of impacts, accounting for close to half the additional costs of the nonrehabilitation alternatives. It was projected that the five-county, southeastern Pennsylvania area could lose 170,000 jobs and 313,000 population (about 10 percent of the present total) by 2020 with the immediate shutdown alternative. Combined local and state revenues were forecast to suffer average annual losses of $632 million with that alternative. The qualitative consequences would include reduced "amenity levels", making the area less attractive for

banking and insurance offices, the anchors of the regional service economy. Reduced access to clerical labor would have the same effect. The impacts would be felt over the entire state of Pennsylvania.

A benefit-cost analysis was also carried out as part of this study. It showed that the full rehabilitation alternative would return three dollars to the region and state for every dollar spent on SEPTA in transportation benefits alone. In terms of total economic impact, the return would be 9 to 1 (DVRPC 1991, p. 15).

IV. Project Objectives Achieved and Results After Investment

Various "before and after" studies have been conducted to consider the actual results achieved after a mass transit investment. System-wide studies of the economic impacts of BART were carried out in 1977, and WMATA was studied in the late 1970s and early 1980s. Although these studies were comprehensive, the systems had not yet reached maturity. MARTA was the subject of a 1988 case study financed by UMTA. This study was never published, but a summary was written by Neuwirth (1990). The 1991 SEPTA study was exhaustive, but only dealt with estimates of future impacts. Although the FTA is in the process of starting impact studies on BART, MARTA and WMATA, these studies have not been completed. In addition, there have been many local before and after studies of land development impacts around transit stations. These impacts have been significant.

Neuwirth, after having conducted case studies on several mass transit systems, concluded that transit systems have the following common elements in their impacts on economic development (1990, p. 149):

- Transit is only one of several factors which must be in place to create and direct new development projects. "However, when all factors are in place, transit provides an important support for allowing large and more dense development and economic activity to occur...downtown."

- Transit provides crucial access into highly congested downtown cores, especially in older and more densely developed cities. "Highways alone cannot provide sufficient levels of free-flowing traffic to support further economic development and expansion in many downtown areas."

- "Transit contributes to the quality of life in urban areas, which makes a city more attractive for economic development."

- Transit plays an important role in providing access to employment for transit-dependent populations such as the elderly, the handicapped, and low-income residents.

All of these impacts relate primarily to social and land development goals, with economic development being secondary. Although economic expansion is not explicitly included, the implicit assumption is that economic benefits flow from achievement of the social and development objectives.

Regarding financial performance, the fact that rail mass transit systems require substantial fare-box subsidies contributes to a perception that the systems' benefits are predominantly noneconomic. However, simply because a subsidy is required for the system's operations does not in itself reveal that the capital investment did not contribute to an economic expansion of the region, nor that it was an inefficient investment for the region. It is simply a measurable indicator of the system's financial performance, not its economic or social importance. Moreover, a positive financial return is not a reason that is usually cited to justify investing in a transit system. Low-cost recovery for transit may reflect the high value that the community places on its transit investment as an essential community service by making generous subsidies available so fares can be low.

The MARTA System

Neuwirth (1990) found that widespread regional growth had not directly been stimulated by MARTA. This may have been due largely to the recession of the early 1980s and a decrease of federal funding for urban improvement projects other than the rail system itself, and private investors' lack of interest in developing sites near stations. As of 1988, land acreage near MARTA stations remained to be developed. However, downtown Atlanta had, as a result of the development boom of the late 1980s, experienced a scale of development and revitalization which fulfilled many of the early desires for the MARTA system. Most importantly, interviews conducted during the course of the MARTA study suggested that people perceived MARTA to be an important factor in locational decisions in the Atlanta region, especially with regard to regional headquarters of major corporations and operations centers dependent on large numbers of clerical and technical labor. Many felt that MARTA has contributed to Atlanta's international image and competitive edge, and is a crucial part of the Atlanta economy (Neuwirth 1990).

MARTA has also had an impact on peripheral office development, as evidenced by a heavy reverse commuting pattern on the system (Pachucki 1993). MARTA promotional literature gives the system credit for directly influencing the development of over 15.5 million square feet of office space, 7,000 hotel rooms, and 2,000 residential units. According to this literature, several major developments have taken place on land leased by MARTA to private interests, and local and state governments have built or are building substantial projects in cooperation with MARTA. As suggested earlier, Atlanta's success in attracting the 1996 Olympic Games is regarded by some as a demonstration of MARTA's contribution to Atlanta's "world-class" status.

The BART System

The experience of the BART rail transit system is similar to MARTA's. The 1977 BART Impact

Program was a comprehensive assessment from many points of view, including transportation and travel, environmental, land use, urban development, and economics. One element of the study focused on the impact of BART on the competitive advantage and efficiency of Bay Area business operations. This element was structured to specifically test the assertion that BART would lead to a number of regional economic benefits, including economic efficiency, availability of workers, and attraction of a larger share of the nation's future growth (MTC 1977).

A statistical test compared shifts in employment in the BART service area between 1965 and 1973 with those across the entire nation, and showed that five industry groups grew at a statistically significantly higher rate in the Bay Area. These five industries (services, finance, manufacturing, central office, and government) were then studied in depth by interviewing numerous knowledgeable individuals in each. The overall conclusion was that BART had been responsible for little or none of the positive growth shifts. According to the study, there "is no evidence...that any industry moved to the Bay Area because BART or BART's service influenced the corporate decision-making process. There is no evidence of even the perception that BART improved the economic viability of the region, or the efficiency with which the region's resources could be utilized (MTC 1977). Of course, it must be noted that this study took place at about the same time as the first phase of BART was completed, and night and weekend service had not yet been implemented. It must also be noted that interview studies of this type have been questioned as to their usefulness in accurately eliciting site-selection decision factors (Deakin 1993).

The BART Impact Program did note that even as early as 1977 there was evidence that BART was influencing Bay Area land use development patterns. It suggested that BART had probably not affected the overall pace of urban development, but that it seemed to have influenced the location of ongoing development, especially around stations in San Francisco. BART was, according to knowledgeable local observers, one of several direct influences in the location of about 10 percent of San Francisco's new office space (MTC 1979, p. 13). BART had influence on some residential development, although the expected clusters of high-density residential development around BART stations had not in general materialized by 1977 (MTC 1979, p. 14). Nor had there been any discernible change in rents or property values related to BART (MTC 1979 p. 15) although, again, the system was not fully implemented at the time of the study. However, it has been pointed out that because BART was intended primarily to facilitate travel from outlying suburbs to downtown areas, it had been designed to do so with the least impact, routed along highways or rail rights-of-way, rather than being located to stimulate development in suburban areas or residential development in the city. Also, no special effort was made to coordinate the planning of the BART system with that of the region's municipalities (MTC 1979, p. 2). BART's construction in fact had the effect of disrupting several older residential areas and reducing their viability (Deakin 1993).

There is some recent evidence that high-density housing development around BART stations might now be occurring. Such housing, along with small shops, is being built to tie into eight BART stations, and is planned for nine more. This development is a result of a lack of affordable housing in the region, with purchasers in search of affordable dwellings buying homes in higher-density, less

expensive neighborhoods (Bernick 1993, p. 38). This trend was in fact predicted by the BART Impact Project (MTC 1979, p. 16). Finally, preliminary findings of recent studies suggest that housing within walking distance of BART stations may actually enjoy a price premium (Deakin 1993).

The WMATA System

President Johnson's original goal for the Washington Metro, that it "take its place among the most attractive in the world", has, by all accounts, been met. A 1985 study by Peat, Marwick, Mitchell & Company (PMM) analyzed the economic impacts for the Virginia portion of the system. The study posed the essential question: Would the development have occurred anyway? (PMM 1985, p. 2). To address this issue, Peat Marwick studied several areas of development in the vicinity of Metro stations, and compared their pace and magnitude in the pre-Metro period (1960-1979) with the post-Metro period (1980-1995). In their assessment, there is little doubt that development has picked up considerably in the post-Metro period, and will continue to do so. The Peat Marwick study concludes that substantial development was stimulated in the vicinity of Metro stations. They cite statements from several real estate developers whose decisions were linked to the Metro.

One of the important reasons for the land development near Metro Stations was articulated by a development practitioner, Jeffrey H. Parker, who stated at a 1990 FHWA/TRB conference, "[WMATA]...has one of the most successful joint development programs in the United States." It has entered into land leases with developers for air rights and other joint development at various stations, producing joint development revenues of about $5 million a year. Its joint development activities have yielded increased ridership, jobs, high density land development, and tax revenues (Parker 1991, p. 56).

Similarly, the conclusion of the Peat Marwick study states, "The presence of Metrorail service in Virginia has caused the refocusing of metropolitan economic growth forces. Rather than having high density development confined to downtown Washington, this type of development is attracted to Virginia station sites" (PMM 1985). However, in making this point, Peat Marwick suggests that the development in Virginia was reallocation of land uses at the expense of downtown Washington, and did not necessarily represent an economic benefit to the overall region.

System Rehabilitation

The results of mass transit system rehabilitation, as is taking place at SEPTA, need not be solely aimed at avoiding economic dislocation. As demonstrated in New York City, it can also be a powerful positive influence if planned and coordinated properly with private interests. New York has invested more than $12 billion in reconstructing its subway system over the past 12 years. By using zoning incentives and other planning tools, the City's program had as of 1990 generated about $120 million in privately funded station improvements, in spite of extremely high land costs and one of the most arduous land use review processes in the nation. New York's success in joint

development has also been due in part to the availability of funding from local, state and federal sources, which made it possible for credible system-wide upgrading to occur (Parker 1991, p. 57).

Other Rail Transit Objectives

Air quality goals of mass transit have attained increasing prominence since 1990, and have always been implicit in land use goals involving reduced use of automobiles. There has not always been general agreement that air quality improvements will automatically result from mass transit investment. The BART Impact Project dealt with the subject in 1977, concluding that BART would not make a significant contribution to pollution abatement relative to the contribution of controls on industrial and automobile emissions. The study asserted that even a doubling of BART ridership would probably not have a major air quality impact (MTC, p. 11).

As the cost of auto purchase and operation rises due to air quality control measures, and as traffic congestion increases, mass transit may become an increasingly attractive option for commuters and others, leading to some modal shift increases in ridership. MARTA has, in its recent promotional literature, made special mention of air quality benefits, asserting that each trip on rapid transit results in 60 to 90 percent less contaminant emissions than a comparable trip by car (MARTA). A recent survey in Atlanta indicated that over three quarters of the metropolitan area's residents were willing to drive less and use mass transit more to reduce air pollution (ARC, p. 13).

There is no doubt that the Clean Air Act Amendments (CAAA) of 1990, with their contemplated shifts in transportation investment priorities in nonattainment areas, will have an economic impact on the national economy. Mass transit is considered to be an important component of congestion management . Under rules promulgated to implement the CAAA, employee trip reduction programs to encourage commuters to use mass transit are being drawn up. However, there is as yet no agreement on what the precise effects of CAAA on transit will be. Some argue, for example, that other congestion management measures, such as reduced work weeks, will actually reduce transit ridership.

If increased usage of mass transit is sufficient to reduce traffic congestion on urban highways, it can be argued that there will be economic benefits. A recent FHWA study of linkages between transportation investments and productivity indicates that there is concern among industrial logistics executives that urban congestion will have an increasingly negative impact on trucking costs. A consensus estimate among these executives suggests that trucking costs have increased already by 15 to 20 percent because of congestion problems, and that these costs could double over the next five years. (FHWA 1994, p. 81)

V. Lessons From Case Study

Mass transit systems in major US metropolitan areas have influenced the location of development. However, it is difficult to pinpoint the overall economic expansion impacts of the systems. The

question of "Would the development have occurred anyway?" has not yet been satisfactorily answered. Each of the three metropolitan areas which built rail mass transit systems in the last 20 years were growing rapidly when the systems were started, and have continued to grow. The economic development process is so complex, that it is not easy to isolate the unique contribution of mass transit; therefore, the specific consequences of an investment in mass transit cannot be accurately measured in terms of employment created and income generated.

However, several general observations can be made about the linkages between mass transit investment and economic change:

- Mass transit systems have resulted in high density development around stations and have been a major factor in maintaining vibrant urban economies in large US cities.
- It is not possible to conclude that metropolitan areas derive greater economic benefit and competitive advantage as a whole, as opposed to a transfer from one part of the area to another.
- Mass transit investment improves access to downtown areas, and makes these areas more attractive as business locations for regional headquarters, operations or central offices, financial institutions, major government agencies, and regional or national headquarters.
- Older mass transit systems are an essential component of the urban economy and their shutdown would result in significant economic dislocation.
- Providing transportation to inner city residents helps them gain access to jobs.
- Mass transit systems increase the locational advantage of suburban sites for clerical and labor intensive office operations.
- The tourism industry can be a beneficiary of mass transit investment if attractions are located close to transit stops and there is convenient access from hotels, rail and airport facilities. This has been the experience of Washington and Atlanta.

As stated earlier, the goals of mass transit are more specifically oriented toward noneconomic land use, urban policy and social objectives. Beyond the impact on economic expansion, the objectives of mass transit investment are intended to direct urban growth patterns, in the same way as highways. The experience of BART and WMATA, and, to a lesser extent, MARTA, suggest that mass transit investment can result in higher density and growth in accordance with planning objectives. Development equaling or exceeding expectations has occurred in downtown San Francisco and in the vicinity of Washington Metro stations. One clear lesson from their experiences

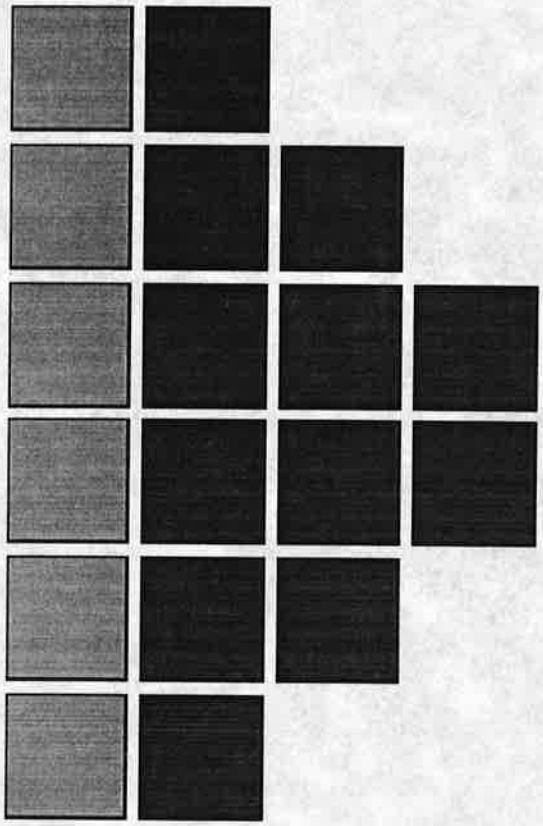
is that the land development structuring impacts of rail mass transit are very much affected by planning and coordination between rail transit systems and private developers.

In the Washington area, this type of planning occurred to a large degree across the entire Metro system, and the results were felt at suburban as well as downtown locations. MARTA and BART were less successful in stimulating development at suburban locations; in each case, the lack of coordinated land use and public investment planning was cited as a key reason. However, transit is only one of several factors affecting development; most or all of those factors must be present, or transit will not make a difference in development.

Mass transit has been shown to have an impact on urban land use patterns. How important is land use structure to overall economic expansion? Perhaps the only way to answer this question in the context of mass transit is with the examples discussed in this case study: the San Francisco, Atlanta, and Washington metropolitan areas have strong, diverse economies which continue to expand and are viewed as desirable in spite of problems with crime and recession. The "world-class" image sought by mass transit advocates is clearly recognizable in those cities. In that sense, then, mass transit can be presented as a good investment. The fact that these metropolitan areas developed rail mass transit, in spite of the expense, effort, and time required, is by itself a statement of the systems' central importance.

Even when a system has aged and becomes obsolete and expensive to maintain, as with SEPTA, it is still crucial to the urban and economic structure of a region. Just as is the case with any major transportation investment, once a rail mass transit system is in place, it must be maintained and preserved, since it becomes part of the economic engine driving the region. The investment requirement for maintenance and upgrading may be large, but it is as necessary as investing in new facilities.

In the final analysis, rapid transit is considered crucial, to the continued success of the metropolitan areas which have invested in them, by the businesses and residents of those areas. While rail transit systems draw criticism and scrutiny for farebox shortfalls, rising operating costs and large capital and maintenance expenses, modern rail transit systems are generally regarded locally as successful investments which have benefited the cities involved. A good deal of pride is expressed in each of these systems, and they are broadly viewed by the residents and the business community as a competitive advantage and a significant asset in a metropolitan area's overall image.



Appendix G

Case Study VI:

Impact of I-70 on Colorado Tourism

LOUIS BERGER INTERNATIONAL, INC.

APPENDIX G

CASE STUDY:

IMPACT OF I-70 ON COLORADO TOURISM

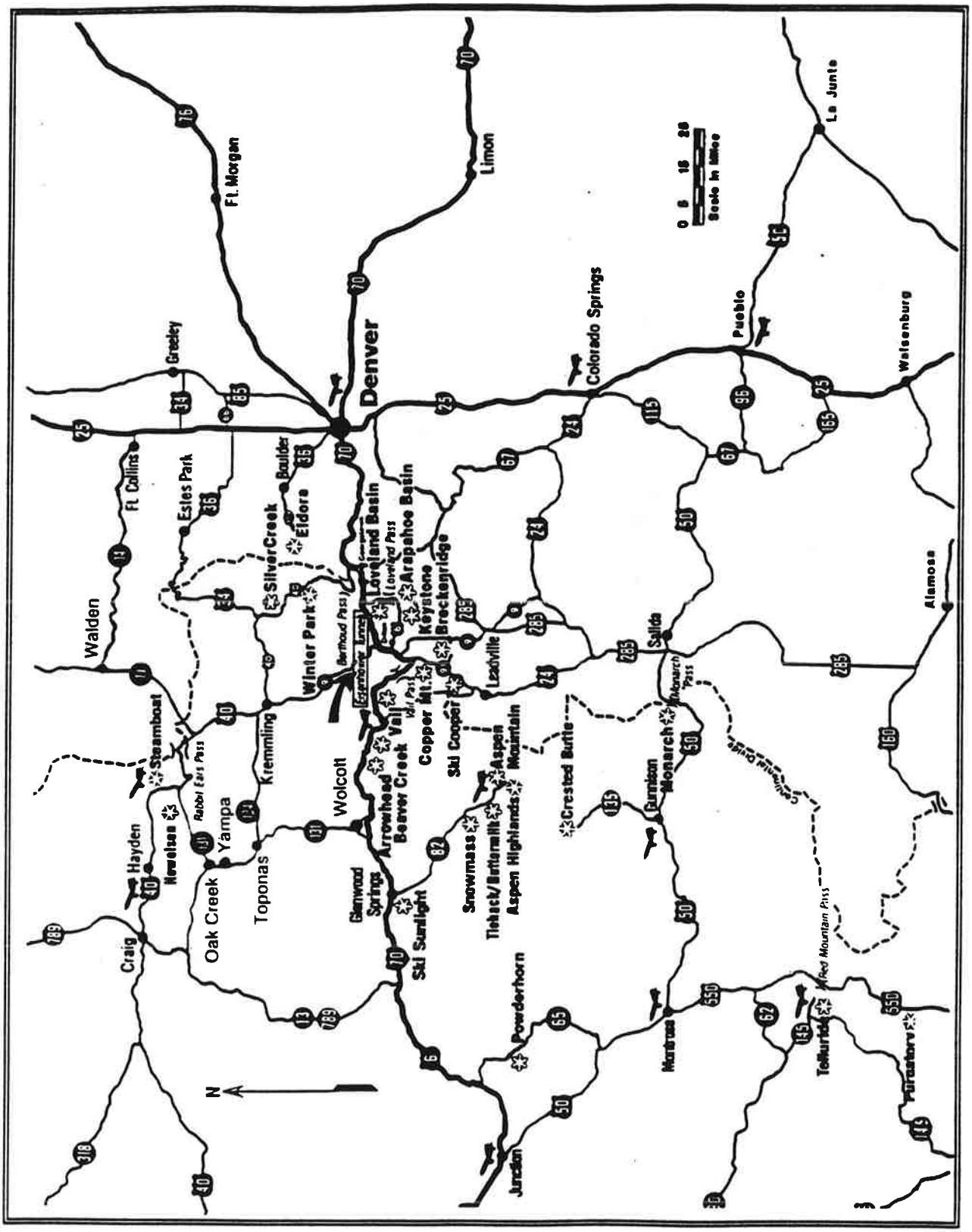
I. Investment Description

Opening up land and natural resources for development is one of the traditional purposes of transportation investment. In the state of Colorado, the construction of Interstate I-70, one of the major east-west national corridors of the Interstate highway system, was not planned with the main purpose of increasing accessibility to tourist areas. However, the highway was planned along and near ski slopes, which significantly reduced travel time from resort areas to a major metropolitan area and its international airport and encouraged the growth of tourism in the state.

The I-70 Corridor connecting the Denver metropolitan area and its international airport to ski resorts and other tourist areas was selected as a case study to examine the effects of constructing a major highway through an area having potential for tourism development but requiring improved access. This case study highlights the role that the construction of I-70 played in serving tourist areas, and expanding and diversifying the state's economic base. As an "export" industry attracting revenues from the residents of other states and nations, tourism has steadily increased in Colorado since the construction of I-70. This case study will discuss the economic development impact of transportation access to tourism where an investment was not planned with economic development as a major objective, but certain natural appeal existed that attracted growth. Selected characteristics and trends of the tourism sector and its impact on the Colorado economy are described, with particular emphasis on the relationship to the construction of the highway.

Before the construction of the Interstate highway system, U.S. 6 was the primary east-west access route into Summit County and other more western portions of Colorado. Interstate I-70 was constructed in segments over several decades as the primary artery through Colorado and through large areas of the U.S. National Forest and the Colorado Rockies. The oldest parts of I-70 were constructed in the high plains area east of Denver in the early 1960s. The next section was constructed near Grand Junction in western Colorado between 1967 and 1968. Also in the late 1960s, the El Rancho to Georgetown section was completed west of Denver. Highly significant for its impact on tourism development, the westbound bore of the Eisenhower Tunnel was opened in March of 1973 costing $117 million. The eastbound bore of the tunnel was completed in December of 1979 at a cost of $145 million. During this same period the 21-mile Vail Pass area between Vail and Frisco was completed in 1978 at a construction cost of $91 million. The Rifle to DeBeque section was built shortly afterward from the late 1970s to early 1980s. The last section of I-70 to be constructed in Colorado and the last unfinished section of the entire I-70 system was in the Glenwood Canyon area. The segment took 12 years to construct and was completed in 1992 at a cost of $480 million (See Figure G-1 showing the location of various segments relative to tourist resort areas, Denver and its airport).

Figure G-1: Map of Denver and I-70



II. Investment Objective and Decision-Making Process

One of the major objectives of the Interstate highway system was to provide limited access highway to improve connectivity, reduce congestion, enhance safety through state-of-the-art design, and improve the movement of people and goods to meet the nation's economic and defense needs.

For the Interstate system as a whole, the construction of I-70 through Colorado was primarily intended to meet traffic demands and ensure safer, faster, more reliable vehicular movement through the Rocky Mountains and several National Forests. While the potential to attract increased number of tourists was generally understood in the 1940s and 1950s when the system was first defined, economic development and land use consequences were not specifically articulated as principal objectives of construction of I-70. Nevertheless, the potential for roadway investment to alter spatial patterns of development was understood by highway planners. The decision-making process for the I-70 construction was similar to other links in the interstate highway system, requiring the typical planning process mandated under federal law.

III. Analysis and Project Evaluation Used Prior to Investment Decision

West of Denver, the I-70 alignment of the Interstate highway system followed a route that incorporated much of existing U.S. Route 6. Following the path of river beds and other low lying topography, the alignment's selection was shaped by engineering feasibility criteria and costs. For some of the latter segments constructed, social and environmental considerations became more significant factors in highway location decision-making.

Following the establishment of the National Environmental Policy Act (NEPA) in 1969, project decision-making necessarily involved greater consideration of both natural resources and socio-economic impacts. Alignment segments of I-70 that would bypass areas previously served by U.S. Route 6 were scrutinized for their potential impacts on businesses and communities. Similarly, in both environmental and travel needs assessment studies, the potential for induced recreational development was considered in areas with improved accessibility.

Project evaluators were aware that the timing and magnitude of land development projects were dependent on the construction and completion of the Interstate highway segments. For example, the Final Environmental Impact Statement (FEIS) for a fourteen-mile section of I-70 in Summit and Eagle Counties from four miles east of Vail Village to a point 1.3 miles west of Copper Mountain noted the following in 1974: "The impact upon the recreation potential of the study area will facilitate the expansion of recreational use." The FEIS also noted that "improved traffic service, because of the new highway, will increase the rate of development of the East Vail and Copper Mountain areas."

Similarly, the 1974 FEIS for the second bore of the Eisenhower Tunnel, a five-mile section through Summit and Clear Creek Counties that enabled a four-lane, divided highway under the Continental

Divide, devoted a section to secondary development impacts. The FEIS stated: "the growth of Summit County and the Western Slope can largely be attributed to three factors. These include the recreation potential of these areas of the State of Colorado, the growth of the ski resort industry, and the completion of I-70 in Colorado." As a result of I-70 providing a major means of access to recreational and ski areas in western Colorado, the highway generated some of the development in the counties through which it passed. This whole western corridor had the potential of becoming a major recreational area not only for Colorado but also the whole nation because of the many recreational opportunities available and the major Interstate highway running through the area.

A FEIS completed in 1976 for the segment of I-70 from Wheeler Junction to Frisco noted the importance of I-70 on private sector development plans: "The development of Dillon Reservoir, the ski resort towns, and associated recreational facilities has caused an influx of tourism. An undeniable factor in the intense activity is the expectation of an interstate highway entering the locale from the east."

To some extent, the strategic importance of I-70 to tourism and land development was anticipated at the time of project evaluation during the analysis of the last segments to be built. The environmental impact studies prepared in the 1970s explicitly considered the potential impact of I-70 on ski and year-round tourism as well as potential year-round land development. These documents, however, provided more qualitative than quantitative discussions of these future potential economic impacts.

IV. Project Objectives Achieved and Results After Investment

The initial construction of I-70 and the Eisenhower Tunnel achieved its primary objectives by reducing user travel times and operating costs and enhancing reliability for the traveler particularly for vehicular movements in the winter months during harsh weather. When completed, its design features enhanced safety and lowered the probability of accidents.

Prior to the construction of the Interstate, the highway between Denver and Grand Junction was treacherous with narrow road lanes, significant slopes, and numerous switchbacks. It required the use of four-wheel drive vehicles and/or tire chains during the winter months. Before the Eisenhower Tunnel's completion, drivers seeking to travel west from Denver had to go through Loveland Pass, which ascended to an elevation of nearly 12,000 feet. Traveling over two lanes at this elevation over the Continental Divide presented substantial safety risks and was extremely unreliable in the winter months. Many people were uncomfortable with the route and would not travel during the winter.

Today, after the construction of both tunnels, it takes approximately 2.5 to 3 minutes to complete a distance of under two miles that formerly took 40 minutes over the Loveland Pass in decent weather. This improvement offered not only substantial travel-time savings, but less wear and tear on vehicles and lower overall operating costs. A 1980 Colorado Department of Highways' study found that fully 94 percent of the traffic use the Eisenhower tunnel rather than Loveland Pass.

Since its completion, I-70's reliability and improved accessibility to natural resources has drawn an increasing number of daily and weekend traffic west of the front range of the Colorado Rockies from the growing Denver metropolitan region as well as from other states. Growth in the use of I-70 has taxed the road's capacity during the summer and winter peak months. The highway exhibits peak periods of congestion on Friday evenings and Sunday afternoons/evenings to the Denver metropolitan region. Table G-1 indicates that average daily traffic volumes during the peak summer months have more than doubled and that winter peak traffic has nearly doubled since the opening of the Eisenhower tunnel.

While there is no information available on the origin and destination of traffic, the growth in traffic volumes generally reflects an increased use of state tourist attractions along the corridor, as well as increased Interstate through travel. The highway investment has greatly improved accessibility to Colorado's natural and recreational resources. West of Denver, Colorado has a vast acreage of U.S. National Forest Lands on either side of the Rocky Mountains including, but not limited to, Pike, White River, Gunnison and Arapaho National Forests and assorted wilderness areas such as Eagle's Nest. These vast land areas offer opportunities for hiking, fishing, boating, hunting and camping during the spring, summer and autumn, and skiing and other recreation during the winter and spring months.

Table G-1: Interstate 70 Traffic Volumes (ADT) at the Eisenhower Tunnel

Year	August	March
1974	8,750	13,612
1980	13,504	18,754
1985	15,342	20,703
1990	19,012	24,421
1992	20,924	27,011
Total Growth in ADT: 1974 - 1992	12,174	13,399
Percent Growth: 1974 - 1992	139.1%	98.4%

(Source: Colorado Department of Transportation, 1993.)

Tourism is one of Colorado's most important growing "export" industries drawing visitors from all over the U.S., North America, and overseas. Despite a recent trend toward shorter vacations, the reliability and speed of overseas and domestic travel, made possible by increased air transportation services and Interstate highways such as I-70, enable vacationers to venture to regions of the national park system and recreational resort areas previously less accessible. As the nation's metropolitan areas have sprawled into more distant suburbs and the exurban periphery, the vacationer in search of natural beauty has sought refuge in the nation's national park system.

Formerly sleepy mining towns now well-served by I-70 experienced a remarkable increase in new commercial opportunities since the opening of the Eisenhower Tunnel. This is largely attributable to the combination of improved accessibility, desirable natural resources (e.g., climate, acreage with development potential, mountains), and private-sector interests. The I-70 and tunnel investments directly stimulated increasingly large mixed-use development commitments at such locales as Keystone, Breckenridge, Vail, Copper Mountain, Aspen and Steamboat Springs.

In the winter months, more than three-quarters of all out-of-state skiers arrive at Denver's Stapleton Airport. Summit County resort and living areas (including Breckridge, Copper Mountain, Dillon/Silverthorne and Keystone) are approximately 90 minutes, or 80 miles from Stapleton. Vail is approximately 110 miles and 2.25 hours from the Stapleton. Steamboat Springs and Aspen are slightly farther from the old airport (165 and 220 miles respectively) and depend on I-70 for part of the total trip.

Since I-70's completion, the resort areas have expanded their capital investments, adding more ski and recreational facilities. Seasonal peaks are balanced with more all-season recreational development such as golfing, alpine slides, marinas and lake development. Greater emphasis has been placed on satisfying summer tourist demand for camping, viewing scenery, bicycling, hiking and water sports. Realizing the implications of improved accessibility to more distant environs, some resorts have also developed convention facilities and marketed their outdoor recreation spots to a segment of the business travel market.

A. Historical Development of Ski Industry

While Colorado's resorts seek to expand their year-round market, the initial impetus for development centered upon capturing a unique market opportunity present in the winter months. Colorado is among a handful of states that have developed a significant ski industry and attracted visitors from all over the nation and world. The availability of excellent slopes and proximity to a large metropolitan area were clearly also factors in attracting additional ski resorts and visitors. The evolving demographic and economic characteristics and relationship to I-70 are further profiled below.

Colorado residents and visitors have been skiing for more than one hundred years. Informal skiing competitions in Colorado's mining towns were reported as early as the 1860s. However, prior to World War II there were only a few ski areas. The U.S. Army Tenth Mountain Division trained at Camp Hale near Leadville during the 1940s. Division members became integral to the development of several modern ski resorts following the war, including such developments as Arapahoe Basin, Aspen, Vail, and Winter Park (Colorado Ski Country, p. 1).

In the early 1950s, annual visits to Colorado ski resorts totaled no more than 250,000 visitors but increased slowly throughout the 1950s and early 1960s (Colorado Ski Industry, p. 14). From 1963 to the present, with the exception of two low snowfall years and recession years, visitation has expanded steadily. In the 1960s, the number of skiers grew from less than 1 million to 2.5 million

visitors annually. Spectacular growth characterized most of the 1970s such that by 1980 more than 8 million annual visits were being made to Colorado resorts. Since 1981-82, visitation has grown at approximately 2.8 percent per year to more than 10 million, although the trend has been toward shorter visits, i.e. fewer days per visitor.

This growth comes not only from new visitors, but from returning tourists. Out-of-state visitors surveyed during the winter months indicated that four out of five tourists had previously visited a Colorado ski resort. Seventy percent had visited at least two times previously. Nine out of ten Colorado residents had visited the ski resort previously with more than 50 percent having visited as many as 21 times.

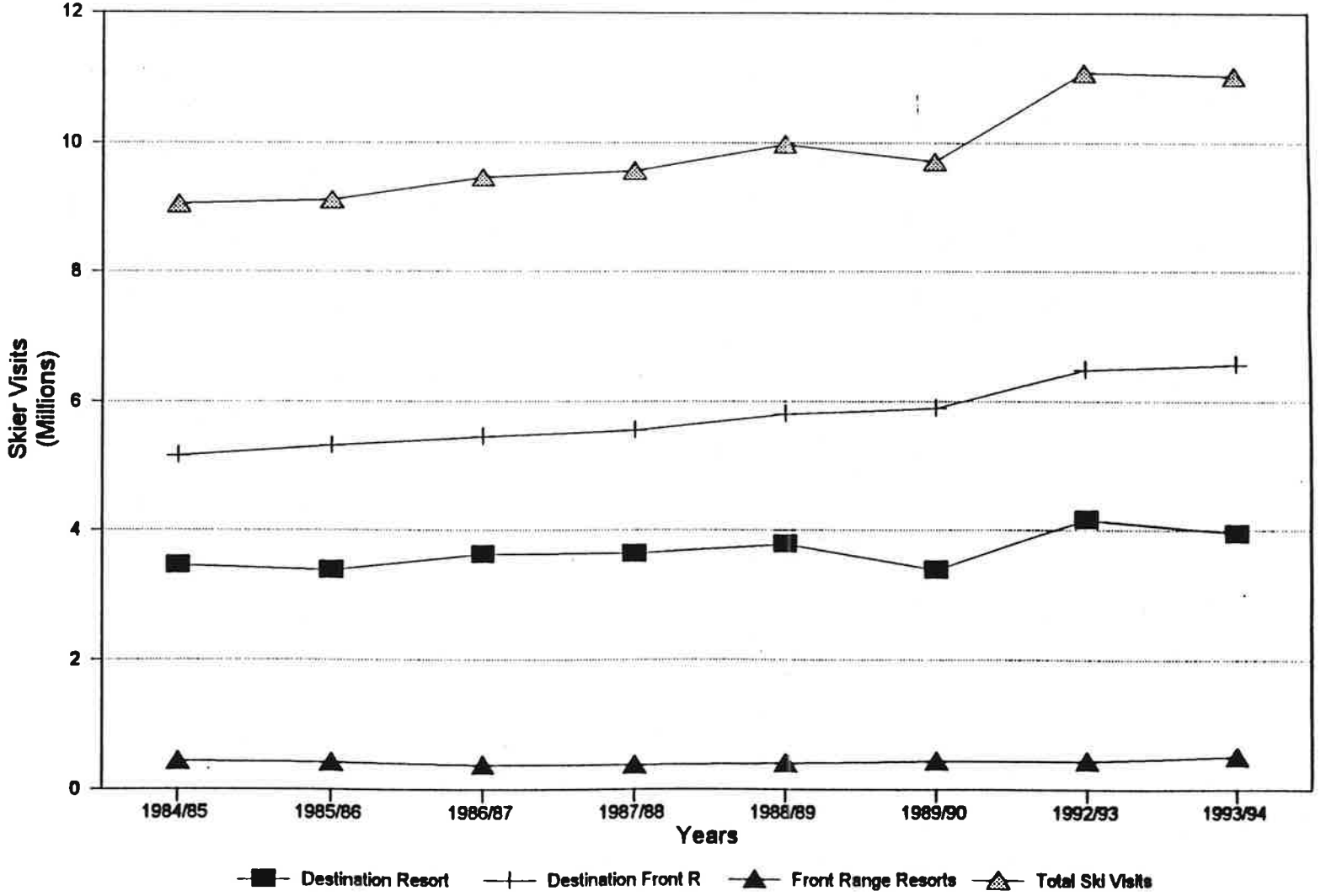
Access made possible by I-70 is integral to the development of many of what are known as the destination/front range resort areas (resorts well served by I-70 that handle both overnight stays and day-trips from the Denver area), as shown in Figure G-2. Destination/front range resorts such as Arrowhead, Breckenridge, Copper Mountain, Keystone, Arapahoe Basin, Vail and Winter Park currently serve about 60 percent of all Colorado ski visits. Destination resort ski areas, by contrast, typically serve only persons staying overnight away from home. They currently handle about 37 percent of all annual ski visits and include Aspen, Snowmass, and Steamboat Springs. Without lodging facilities, what are known as the front range ski areas are generally closer to the Denver metropolitan region and tend to serve a smaller market of day-trip ski visits. These areas include Ski Cooper, Ski Broadmoor, Berthoud Pass, Eldora and Loveland Basin. Figure G-2 presents the trend in annual ski visits for the three categories of ski areas and resorts since 1984/85.

B. Ski Resort Tourism Impacts

In 1950, the World Alpine Championships were conducted in Aspen drawing international attention. At that time, only a few hundred people depended on skiing for their livelihood in Colorado. By contrast, by 1994 it is estimated that the state's ski and recreational resort industries (both summer and winter) account for 66,000 jobs, over $2.5 billion annual retail sales and $1.3 billion in personal income. The ski resort industry includes more than 27 ski areas and provides an estimated $113 million in tax receipts. The U.S. Forest Service received approximately $6.6 million in fees as well.

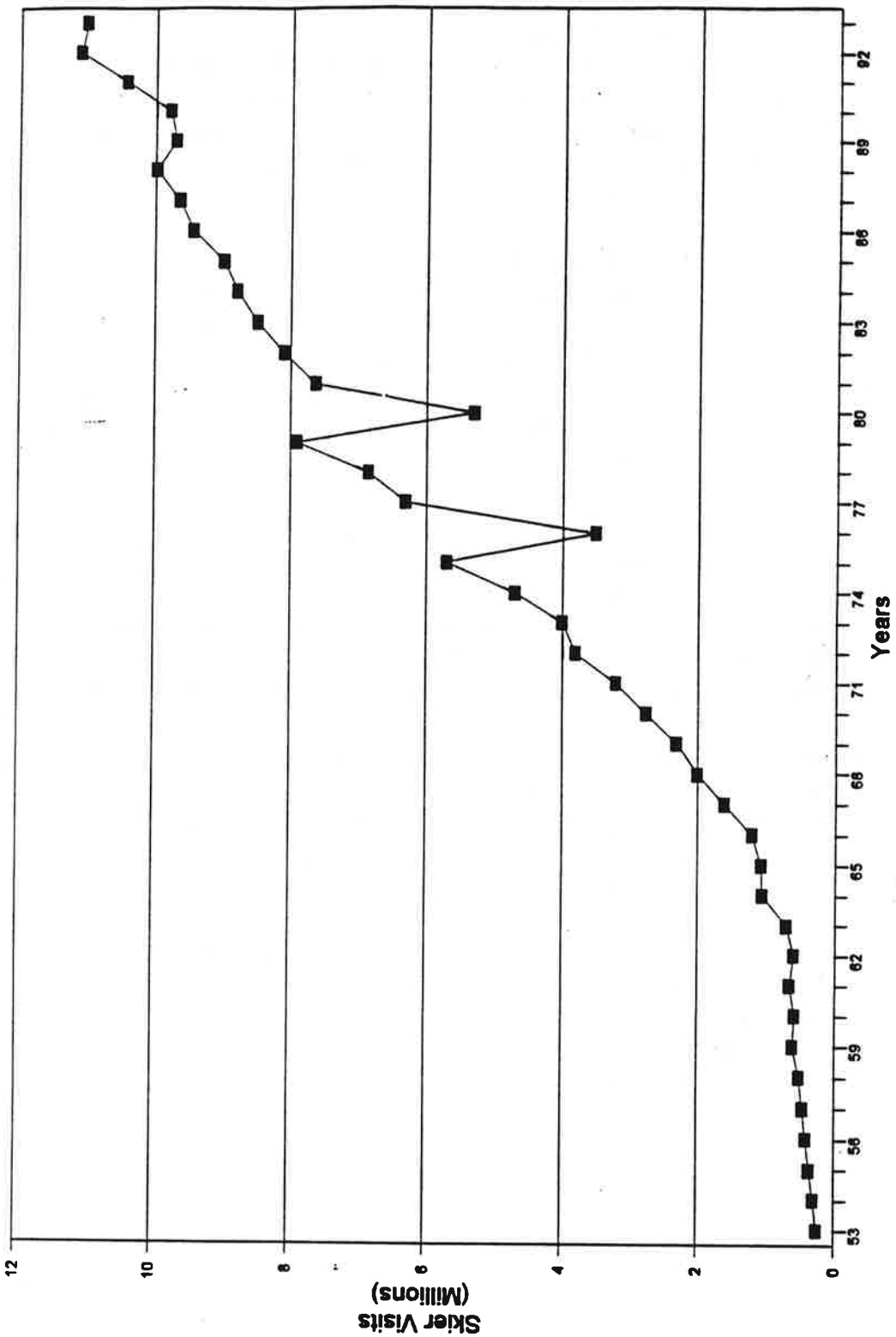
Recreational tourism represents the single largest industry for the state's Western slope. This economic activity generates more than 10 million skier resort visits annually including 6.8 million destination visitors (persons staying overnight) and 2.9 million "day tripper" visits. (See trend in Figure G-3). Colorado draws an average of 10,000 out-of-state visitors a day to the state's resorts. Out-of-state visitors typically account for 30 to 35 percent of the skier visits, in-state destination visitors account for 7 percent, with the remaining skiers generally in-state day trippers. Out-of-state visitors arrive from nearby states, most notably Texas and Oklahoma. Significant numbers of visitors are also drawn from throughout the United States, Canada, Mexico and Great Britain. Substantial effort has been made in recent years to further market Colorado tourism towards international visitors. Marketing efforts and airport improvements to ensure more international airline connections are expected to further contribute to growth in the future.

Fig. G-2: Colorado Skier Visits by Destination (1984-1994)



Note: Destination Resort Ski Areas serve persons staying overnight. Front Range Ski areas are skier destinations which tend to serve day skiers. Destination Front Range tends to include ski areas well served by I-70 that handle both resort overnight stays and residents from the Denver metropolitan area.
Source: Colorado Ski Country USA, 1994

Fig G-3: Colorado Annual Skier Visits
(1953-1993)



Source: Colorado Ski Country USA, 1994

Direct visitor expenditures total more than $1.4 billion in retail sales, which include lift tickets, equipment, lodging, eating and drinking and other retail and services. Destination skiers are estimated to spend approximately $152 per visit. Day skier visitors who are typically state residents, spend approximately $25 per visit. While the ski resorts are the principal beneficiaries, other off-site retail and service areas also benefit from these expenditures. The Denver area, as the primary gateway for air travelers, receives approximately $50 million; excluding air fares, from ski-related tourism. The indirect and induced multiplier impact of all these direct expenditures result in an additional $1.1 billion in business activity throughout the state, including $160 million for the Denver metropolitan area (Colorado Ski Country, p. 4).

The majority of out-of-state skiers travel to Colorado by commercial air (70 percent) followed by private car (22 percent). The remainder generally arrives by bus, train, or other charter or private plane. Air travel to destinations other than Denver and Stapleton Airport has become a more common occurrence, but the vast majority of out-of-state visitors still arrive through the Denver gateway. An estimated 20 percent of out-of-state visitors flew directly to such Colorado resorts as Steamboat, Vail/Eagle (Vail/Beaver Creek), Gunnison (Crested Butte), Aspen, Telluride, and Durango (Purgatory) (Colorado Ski County, p. 18).

Local economic growth has risen substantially and steadily in recent years as a result of ski-related tourism. Colorado's resort towns reported growth in retail sales more than double the state's 4 percent annual growth in retail activity between 1986 and 1991. Similarly, employment grew approximately 8 percent annually at the state's ski resorts compared to one percent statewide over the last five years. Currently, ski resort operators are estimated to employ approximately 8,100 individuals. Other area businesses directly engaged in services for visitors provide an additional 29,100 jobs.

For Summit County alone, which has been a principal beneficiary of I-70 improvements and the tunnel and includes such areas as Breckinridge, Keystone, Dillon and Copper Mountain, annual retail sales have grown from $53 million to $562 million between 1975 and 1992. Average annual employment has grown comparably from 1,830 to 12,782 jobs between 1975 and 1992. Employment is 15 to 20 percent higher in the winter months.

In addition to skiing operations, the resort industry has been responsible for substantial capital investment and construction activity. Many of the resorts continue to add equipment, ski trails, base facilities and recreational amenities to fulfill demand and remain competitive. For example, Keystone was started in 1971 and completed its first round of second home construction by 1974. Over the years the resort has added more ski runs and base facilities, a 53,000 square foot conference facility, golfing, night skiing and employee housing. Keystone's developers alone invested an estimated $30 million in on-mountain improvements in 1990. The resort continues to add more ski-in/ski-out lodging, single family homes and condominiums.

While there had been a period of over building, residential development in the resort communities accounted for typically more than 1,500 residential units annually through the 1980s and early 1990s. This includes both year-round and second home development. State population projections

through 2005 anticipate an increase of 14,500 year-round residents, a 30 percent rate of growth over a 15-year period (2 percent annually) for Eagle, Pitkin and Summit counties which have been the dominate counties for ski resort employment and are all accessible by I-70. Second-home population is estimated to be more than four times the year-round population.

C. Impact of I-70 Investment

As ski technology and apparel has improved, and air travel has become more reliable and affordable, interest in skiing has centered on parts of the country such as Colorado that can offer an exciting destination and challenge. As the nation's culture has evolved to further embrace outdoor recreation and the nation's disposable personal income has grown to afford such travel, improved accessibility provided by I-70's construction has contributed to the growth of Colorado tourism and the development of particular resort industries and land development opportunities.

Destination front range resort areas such as Vail, Copper Mountain, Keystone, Winter Park and Breckinridge have grown to meet increasing demand and together account for 55 percent of the state's skier visits. Resort operators and planners confirm the essential importance of I-70 to the timing of their development and expansion. Other destination resorts including Aspen and Steamboat Springs are accessible in part via I-70, and play an integral role in their usage by residents and out-of-state travelers arriving by auto, as well as by out-of-state travelers arriving through the Denver gateway.

The completion of the Eisenhower Tunnel altered the relative ease of accessibility of the destination front range and destination resorts in part to the detriment of the front range areas. This can be found in market share statistics and anecdotal notes. The front range currently accounts for less than four percent of total skier visits, a share that has not grown in the last four years. One colorful indication that the Eisenhower Tunnel had an impact on skier destination can be found in a Loveland Basin's advertising after the tunnel's completion, "The Eisenhower Tunnel is a bore, Ski Loveland."

A 1990 analysis by the Colorado Department of Highways compared the actual 1990 population figures of counties near the Eisenhower Tunnel to predicted figures based on trends prior to the tunnel construction. The increases in all counties close to the highway were significantly higher than what would have been projected based on prior growth trends. Significantly, the percentage change in population was much greater for counties closer to the tunnel.

The improved reliability and accessibility of the interstate highway system has not just shifted market share, but brought many more individuals of all ages to the Rocky Mountains in Colorado not only for skiing but for outdoor recreation, and out-of-the-way convention areas. Their travel experience and enjoyment at the final destination has been sufficiently positive to attract repeat customers from out-of-state. Denver metropolitan region residents, in particular, perceive the mountain resources as accessible for weekend use and vacations of short duration. I-70 has contributed to active recreational "life-style" choices for many Colorado residents, and the state's

reputation as an active summer playground for visitors continues to develop as the winter resorts add amenities for year-round use.

The active outdoor lifestyle supported by these resorts has not only attracted a year-round clientele, but also a residential base. County planners report an increase in year-round residents who commute to the Denver metropolitan region, as well as residents whose work uses telecommunications or have schedules that do not require daily interaction with the metropolitan region, such as computer software, finance, and the airline industries. Cottage craft industries have sprung up to support both year-round and seasonal demand for recreational equipment, personal services and retail and has supported youth employment. Affluent, active, independent older residents not significantly in need of medical services have also purchased second homes or established their retirement dwellings in several mountain area communities.

I-70 has played a central role in bringing about economic development to these communities by offering travel convenience, travel-time savings and safety benefits. However, as traffic volumes have steadily increased, the perceived convenience and escape from the metropolis that many visitors seek is threatened. Physical, financial and environmental constraints preclude the easy expansion of highway capacity to ease congestion. Some residents who value the lifestyle of the mountain resorts fear overdevelopment and seek to limit growth.

D. Future Development Issues

How can I-70 continue to promote tourism and economic expansion under these capacity constraints? One solution Colorado is currently exploring is the development of a multimodal passenger transfer station at the western edge of Lakewood in Dakota Sandstone Hogback. The park-and-ride station would provide an access point for various modes of passenger transport and encourage the use of mass transit to points further west along I-70. The station is expected to help alleviate current levels of congestion, which are acute at the peak of the ski season. The proposed project could include a public-private partnership between the Colorado Department of Transportation and various private sector interests including ski resorts, retail and new gambling casinos in Central City west of Denver. Information about bus schedules, ski conditions, weather, hotels/restaurants and other information for visitors would be provided at electronic kiosks. The proposed transfer station represents one congestion management strategy instead of funding lane capacity enhancements to the interstate highway.

Alternate modes to tourist destinations are being considered for their feasibility by state transportation planners. This would include the rehabilitation and extension of passenger rail service between Aspen, Vail and Glenwood Springs and further expansion of direct aviation links to destination resorts. Other strategies involve increased coordination of travel between resorts and Airports such as the Summit Stage, which has grown from 50,000 to 350,000 annual riders over the 1980s, as well as other private and public transit links, and demand management solutions like high-occupancy vehicle lanes and incentives for nonpeak hour travel. The state is also studying Intelligent

Vehicle Highway Systems technologies to better manage the efficiency and safety performance of I-70 by improving communication to drivers at rest areas about incidents, weather conditions, and alternate modes.

The state's electorate recently voted to eliminate most functions of the state's tourism bureau. In the years ahead, the burden of communicating tourism's importance both to state and out-of-state residents will increasingly shift to the beneficiary tourist-oriented industries. As increased demand places additional stress on highway infrastructure, the challenges of successfully integrating a multimodal network to serve Colorado tourism will likely require more public-private partnerships. Designing these partnerships and investments to serve tourism demand effectively will be a challenge for the state if it is to pursue continued economic expansion in the corridor in the future.

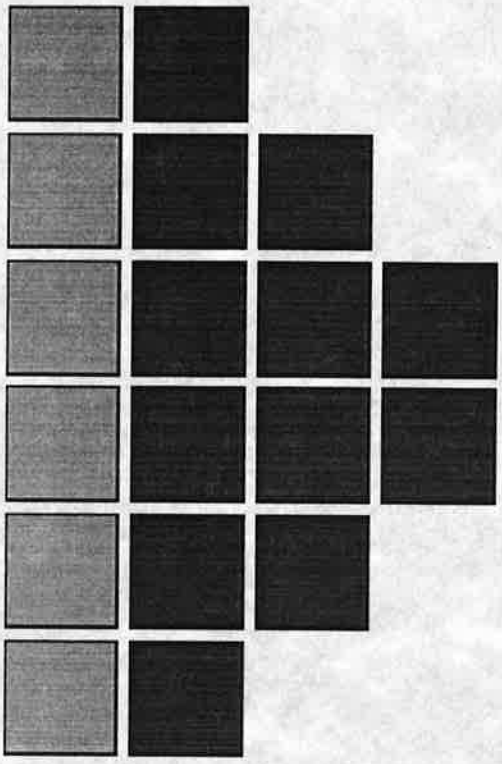
V. Lessons from Case Study

Transportation investment in the I-70 corridor and the Eisenhower Tunnel has clearly had a major impact on economic development in the area. It is not realistic to assume that the population and employment growth that has occurred in the corridor would have been possible without an increase in accessibility for both metropolitan area residents and out-of-state visitors. The major effect of the investment was the reduction in travel time between the resort areas near the highway and Denver and its airport, resulting in significant land development, job creation, and tourism-oriented economic activity. This growth has had vast implications on land and economic development in western Colorado. Although there is no simple way to measure the linkage between transportation investment and economic development in the corridor, the best measure of the success of the investment in terms of economic development is the significance increase in traffic demand in the corridor and the increased number of skier visits to the area. Furthermore, several points can be made:

- I-70 brought more dependable, safer, faster, and cost-effective access from the Denver metropolitan core and its airport to the rural, mountainous hinterland. Since users of I-70 can readily appreciate its utility in accessing resorts, land developers have had little difficulty identifying and marketing the competitive advantages bestowed upon their properties by the transportation improvements.

- The high degree of tourism development would not have been possible without the construction of I-70 and the Eisenhower Tunnel. There is little reason to believe that tourism development was not closely linked to the improved accessibility brought about by the transportation improvements. Support for the assertion that I-70 was integral to the timing and expansion of a tourist-oriented regional economy in the Colorado Rockies can be found in demographic and economic data, travel volume and travel-time statistics, discussions with area residents, planners and businessmen, and survey data of visitors.

- I-70 contributed to the active recreation life-style choices of many Denver area and Colorado residents. The active outdoor lifestyle supported by these resorts has not only attracted a year-round clientele, but also increased the competitiveness of the Denver area as an attractive business and residential location.



Appendix H

Case Study VII:

Port and Airport Economic Impacts - Oakland

LOUIS BERGER INTERNATIONAL, INC.

APPENDIX H

CASE STUDY:

PORT AND AIRPORT ECONOMIC IMPACTS - OAKLAND

I. Investment Description

Ports and airports are major elements of the nation's transportation infrastructure. State and local jurisdictions, through government agencies or independent public authorities, invest in these transportation facilities mainly for the purpose of attracting jobs and economic development to their areas. Typically, these transportation facilities, particularly ports, compete with other ports in the region for cargo in their local hinterland, and with ports around the nation for cargo bound for farther inland destinations. Recently, with the establishment of more hubs and international gateways, larger airports also increasingly compete for international and long distance travel not originating or destined to the local area.

Port and airport facilities are viewed by local governments as catalysts for development. Having an airport or port locally with extensive direct and fast domestic and international connections can serve as an important incentive to attract new business to the area. Depending on the competitive situation in the region, ports and airports can be profit-making enterprises. Because of their ability to generate their own revenues, they usually are structured to function with some autonomy and with independent financial authority.

The port of Oakland was selected as a case study of transportation investment by a local jurisdiction, with the explicit objective of generating economic activity and serving the needs of local businesses. The case study will be used to discuss how airports and port terminals impact the economies of the regions they serve. The focus of this case study will thus be on the economic impact of the aviation and maritime investments of the port of Oakland. The term "economic impact" used in this case study simply refers to the impact of the investments on the local and regional economy.

The port of Oakland is a public enterprise established in 1927 by the City of Oakland and is a component unit of the city. Its operations include:

- the Oakland International airport,
- the port of Oakland marine terminal facilities, and
- a commercial real estate division.

The port is run by an Executive Director, under the guidance and control of a Board of port Commissioners. The port prepares and administers its own budget, controls its fiscal resources, and is responsible for all port construction and operations.

The port infrastructure represents the local gateway for cargo and passenger movements to the outside world, serving the needs of businesses and residents. Oakland's port is one of the top ports in the West Coast competing for intermodal cargo moving inland to the US Midwest and East Coast. The port also competes for steamship line services and cargo locally with the port of San Francisco across the bay. Similarly, Oakland's airport competes for airline services, cargo and passengers with San Francisco's larger facility.

A. Aviation-Related Investment

Oakland International Airport is built on 2,580 acres of land, 10 miles south of the city of Oakland. Out of the 2,580 acres, a portion (180 acres) is considered wetland.

Oakland International Airport is one of the fastest growing airports in the US both in terms of freight and passenger throughput. It is the 10th busiest air cargo facility in the nation, with a current annual volume of more than 400 million pounds. These air cargo activities are carried out by companies providing international and domestic services centered around overnight, express and small package services, such as Federal Express, Emery, Burlington Air Express, Airborne, Evergreen, and UPS.

Passenger throughput has increased from 3 million passengers in 1982 to 7 million in 1992. Annual growth rates soared as high as 30 percent in the past few years, the highest of any airport in the US. By 2000, passenger throughput is expected to exceed 10 million. Figure H-1 illustrates the existing airport facilities. As shown, the facilities consist of runways and taxiways, passenger terminal facilities, air-cargo facilities, aircraft maintenance support facilities, and corporate/general aviation facilities.

The airport is divided into a North and a South Airport. Both are operated as independent and separate facilities. There are four runways in total. Runway 11/29, grooved asphalt 10,000 ft. by 150 ft. located in the South Airport operations area, is used primarily by commercial air carriers. This runway has a precision integrated landing system (ILS) for each direction with clear overwater approaches at each end. The three North Airport runways are used primarily for corporate/general aviation (GA) activity. A system of taxiways connects the runways to the general aviation apron areas and the passenger terminal apron. The passenger terminal area includes two terminal buildings, a terminal apron, and a roadway and parking system.

The port has continued to invest regularly in the expansion of its facilities to meet the growing needs of individuals and businesses in the region. Aviation-related investment projects over the next 5 years amount to an estimated cost of $103.6 million. Details are shown in Table H-1. In addition, a current Master Plan Study is underway and port officials anticipate that demand will justify the need for a major terminal expansion project at some point within the next 10 years.

B. Maritime-related Investment

The marine port facilities serve as the conduit or interchange point between inland and ocean transportation for both international and domestic waterborne trade. The facilities serve as the major ocean gateway for northern California and the San Francisco Bay area for general cargo.

Figure H-1: Oakland International Airport

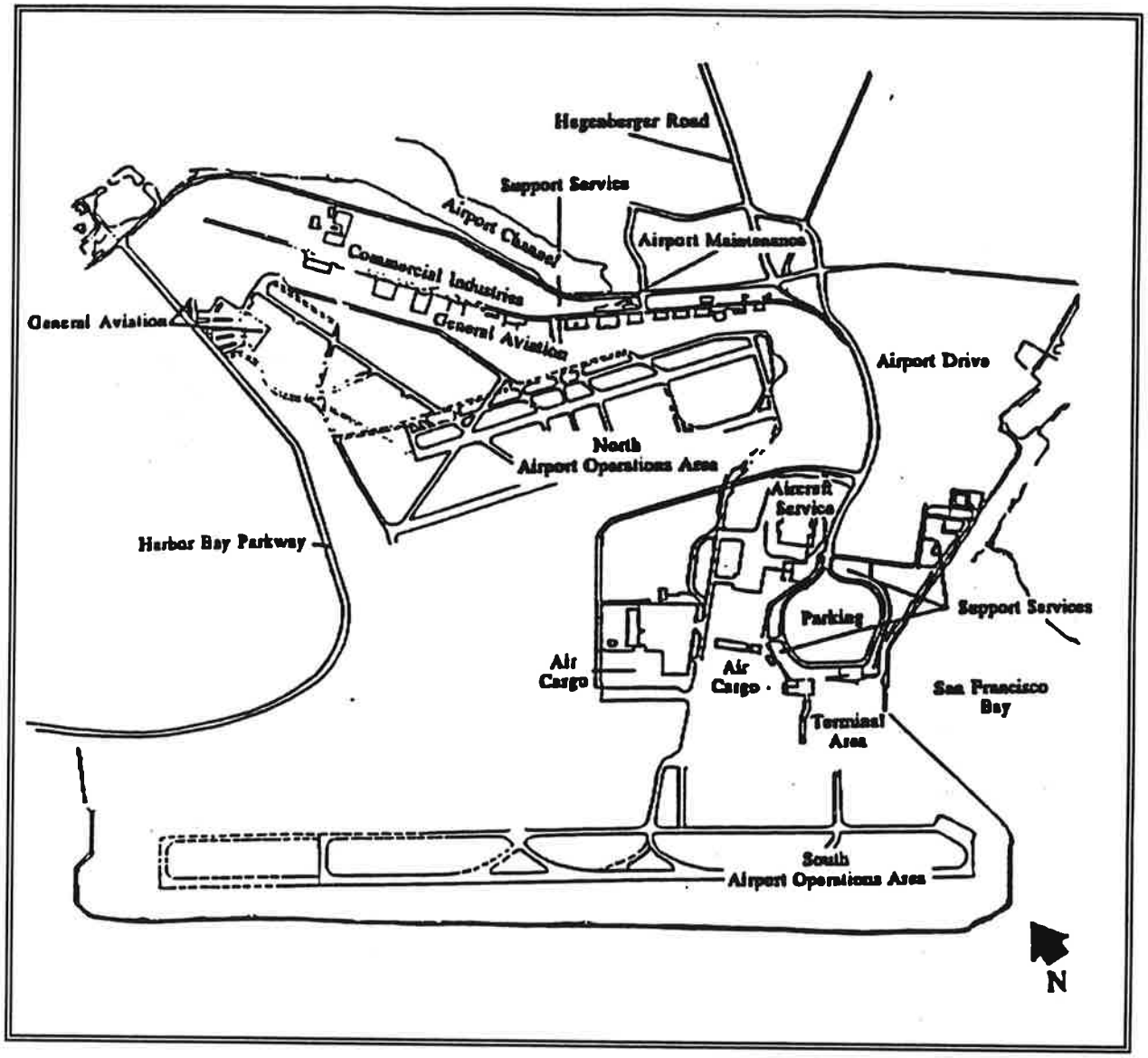


Figure H-2: Port of Oakland Maritime Traffic

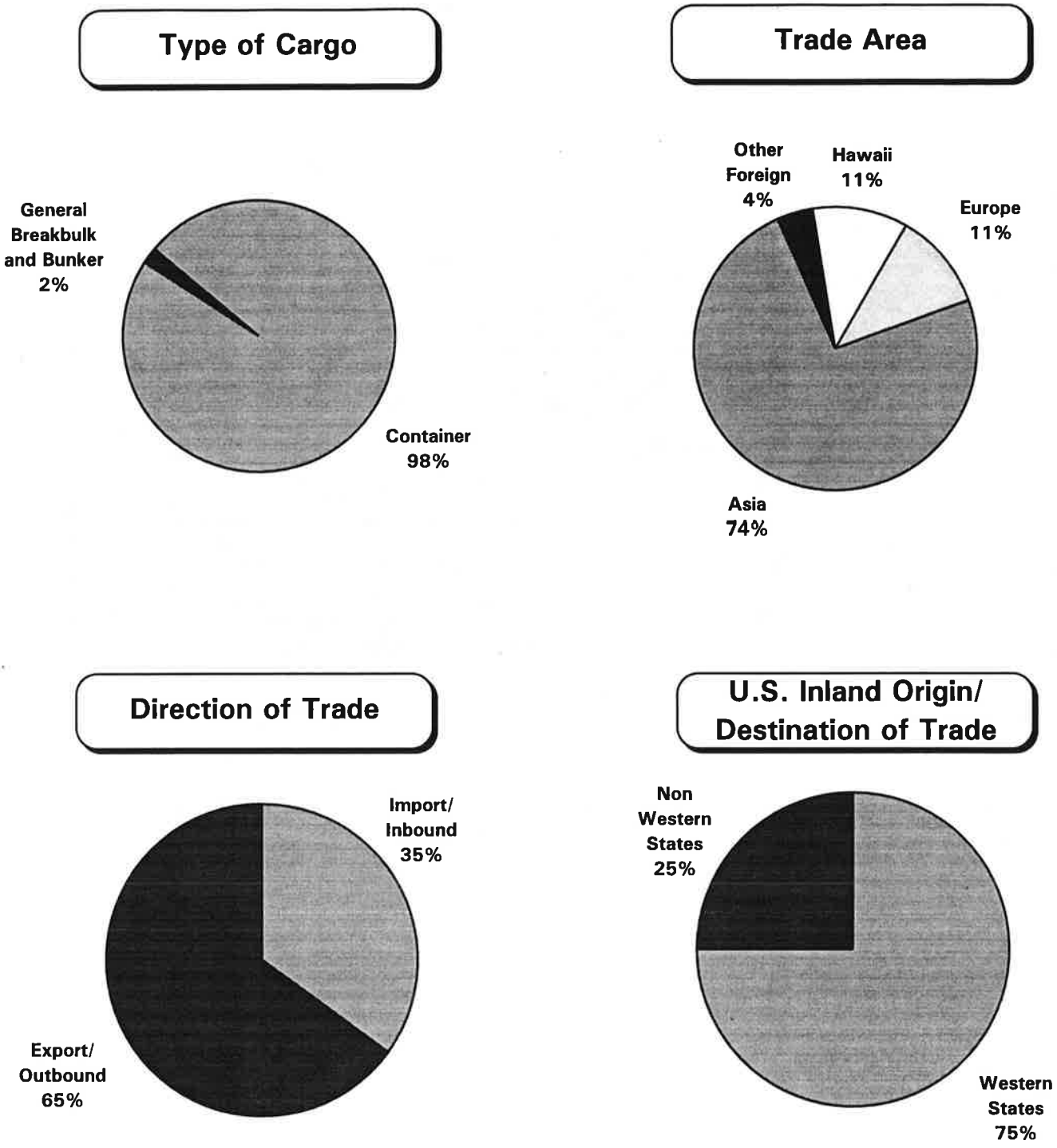


Table H-1: Port of Oakland Aviation-Related CIP, 1992-1996

Projects at South Airport	$53,403,000
Projects at North Airport	$31,548,000
Miscellaneous	$18,649,000
Total Aviation-related CIP	**$103,600,000**

Source: Port of Oakland - Project costs compiled by Aviation Planning Associate

The port was among the first ports in the US to specialize in the intermodal container operations whose cost and service advantages have revolutionized international trade. Since 1962, the port has spent more than $650 million to construct 550 acres of modern marine terminals and install the equipment needed to handle containerized cargoes. The port loads and discharges more than 90 percent of containerized goods bound to and through the nation's fourth largest metropolitan area. In 1992, the port marine facilities handled the equivalent of 1.2 million 20 foot containers, representing a 4.9 percent increase over 1991.

As shown in Figure H-2, 74 percent of Oakland's foreign trade is with Asia. Hawaii accounts for 11 percent, Europe for 11 percent, and other regions on the world account for 4 percent. In terms of US markets served, the port's hinterland is focused on the western states (three quarters of the tonnage is to or from western states). The theoretical capacity of the port is estimated at 20.4 million revenue tons. As shown in Figure H-3, the maritime facilities of Oakland's port are located in four terminal areas: the Outer Harbor; 7th Street; Middle Harbor; and Inner Harbor. These four areas cover 550 acres of developed terminal and active support areas.

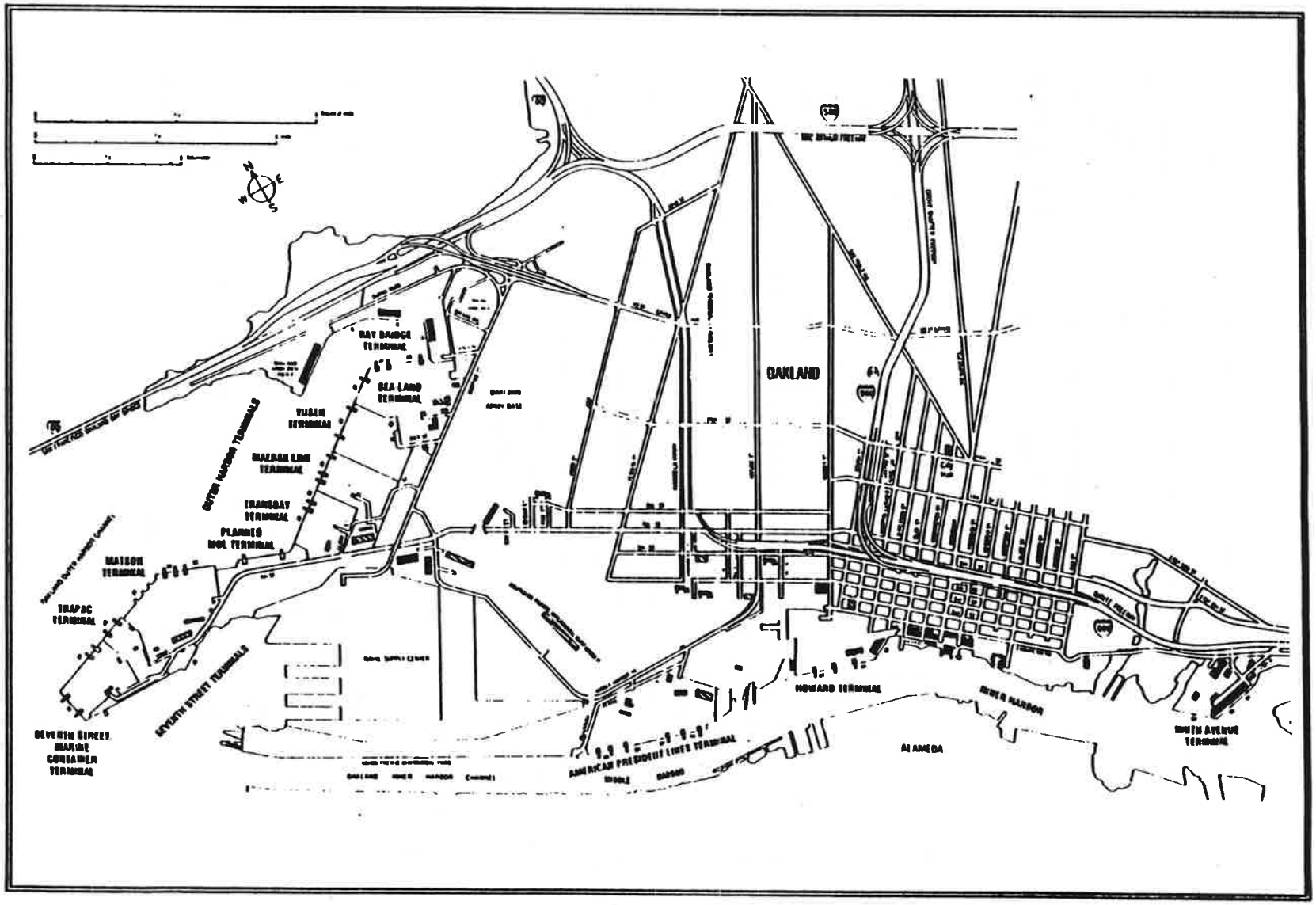
Proposed maritime-related investments over the next 5 years amount to an estimated cost of $195.7 million (See Table H-2).

Table H-2: Port of Oakland Maritime-Related CIP, 1992-1996

Projects at Outer Harbor	$33,588,000
Projects at 7th Street	$98,158,000
Projects at Middle Harbor	$9,642,000
Projects at Howard Terminal	$6,995,000
Miscellaneous	$47,359,000
Total Maritime-related CIP	**$195,742,000**

Source: Port of Oakland - Project costs are compiled by Aviation Planning Associates

Figure H-3: Port of Oakland Maritime Facilities



3. Funding Sources

The proposed aviation and maritime investments described above are to be funded from the following sources: (1) federal, state and local grants; (2) passenger facility charges for certain airport projects; (3) FEMA/OES grants, and special facility bonds for certain maritime projects; (4) third-party financing; (5) ports own funds; and (6) proceeds from the issuance of the 1992 Series E Bonds. Table H-3 below summarizes the expected funding sources for the 1992 Capital Improvement Program.

Table H-3: Port of Oakland Estimated CIP Funding Sources, 1992-1996

	AVIATION CIP	MARITIME CIP
Project Costs	$103,600,000	$195,742,000
Funding Sources		
Grants	$53,846,000	$5,000,000
FEMA/OES	0	$17,272,000
PFCs	$27,941,000	0
Special Facility Bond	0	$39,179,000
Third Party	$1,360,000	$17,284,000
Port Funds	$6,532,000	$26,931,000
1992 Bonds	$13,921,000	$90,128,000

(Source: port of Oakland. Project costs are compiled by Aviation Planning Associates.)

II. Investment Objective and Decision-Making Process

As indicated in the port's official documents,[1] the overall objectives of the aviation and maritime investments are as follows:

- Upgrade and maintain aviation facilities to keep pace with increased passenger demand and to make airfield improvements that result in increasing overall airport capacity.

- Help the maritime facilities maintain their current competitive position and business volumes, and achieve a "moderate" growth rate in the future: 2.4 percent annual growth rate in revenue tons over the 1992-2000 period.

In addition, the port literature continually refers to the economic impacts of the investments as the major purpose of expansion and facility rehabilitation.

[1] "Feasibility Report" (Appendix A of Official Statement on Revenue Bonds, 1992 Series E) Port of Oakland, 1992.

III. Analysis and Methodology Used for Project Evaluation Prior to Investment Decision

The port is city enterprise and as a financially self-sufficient organization, the main factors used in the decision to invest in various airport-related and seaport-related expansion and/or rehabilitation are the revenues such projects would generate and their financial feasibility. In particular, when issuing debt, the port must consider the ability of the investments to pay the debt service.

Prior to issuance of the 1992 Series E Bonds used to help finance certain aviation and maritime projects included in the 1992 investment program, port officials commissioned a team of consultants[2] to carry out a financial analysis focusing on the future debt service coverage. In their Feasibility Report (Appendix A of the Official Statement on Revenue Bonds, 1992 Series E), the consultants set forth their assumptions and projections and concluded that the port's planned development and acquisitions were financially feasible, based on the "projected debt service coverage."

The indicator usually measured and cited as evidence of a port's importance to the economy of the area is its regional economic impact[3]. Most ports and airports in the US periodically update and publish an estimate of their economic impact.

The regional economic impact of developing and maintaining a seaport and/or airport is measured in terms of the employment it provides and the goods and services it consumes. Usually, four general categories of impacts are defined: direct, indirect, induced, and related. Direct impacts are direct consequences of port activities. These impacts are usually measured in terms of income distributed and employment generated. Indirect impacts derive from off-site economic activities attributable to the port and/or dependent upon port activities. These indirect activities include those of construction contractors, suppliers of materials and equipment to the port, retailers, restaurants and hotels. Induced impacts are the increases in employment and income over and above the direct and indirect impacts, those created by successive rounds of spending. Induced impacts can be roughly estimated by applying a multiplier to the aforementioned direct and indirect impacts[4].

Related impacts represent activities not as clearly dependent upon the port as direct and induced impacts, but which reflect the importance of the port as a catalyst for development. The related activities include activities of exporters and importers using the port facilities.

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[2] Aviation Planning Associates and Booz-Allen & Hamilton

[3] See Federal Aviation Administration "Measuring the Regional Economic Significance of Airports", September 1992.

[4] Aviation-related activities, standard regional multiplier values have been empirically established by the US Federal Aviation Authority, based on population size and regional import content of the region considered.

A. Aviation Economic Impact

A 1992 study carried out by Martin O'Connell Associates estimated the regional economic impact of the Oakland airport. Impacts were analyzed in term of jobs, personal and business income. At that time, airport operations supported 6,134 direct and indirect[5] jobs at the airport and 2,701 induced jobs in the State of California. Another 42,000 jobs were supported in the Bay Area as a result of visitors arriving via Oakland International airport. In addition, $1.3 billion was distributed as personal income to state residents. Total business revenues generated added up to $3.6 billion.

Impacts were also analyzed in terms of tax revenues generated. In theory, tax revenues are not usually considered economic benefits, since they simply reflect a transfer of income. For a government jurisdiction, however, competing for development and tax revenue with adjacent jurisdictions, the generation of additional tax revenue can be another factor in their decision-making.

This economic impact represents the contribution of the airport investment at one point in time to the region as a whole. It represents the impact of the entire investment since the facilities were first developed, and does not represent an attempt to measure the economic impact of a specific past investment over the life of the investment.

The specific employment and income impacts of the individual investments were not documented. Port officials who were interviewed noted that an impact analysis of the 1992 investment program was carried-out through the use of an input-output model, but the results of these analyses are not available to the public.

It is also worth mentioning that no attempt was made to estimate the transportation benefits of the aviation investment package. The latter are benefits that a community expects to obtain by developing and maintaining an airport and include the time saved and cost avoided by using air transportation.

B. Maritime Economic Impact

A 1991 study carried out by Martin O'Connell Associates estimated the impact of Oakland Port maritime activities on regional employment and personal and business income. Maritime operations generated 6,700 direct jobs, 2,800 induced jobs, and 179,300 related jobs at the time of the study. No estimate of the indirect employment impact was given. Personal and business income generated by port operations stood at $430 million and $729 million, respectively.

As with the aviation investment discussed above, this economic impact represents the contribution of the seaport investment at one point in time to the region as a whole. It represents the impact

[5] The report indicates that since many industries serving the Airport are located on the Airport property, impacts on these supplying industries are considered as direct impacts.

of the entire investment since the facilities were first developed, and does not represent an attempt to measure the economic impact of a specific past investment over the life of the investment. Similarly, no estimate of the transportation cost savings to users was estimated.

The specific employment and income impacts of the individual investments were not documented. The port has also released its estimate of the economic impacts of constructing six new berths and an intermodal rail yard using land leased from the Navy Supply Center. The port estimates these investments would generate 2,800 direct and 1,300 induced jobs, produce $187 million in personal income, $15 million in taxes, and $500 million in business revenues.

IV. Project Objectives Achieved and Results After Investment

As of 1991, airport operations supported some 50,835 jobs, $3.6 billion in business revenue, and $1.3 billion in personal income. In addition, in 1992, maritime operations generated some 188,800 jobs, $729 million in business revenue, and $430 million in personal income. Although the above economic impact is not tied to any specific investment, to put things in perspective, it is clear that the current level of operations at the Oakland seaport and airport would not have been possible without past investment efforts totaling some $840 billion as of mid-1993. However, no analysis of the net benefits compared to costs of these investments has been developed.

To illustrate the importance of facility investment to attract port business, one can point to the historical development of the container and intermodal business along the west coast. Oakland was the first port in the west coast to build specialized container handling port facilities, as early as 1962. However, during the 1968-74 period, the competing ports of Los Angeles and Seattle made significant investments in container port facilities and were able to attract significant business and gain parity with Oakland. In the 1980s, intermodal transportation developments focused on the initiation of double-stack services to the midwest and east coast of the US, requiring tunnel clearances that not all railroads could provide from Oakland. LA/Long Beach developed a new Intermodal Container Transfer Facility 4 miles from their container berths to minimize drayage costs from the rail yard to the berth. Seattle and Tacoma developed several facilities with on-dock rail access. These west coast ports also were able to provide deeper access channels, while Oakland's channel deepening was delayed primarily due to lack of approved disposal areas. As a consequence of Oakland's inability to invest in new port facilities at the same rate as competitive ports did, the port lost a significant share of the west coast market.

V. Lessons From Case Study

The case study sheds some light on the relationship between transportation investment in a major US port and airport organization and the economic development generated. The investment criteria usually considered by port officials include the following:

(1) financial viability, measured typically by the payback period and debt coverage ratios,

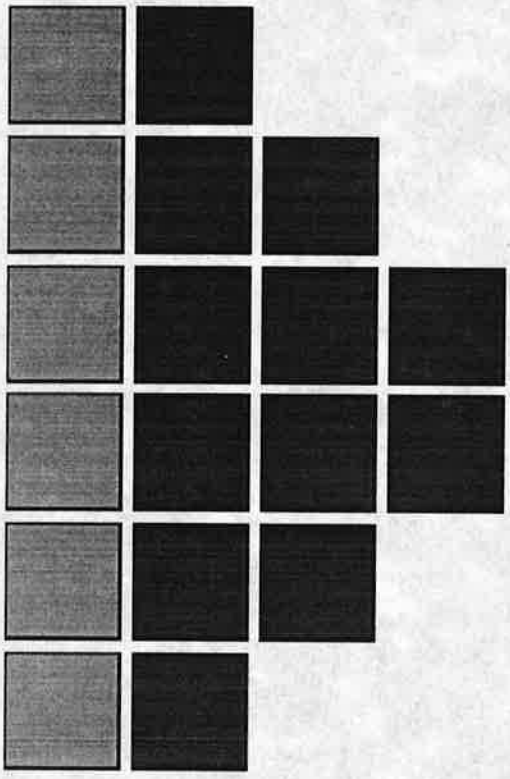
(2) the regional economic impact of the project(s), as measured by the number of jobs and the amount of income generated.

Port and airport investments, such as those in Oakland, are also aimed not just at serving local industry and maintaining the competitiveness of the area's industries, but also at attracting new companies through cargo and related jobs and economic activity that otherwise would flow through a competitive gateway. These type of transportation investments

- are important direct generators of economic activity and revenue production, through their operations and through their attraction of transhipment, cargoes and/or transfer passengers;
- meet increased trade needs, through capacity expansion;
- increase productivity of port operations and reduce cargo handling costs, through technology applications and other innovations,;
- typically represent a significant catalyst in nearby land development, such as warehousing and other related distribution businesses; and
- make an area more attractive to business location decisions, since businesses and individuals seek access to more efficient port operations, with adequate capacity, fewer delays, easy cargo intermodal transfers and access to highways, and increased services connecting to foreign and domestic markets.

Port and airport investments are also major factors in the economic development competition among various areas in the US. One could argue that a national airport and port strategy would be appropriate to avoid overcapacity and wasteful investments. On the other hand, one could counter that the competitive system encourages lower user costs and efficiency in operations that would otherwise not exist under a centralized investment policy.

In conclusion, although it is no simple matter to measure the linkage between these port and airport investments and increased economic productivity and development, the importance of these investments to growth of regional economies in today's increasingly global economic environment is intuitively clear.



Appendix I

Case Study VIII:

Metropolitan Beltways - Routes 128 and I-495, Boston

LOUIS BERGER INTERNATIONAL, INC.

APPENDIX I

CASE STUDY:

METROPOLITAN BELTWAYS: ROUTES 128 AND I-495, BOSTON

I. Investment Description

Route 128/I-95 is a circumferential beltway located approximately ten miles west of the Boston, Massachusetts, Central Business District. It is a half-circle since the Atlantic Ocean lies to the east. It passes by or through twenty-seven communities on approximately 66 miles of roadways extending from Braintree to Gloucester. A long segment of Route 128 has been designated as part of the Interstate system as I-95, but the original roadway was designed and built before Interstate funds were available (see Figure I-1). Route 128/I95 is a limited access highway varying from 2 to 4 lanes in each direction for a total of approximately 211 lane miles, 55 full grade-separated interchanges, 6 other interchanges, and approximately 65 other bridges, including stream, rail, and local roadway crossings. Its busiest sections serve between 80,000 to 150,000 vehicles per day.

Route 128 is of interest for at least three major reasons:

- It is considered to be the first major circumferential highway built around a U.S. city.
- It was built in segments over a 30-year period and periodically expanded.
- It has proved to be one of the most important, if not the key infrastructure element which has shaped the Boston region's growth since the late 1940s.

Interstate Route 495 (I-495) is Boston's outer circumferential highway, lying some 20-25 miles beyond Route 128. It was conceived and built as part of the National System of Interstate and Defense Highways. As shown in Figure I-1, this 6-lane limited access highway runs for a length of approximately 125 miles with 12 full cloverleaf interchanges, 37 other grade-separated interchanges, and approximately 320 bridges. Its busiest sections carry approximately 90-105,000 vehicles per day.

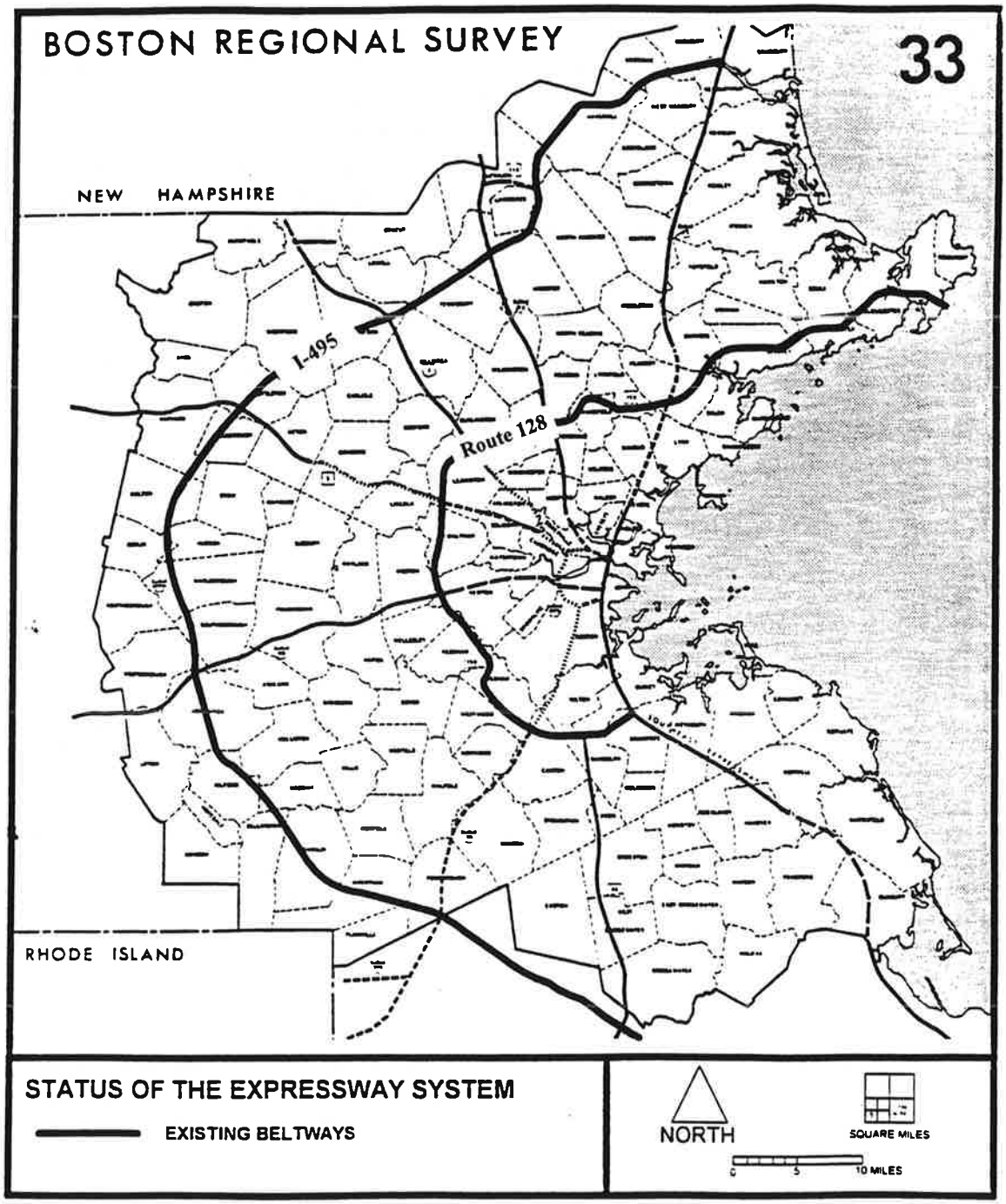
As a circumferential highway planned and built along an undeveloped area, I-495 resembles and was conceived after Route 128 achieved renown as Boston's Golden Semi-Circle success. The I-495 investment created another opportunity to follow the Route 128 example, and therefore, it could be viewed as built deliberately to shape development along the corridor.

A. Route 128

Design/Construction History - By the early 1900s, interconnected local streets allowed travel from

the South Shore to the North Shore in a somewhat circuitous route around Boston proper. When these streets were designated as Route 128 cannot be established because official records were donated to a paper drive during World War II. Nevertheless, it is clear that the concept of a circumferential highway had emerged as an element of a regional plan by 1925 in the work of Benton Mackaye, a regional planner who later helped to shape the US Forest Service.

Figure I-1 Boston's Beltways in 1995 (Adapted from Boston Regional Survey-Highways, MTC 1962)



In the late 1920s, Franklin Calhoun Pillsbury, a project engineer for the Massachusetts Department of Public Works, based his planning and mapping of a new Route 128 on Mackaye's concept. By 1929, the initial planning was finished; it proposed a roadway which shortened the existing path of interconnected roads from 80 to approximately 65 miles slightly outside its current alignment (see Figure I-2). His recommendations were incorporated by brief reference in the Report on a Thoroughfare Plan for Boston, City Planning Board (1930) also known as the Whitten Report after its chairman (see Figure I-3). It was repeated in the 1948 Master Highway Plan by the Joint Board for the Metropolitan Master Highway Plan (see Figure I-4). Route I-495 does not appear on any known plan until 1957 when it was first shown as an element of Massachusetts' Interstate System.

In a doctoral dissertation entitled Highway Development and Local Government, Levitan divided the construction of Route 128 into three distinct periods whose names reflect how the highway was viewed by the general public as well as transportation planners.

1925-1945	Road to Nowhere
1946-1957	Major Construction
1958-1972	Golden Semi-Circle

1925-1945 Road to Nowhere - The Great Depression which began in 1929 and the subsequent New Deal generated public works programs which led to the construction of the first major segments of Route 128. Highway construction based on the rationale of the Federal Highway Act of 1921, which called for federally-aided development of a logically interconnected system of highways, was used to relieve unemployment. In addition, the Federal Housing Authority underwrote the building of homes in the suburbs in a process which, over time, increased demand for the highway. The post-Depression concept of the regional city also helped to create a climate in which circumferential roadway construction became desirable. The design pursued was based on the Pillsbury plan referenced in the Whitten Report.

Under this program, the first improvements to Route 128 were made in 1932 and 1933, when nine miles of three-lane and four-lane undivided highway were built on new locations in the towns of Needham, Dedham and Canton, between Routes 1 and 138. Cloverleaves were constructed at all important cross roads, but several minor roads were allowed to cross at grade. Residential development spread along the road in Needham, and commercial establishments soon lined the highway near Route 1 north of Boston. Nevertheless, the "Road to Nowhere" nickname stuck during this period because Route 128 did not connect major activity centers.

1946-1957 Major Construction - Following World War II, a five mile section of the four-lane divided highway was built westward from Route 1 to Wakefield, and the prewar section ending in Beverly was extended in stages as a four-lane limited access highway to Gloucester. In August 1951, the longest link to be built at one time was completed. This section consisted of twenty two and one half miles from Wakefield to Route 9 in Wellesley, a four-lane, fully controlled access highway bypassing the congested business districts of Wakefield, Stoneham, Woburn, Lexington, Waltham and Newton. It provided, for the first time, an effective, high speed circumferential highway around

Figure I-2 Route 128 as Proposed in 1925 and as Built in 1995 (Adapted from Trustees of Reservation map cited in Whitten report)

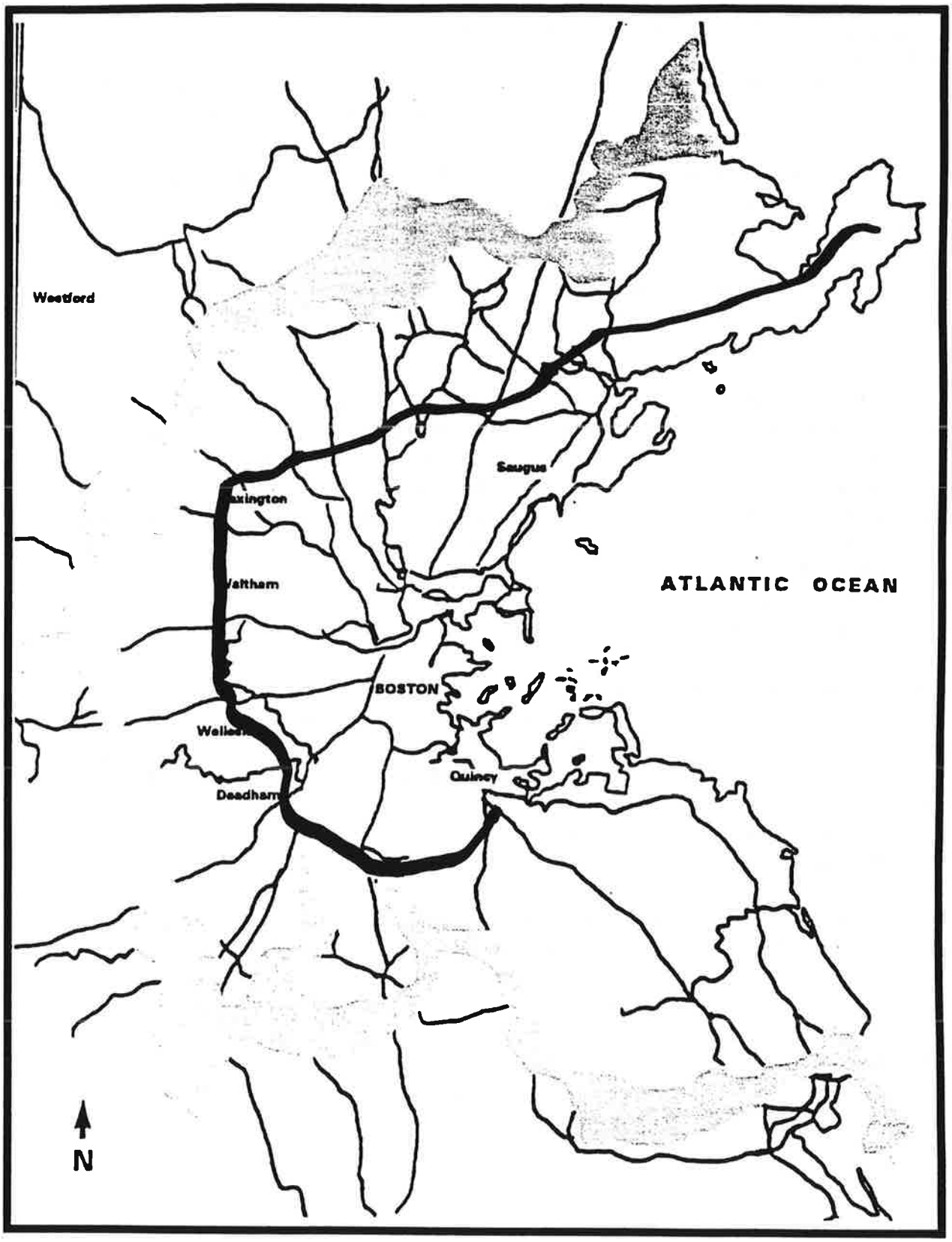


Figure I-3 Route 128 as proposed in 1930 Thoroughfare Plan, "Whitten" Report (Adapted from Boston Regional Survey-Highways, MTC 1962 and from Trustees of Reservation map cited in Whitten report)

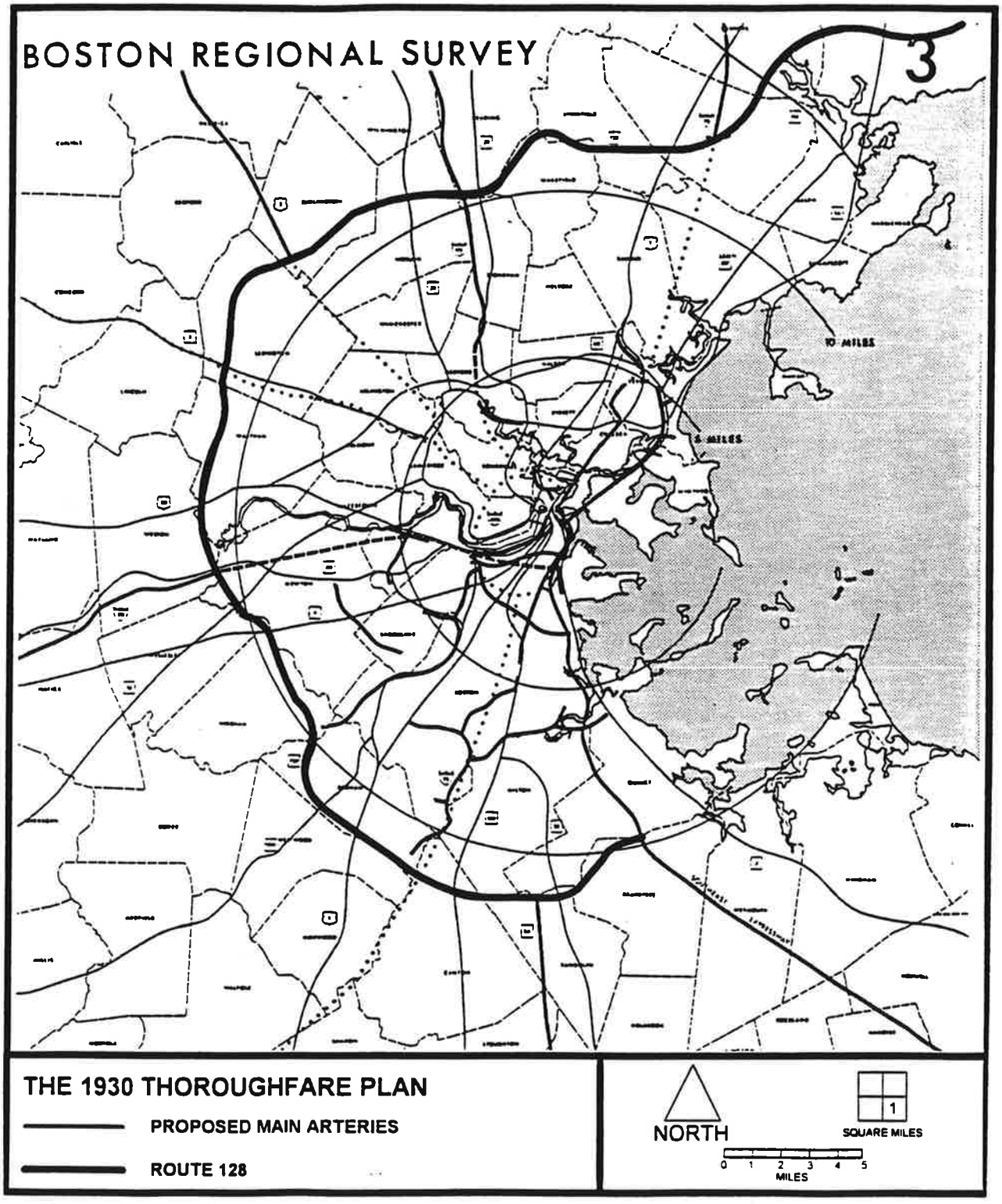
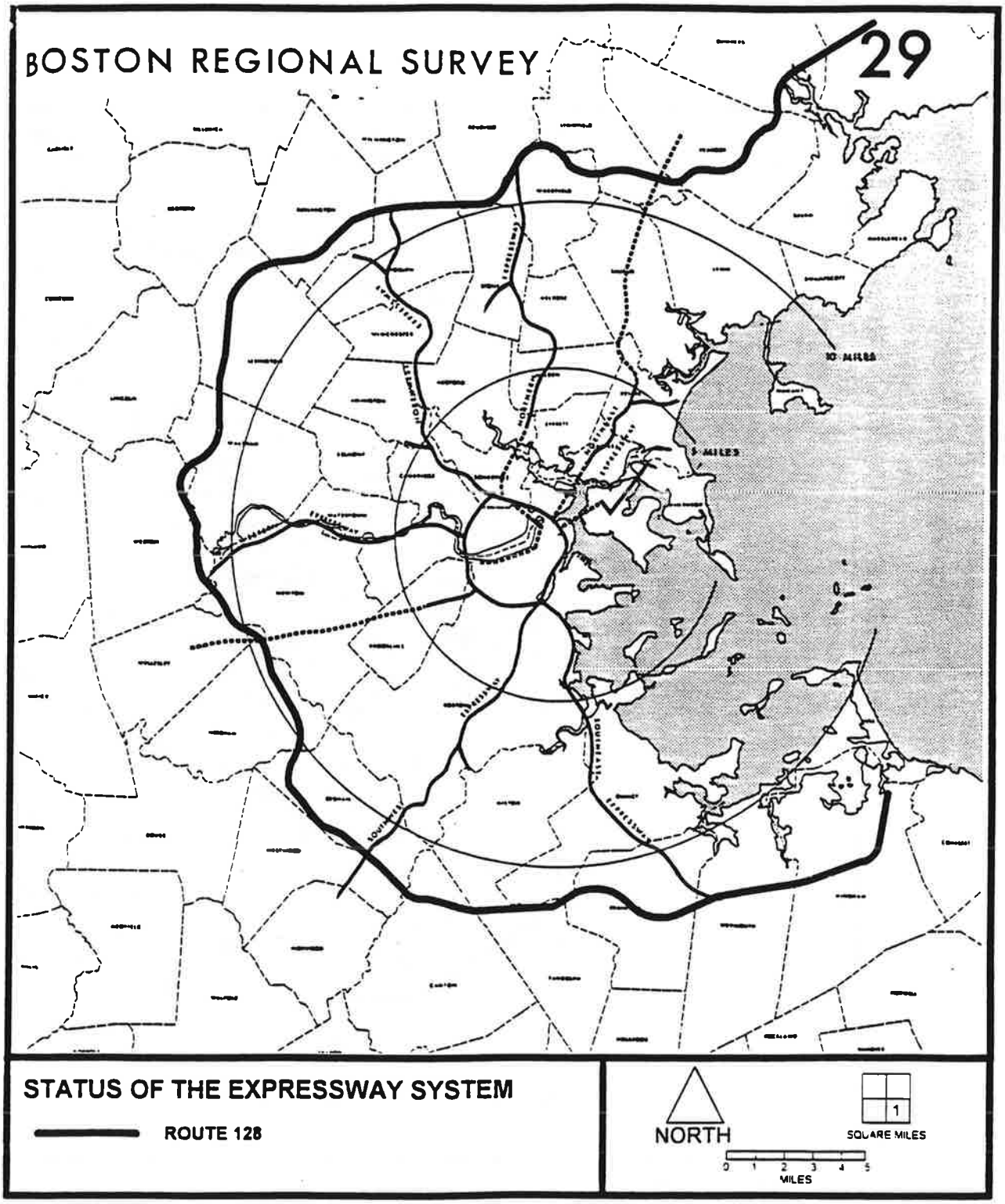


Figure I-4 Route 128 as proposed on 1948 Master Highway Plan (Adapted from Boston Regional Survey-Highways, MTC 1962)



the most congested districts of the Metropolitan area. By December 1956, work had been extended south of Route 9 as a limited access six-lane divided highway, mostly on new location, and was opened as far as Route 138. Construction then continued to a junction with Route 3 in Braintree.

1958-1972 Golden Semi-Circle - Between 1958 and 1963, a fourth lane was added in each direction between Peabody and Wellesley. Since that time, plans have been prepared for adding a fourth lane from Route 9 to Route 24 in Randolph, the only heavily traveled segment which is not 4 lanes in each direction. Completion is expected by 1996.

Investment History -- Reconstructing an accurate investment history of Route 128 capital improvements is difficult as records from prior years were destroyed during a World War II paper drive and have since been kept by year of funding rather than by highway. Construction costs were reported as totaling $62.5 million in 1957, but it is not known whether this is a simple summation of authorizations or whether it reflects escalation to 1957 dollars. Widening projects, including the necessary reconstruction of fifty bridges, added $46 million between 1958 and 1963. Construction costs through 1972 were estimated to total $119 million, including approximately $6.5 million in land purchases, without adjustments for inflation. Expansion of the Route 1/I-95 interchange in Peabody which was completed in 1991 and the still proposed lane widening project from Route 9 south add at least $70 million in 1993 dollars to overall investment. Perhaps the simplest way to estimate investment in Route 128 is to note that replacement cost of its major facilities would be approximately $2.4 billion in 1993 dollars, excluding land acquisition.

Construction and reconstruction funding for Route 128 have been shared between the State of Massachusetts and the Federal government. Federal funding programs include the Federal Highway Act of 1921; New Deal programs for highway construction and the Federal Aid Highway Act of 1944; the Federal Aid Highway Act of 1956 and its subsequent amendments, which made the Interstate Highway System possible; and the passage of the Intermodal Surface Transportation Efficiency Act in 1991. Over time, the federal aid share of construction costs has ranged from 20-90%.

The Federal Aid Highway Act of 1944 provided for construction of a national system of interregional highways after World War II. The grant formula of 50% federal funds and 50% state funds made the construction of Route 128 very attractive. After 1956, when the interstate highway system was funded by Congress, federal funds were relied on for improving and maintaining Route 128. It was some years before Route 128 became part of the interstate system; for a variety of political reasons, only the roadways from Lynn to Randolph became part of the interstate system as I-95 in 1990 and more southerly segments part of I-93.

The State portion of funding has typically come from general revenue obligation bonds. Decisions to construct segments of Route 128 occurred over several decades as a function of unallocated funding and the state's interest in spending its discretionary funds to leverage federal funds.

B. Route I-495

Although construction of Boston's outer beltway started in the 1950s and was substantially complete by the early 1970s, surprisingly little detail is available about its history. This may be partly the result of the fact that it has not, to date, generated an identity as an economic engine as strong as that of Route 128. It may also be partly the result of the fact that it was conceived and decided upon at a time when such decisions were made with little scrutiny from the public or various governmental entities, and the emphasis was on using available funding at both the state and federal level. The evidence collected to date does not suggest articulated expectations that I-495 would work as effectively as Route 128.

A map of eastern Massachusetts suggests a kinship between Route 128/I-95 as the Inner Beltway and I-495 as the Outer beltway (see Figure I-5). Clearly the intent was to build an outer circumferential highway, but it is not known whether the success of Route 128 as an economic engine led to a reasoned decision to repeat the process 20-25 miles further out.

Construction of I-495 was financed as part of the interstate system, using approximately 90 percent federal funding, with the matching funds provided by the state. Today, the estimated replacement cost for Route I-495 is 2.8-3.0 billion, exclusive of land costs.

II. Investment Objectives and Decision Making Process

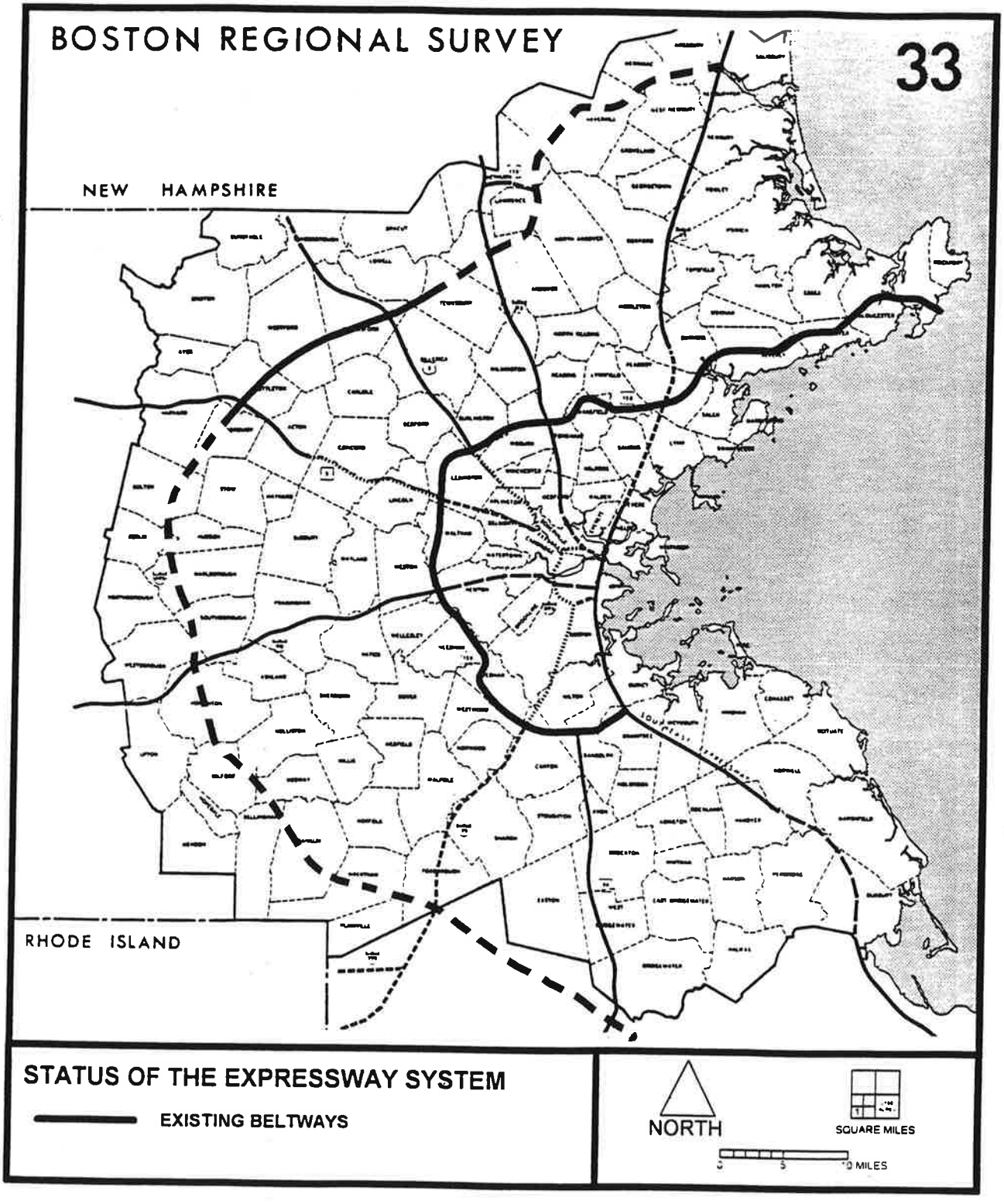
The process used to support the investment decisions for routes 128 and I-495 were markedly different. The first involved extensive planning to establish the need for new roadways; however, the traffic analyses and forecasts did not focus on Route 128. The second did not involve detailed study of any kind to justify construction. Neither decision involved extended economic analysis or setting of objectives prior to proceeding, and both highways were, in great part, built to generate construction jobs.

A. Route 128

Until the late 1950s, Route 128 was primarily justified on the basis of transportation need such as reducing congestion on existing radial roadways. Although its role as an economic catalyst for the region has since been recognized, federal funding requirements focus attention on transportation rather than economic performance. Thus, except for minimizing the overall cost of land acquisition and awarding construction contracts via a low-bid process, formal economic analysis has played no role in decisions to build Route 128 or its subsequent improvements. The reasoning expressed in the 1930s summarizes the approach to justifying Route 128 improvements through the 1980s:

> "The proposed express roads and other projects are costly but not nearly as costly as the present congestion and delay." (Whitten 1930, p. 14)

Figure I-5: Routes 128 and I-495 in the Boston region, as of 1962 (Adapted from Boston Regional Survey-Highways, MTC 1962)



The initial objectives of Route 128 were quite different from its roles as a catalyst and vital infrastructure for development of the regional economy. Transportation planners focused on improving the transportation performance of existing systems of public transportation and radial highways. They were dealing with solving the problems of the day rather than how a highway such as Route 128 might influence future changes in the economy or land development patterns. Route 128's role as a collector-distributor for the Boston Metropolitan area was probably not generally realized or well understood until the 1950s. As with most innovations, people did not grasp the role Route 128 could play in economic growth and development until it had already assumed that role.

For example, Benton Mackaye, who first suggested the development of a beltway to the Massachusetts Legislature in 1925, based his concept on the Garden City ideals of Howard and Stein. He wanted to ensure that local businesses and residences would be unaffected by the new facility. To accomplish this, Mackaye proposed what was in effect a metropolitan area bypass, i.e. a highway which went along the edges, but did not traverse the center of cities on its path; he described this concept in an article entitled "The Townless Highway." It was to be called the Bay Circuit and gained support from The Trustees of Reservation, a major regional conservation group (see Figure I-6). He also wanted to create a regional authority to ensure that only rural areas would border the highway.

The highway plan of 1927-1930 was based on Mackaye's original concept of bypassing congested downtown Boston, without impacting the rural hinterlands beyond land taking. The unexpectedness of the effects of Route 128 is illustrated by the fact that Whitten (1930), Coolidge (1946), and the Master Highway Plan (1948) based on its predecessors included Route 128, but made no traffic assignments to it, and proposed no priority for its construction. The Master Plan stated that the purpose of the highway was to

> "provide ready access to the North and South Shore recreational and residential areas for traffic from the Metropolitan area and the Western section of the state." (Joint Board for the Metropolitan Master Highway Plan, 1948)

It saw the projected use of the facility as follows:

> "Most of the route is in suburban areas beyond the limits of congested developments. The new location is such that right-of-way taking will be held to a minimum and the highway can be developed prior to further expansion of population outward from the Metropolitan Area. This highway should serve a useful purpose in connecting the various radial expressways and other important arterial highways, as well as, a bypass and outer distribution route." (Joint Board for the Metropolitan Master Highway Plan, 1948)

At the time of major construction during the 1940s and 1950s, planners thought that limiting access to Route 128 would discourage commercial or industrial use along the highway. Because manufacturing was then concentrated in downtown cities near railroad termini, they did not expect industry to notice the benefits of locating along a new transportation system. No one anticipated the

potential role of Route 128 in affecting the patterns of land development or the levels of regional economic development that came as a result of growth in the defense industries, the new computer industry, the growth of the service sector, and the decline of downtown-based manufacturing which would follow World War II. Even the real estate development firm of Cabot, Cabot, & Forbes, which built industrial parks on cheap land near interchanges was, at first, only taking advantage of localized opportunities.

Route 128 was regarded as a bypass to improve accessibility between the spokes of a radial highway/rail system centered in downtown Boston. The potential impact of the additional connectivity was not investigated as justification for building Route 128; for example, the 1948 Master Highway Plan made no traffic assignments for the proposed completion of the roadway. The generally assumed transportation benefits of connectivity and reduced travel time seemed sufficient justification without recourse to economic impact considerations.

B. Route I-495

The person most responsible for the decision to build I-495 was William Callahan, Commissioner of the Massachusetts Highway Department during the 1950s, who had substantial independence. He had decided to complete Route 128 before deciding to build Route I-495, thus suggesting he might have had some interest in applying the successful formula of the former to the latter. Circumstantial evidence from people who worked with him during that time suggests that his rationale for I-495 was different.

Interviews were conducted with the former Chief Engineer of the Massachusetts Department of Public Works (MDPW) and a transportation planner who was one of the chief authors of the 1960-1962 Massachusetts Transportation Commission (MTC) studies which developed the transportation plans for the eastern Massachusetts region in the early 1960s. Their recollections of the sequence of events and the basis for these highway decisions are remarkably similar.

The MDPW engineer was one of the two engineers who prepared the 1957 Interstate Cost Estimate for Massachusetts. This document was the basis for funding and building I-495; there was no EIS or economic analysis for the road as a whole, as none was required. According to the engineer, Commissioner Callahan was interested in building roads to bring the economic benefits of federal funding to Massachusetts. A number of potential roadway alignments met the federal criteria for connecting cities of 50,000 or larger population. I-495 received priority not because there was a demonstrated need as in Boston's congested neighborhoods - the relevant traffic studies for I-495 were not even begun in 1957 - but because it could be built with little or no opposition and property-taking costs were low. In Boston, vehicular congestion was an undeniable problem, but the property takings involved in building circumferential "inner belt" highways would clearly lead to major political controversies that would delay or stop the project.

The pragmatic approach of building where you could rather than on the basis of the largest perceived future economic benefits was confirmed by the planner who added some further insight into the

Commissioner's rationale. Callahan was interested in building as many miles of roadways as possible and was generally acknowledged to be the most effective builder of highways in Massachusetts. He eventually moved from the Public Works department to become chairman of the newly-formed Massachusetts Turnpike Authority, where he continued his policies.

When asked where the idea for the hub and spoke/circumferential and radial patterns of the regional roadways came from, both interviewees said design engineers followed the philosophy of the 1948 Master Highway Plan for the region. The 1962 and later studies extended the concept of circumferential roadways to include an "Inner Belt" between Route 128 and downtown, an idea recently resurrected for transit purposes as the "Urban Ring." An "Intermediate Belt" was also proposed between the Inner Belt and Route 128. The 1962 document was based on the physical city planning ideas that were then current in the profession and in academia. For example, R. Davidson at Boston College pioneered the use of gravity models for estimating traffic demand, but the physical layout of his proposed solutions continued the already well-established notion that roadways should follow a hub/spoke pattern--e.g. the Boston Plan of 1930 (see description in Massachusetts Transportation Commission, 1962).

By the mid-1950s, it was generally recognized that a 1945 Origin-Destination study on which the 1948 plan was based had been done before the explosion of car ownership in the late 1940s and 1950s. Transit then carried the majority of commuters to work in Boston, and it was assumed this pattern would continue. The 1930 and 1948 highway plans and their successors through the 1960s continued to stress the importance of transit as a major travel mode and means of reducing urban congestion. In fact, nearly all of them devoted significant numbers of pages to transit ridership analysis and forecasts. The 1948 plan went so far as to propose building a transit line in the median of the proposed I-95 in Boston. Nearly every succeeding transportation plan for the region has recognized the importance of providing public transportation in reducing roadway congestion, but this did not have much effect on decisions until after the completion of the Boston Transportation Planning Review in 1972.

Despite the obvious need for revision, the 1945 O/D survey was not significantly updated until 1965. Nevertheless, it was used to justify all of the inner and outer ring highways planned for the Boston region during those two decades. Since all of the highway plans through the mid-1960s emphasize the role of transit in relieving downtown Boston congestion, one may wonder at the continued pressure to build highways in undeveloped areas rather than transit in the urban area. Certainly, the availability of federal interstate funding and the imbalance in federal funding helped tilt decisions towards those roadways, at least they could be built and roadway congestion was an everyday problem that commanded public attention.

The transportation planner also pointed out that up through the 1950s, before the economic base of communities such as Lowell, Lawrence, Haverhill, and Brockton declined, their needs for interconnections were considered high priorities. Conceptually, Route I-495 was the link between interchanges that would connect these communities to each other, extending the concept of the 1948 Master Highway Plan to the eastern Massachusetts region as a whole. He noted that traffic analysis

was only used to establish the numbers of lanes a highway should have rather than whether to determine whether and where a highway might be built, as is sometimes the case today.

I-495 was located as much as possible along and between town boundaries. Part of the reasoning was based on avoiding controversy, but this approach also protected town centers, as per Mackaye's 1925 strategy, which determined the routing of Highway 128: In addition, locating the highway to avoid town centers also lowered the costs of property takings. A cost estimate for the facility, based on unit costs, was developed early on, and in 1964, allowed Massachusetts to preserve most of its interstate allocation and thereby provide the needed funding.

III. Analysis and Methodology Used for Project Evaluation to Support Investment Decisions

Although no comprehensive project evaluation was conducted prior to the decision to build Route 128 or I-495, the success of Route 128 has engendered a history of analysis to gain insight on the reasons for its effectiveness. Economic analysis, transportation planning and demand analysis, and before-and-after studies have all been used regularly to study Route 128 and its role in the regional highway system. To date, Route I-495 has not received a similar level of attention.

A. Route 128

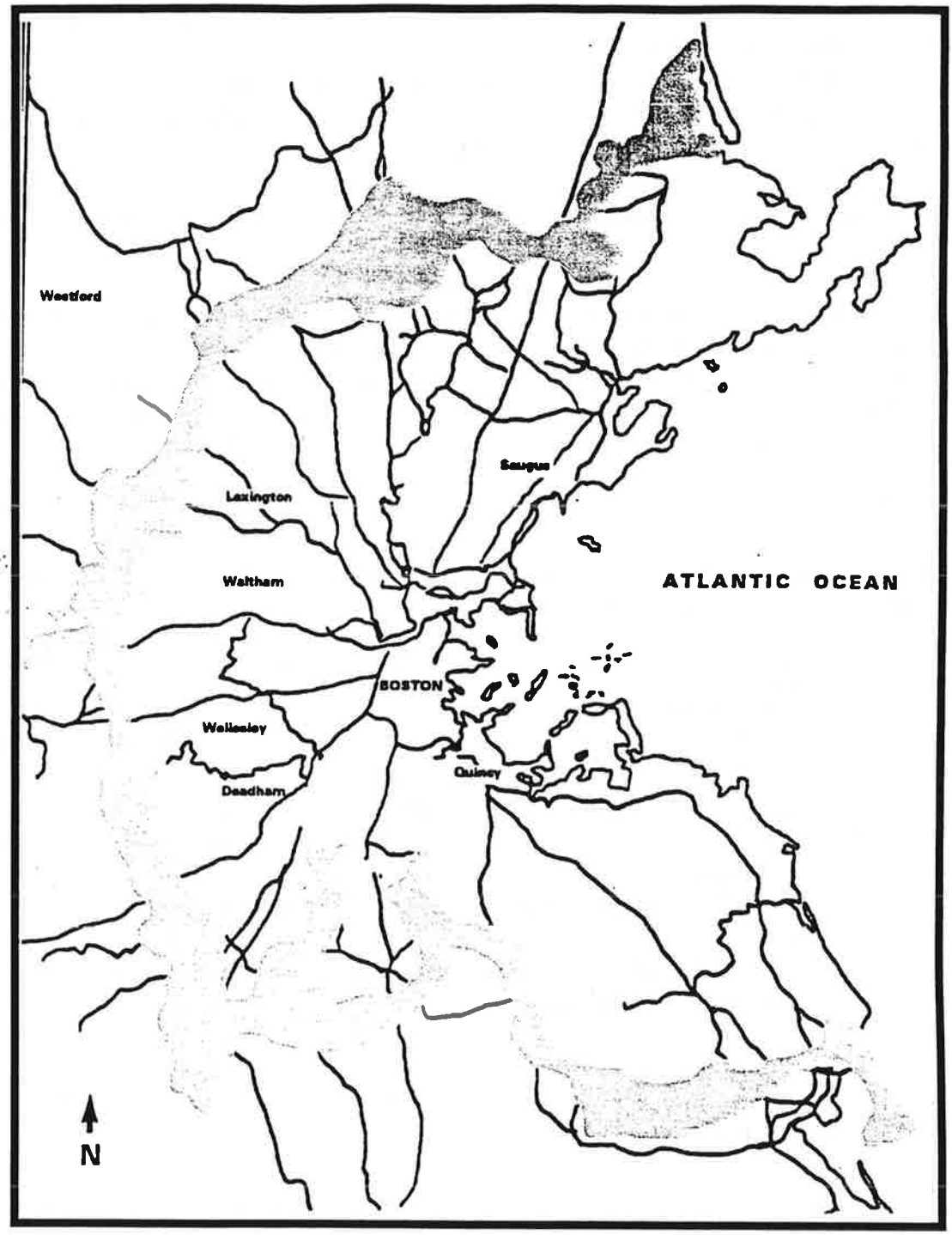
A number of studies have contributed to the continuing evolution of Route 128. The most notable in a transportation planning sense are

1. Thoroughfare Plan for Boston, the "Whitten" Report (1930)
2. The "Coolidge" Report (1946)
3. The Master Highway Plan by the Massachusetts Department of Public Works (1948)
4. Boston Survey by Mass Transportation Commission (1962)
5. Eastern Massachusetts Regional Planning Study (1963) by the Massachussetts Department of Highways and others, which forecasted future travel demand in eastern Massachusetts including the Route 128 corridor
6. Various Boston Transportation Planning Review documents addressing segments of Route 128 (1969-1972)
7. Environmental impact statements for individual projects such as the widening project from Route 9 to Route 24 in Randolph, begun in 1984.

Despite its lengthy history and gradual transformation into an entirely limited access facility, Route 128 essentially follows the alignment first presented in the late 1929 design by MDPW, i.e. closer to Boston than Mackaye's proposal (see Figure I-6).

In the period between the 1930s and 1950s, decisions to build segments of Route 128 or to improve it appear to have hinged on a combination of perceived transportation needs and the availability of federal funding for specific types of improvements. Quantitative economic analysis appears to have

Figure I-6: Mackaye proposal for Circumferential Roadway and Park based on 1925 plan (Adapted from Trustees of Public Reservation map, 1933)



been limited. In 1948, the Department of Public Works' Master Highway Plan addressed the economics of Route 128 in a special section: "Economic Justification." The justification was based on formulas comparing the cost of building the highway versus the cost of driving time, the "immeasurable" benefits of less traffic accidents, and the more efficient operation of public bus service. However, the greatest economic value the highway was expected to provide was an increase in property values in the central business district of the Metropolitan area by drawing traffic out of the city to the beltway. Property values did indeed increase, but the increases followed vehicular traffic away from downtown, where overall assessed valuation dropped 6 percent between 1947 and 1958.

The basic methodologies applied in highway planning included analysis of the implications of origin/destination studies, related traffic forecasts with 25-35 year time horizons, and estimates of travel time savings. Corridor studies were driven by the interest in reducing existing roadway congestion, primarily in Boston and its immediate suburbs. Analysis prior to investment decisions focused almost exclusively on forecasting traffic needs, with sometimes surprising accuracy. For example, Whitten (1930) estimated that Boston-area traffic would be 2.1 times greater in 1965 than it would be in 1927, less than 10% off the mark. Later forecasts vastly underestimated the level of traffic on Route 128 in 1975. While traffic attracted to a facility is an indication of the economic benefits the facility generates, since economic analysis is generally based on traffic demand, it is obviously not a substitute for a comprehensive economic analysis of benefits and costs.

The major traffic studies, including the 1930, 1948, and 1962 planning studies, relied on the results of the 1945 origin/destination survey, conducted at a time when transit was still the major mode of transportation in the Boston area, to provide baselines for future growth. By 1957, the social and economic impacts of Route 128 on the region were beginning to be noticeable. Publications began to refer to the "magic semicircle" around Metropolitan Boston as an economic engine that seemed to generate jobs by its very existence; however, some observers noted that its construction had reduced the ability of poorer, inner-city residents to get to the better paying jobs in the suburbs. In fact, over 96 percent of the industries located along Route 128 in 1957 had come from within 4.5 miles of downtown Boston; people without cars could not easily get to jobs along Route 128's suburban interchanges.

In 1957, the Massachusetts Department of Public Works and the U.S. Bureau of Public Roads began an investigation into the basic factors underlying the changes that had taken place along the highway. The investigation was conducted by A. J. Bone and members of the MIT Department of Civil Engineering. This investigation was the precursor to an Economic Impact Study of Massachusetts Route 128 (1958). This study was commissioned to provide more detail on the 1957 findings. Its results were used to justify the continued construction of the highway as well as the reconstruction and widening of congested sections. It probably also played a role in justifying the decision to build I-495 as an outer circumferential, approximately 20 miles to the west of Route 128.

The 1957-1958 studies are probably the only detailed, quantitative economic analyses performed on Route 128 prior to construction of new improvements. The study was conducted at the same time

as the first phases of the planning and design of the roadway improvements it was expected to justify and did not set economic objectives or propose performance criteria.

Since the advent of EISs in the early 1970s, economic analyses for Route 128 improvements have addressed short-term and long-term job creation and travel time savings. They have addressed economic performance in a superficial way via multiplier effects. At best, economic analysis is used to compare alternative alignments, not to determine whether a new roadway corridor or other mode has better economic potential for the regional economy than another. In these circumstances, it is not surprising that EISs set forth no economic objectives whose achievement might be assessed over time. Such economic analysis is not required of highway agencies and thus plays no material role in the technical analysis preceding highway decisions.

In 1974, the Massachusetts Department of Commerce and Development conducted a survey for the period from 1955 to 1973 tracking the number of companies along Route 128, the ratio of employees to companies, the type of operation and other information pertinent to the study of economic development along what was then called the "Golden Semi-Circle."

In 1992, the Metropolitan Area Planning Council (MAPC) completed a draft of the Route 128 Corridor Study, which provides an overview of trends in the roadway corridor from 1951-1988 or 1951-1991, depending on the topic. It focuses on changes in population, employment, and land use along the entire corridor aggregated at the town scale rather than the 1-mile "access" corridor used in the MIT studies. The MAPC work reports on later stages of the highway life-cycle when the highway is essentially completed, the service hinterland in areas abutting interchanges is relatively completely developed within existing zoning, and capacity/throughput become the real issues.

- **Methodology of 1957 - 1958 Studies**

Both the 1957 studies and their 1958 updates investigated land use change that had taken place along Route 128, the basic factors underlying such changes, and the traffic generation characteristics of the industrial development adjoining the highway.

> "The purpose of [the] study, sponsored by the Massachusetts Department of Public Works and the U.S. Bureau of Public Roads, [was] to make a more thorough investigation of the basic factors underlying the changes that [had] taken place along the highway." (Source: MIT, Transportation Engineering Division, Department of Civil and Sanitary Engineering; Economic Impact Study of Massachusetts Route 128, December 1958)

The communities of Needham and Lexington were used in case studies to evaluate direct impacts from the Route 128 development within a one-mile "access" zone by comparing its evolution to a "control" area farther from the highway. The former consisted of businesses that had located along the highway after its construction whereas the latter were industries that had been located in the Route 128 area prior to new construction. The survey asked the first set of businesses why they had chosen to locate along the highway. The second set were asked what benefits, if any, were received

as a result of the building of the new highway. In addition, an origin/destination survey was used to evaluate the impact of Route 128 on metropolitan area development and traffic patterns.

The basic empirical question was whether locations within one mile of interchanges showed more economic value, e.g. number of jobs, larger values, larger tax revenues, etc., than those further away. A number of related questions were also examined, e.g. the origin and destination of workers and what influence, if any, the use of Route 128 had on work-residence decisions. A literature search of previous studies along with a search for available data particular to Route 128 were conducted prior to performance of four surveys:

1. Industrial and commercial developments along the highway and in nearby areas, 1945-1957;

2. Residential building activity, property values and sales before and after highway construction, within 2 miles of interchanges in ½ mile increments, 1945-1957;

3. Origin/destination survey to study Route 128 traffic, including trends in volumes over a period of years;

4. Travel patterns of employees before and after employment at a Route 128 plant.

Surveys were initially conducted in 1957 and, where possible, updated in 1958. The surveys of industrial and commercial enterprises were conducted by direct interviews with company officials, making it possible to obtain information on capital investment in plant, type of operation, factors considered in choosing a site along Route 128, other sites considered, and advantages and disadvantages expected and realized by virtue of the particular plant location.

Percentage distributions of industrial and commercial investment were broken down according to the type of business: distribution, production, research & development, and service. The distribution of employment and the total number of plants were also compared. These same four types of business were used to aggregate figures on the investment in land, building and equipment for those along the Route 128 corridor and throughout the metropolitan region. The net gain in investments and job opportunities were calculated and tabulated for new operations and relocated operations prior to 1957 and, where possible, updated to 1958.

Increases in residential population for the towns along the corridor were measured for various towns. The increase in roadside establishments, gas stations, motels, restaurants, etc. were also tabulated. Assessed real estate valuations of the areas immediately adjacent to the highway were compared to those of the rest of the town.

- **Analysis of Economic Expansion and Development Considerations**

An unstated assumption of both the 1957-58 and 1992 studies is that more employment and more construction represent regional economic growth and development. The analyses were done on the basis of net *regional* change, i.e. without regard to whether this growth meant relative decline in other areas. Typical city vs. suburb equity questions are not addressed at all although the 1958 study recognizes the shift in jobs and property value from Boston itself to the Route 128 area. The clear implication is that a net gain in regional employment benefits everyone in the region. Whether the improvements in economic indicators would have occurred without the highway that prompted so many businesses to move out of central city neighborhoods is not addressed.

The 1957-1958 analyses are quite detailed for property values, tax revenue, and traffic volumes. The 1992 study was designed to give area decision-makers a sense of the remaining development potential in Route 128 communities on the basis of existing zoning. The study reports the changes in land use acreage for residential, commercial, and industrial purposes from 1951 to 1988. It was not designed as an economic study as such. While the state of Massachusetts and local communities now have sufficient computerized data bases to update specific aspects of the earlier studies, additional research would be needed to make worthwhile comparisons.

These studies do not address socioeconomic questions such as which sectors of society benefited or were disadvantaged by the construction of Route 128. EISs do report some of this information for adjacent areas impacted by a project. But, as noted earlier, EISs only report pro forma economic analysis based on multiplier effects, without elaboration or extended interpretation. Because they are project specific, they provide only fragmentary data about changes in the economy of the communities affected by Route 128 projects.

The history of Route 128 shows that rigorous economic analysis was not used in making decisions about highway location, investment in other forms of transportation, or the impacts of future growth on the central city. The focus was on potential transportation benefits and economic benefits were assumed to follow.

Rigorous economic analysis of the kind needed to inform investment decisions in transportation facilities has had no role in decisions to build and upgrade Route 128 over the years. Travel time savings analysis always supported further improvement since they were conducted when new roadway capacity was needed. Cost minimization influenced decisions to locate the roadway on the edges of communities, their generally less developed areas. Interchange locations were mostly dictated by existing radial roadway locations. Cost considerations prompted by federal aid requirements clearly influenced the timing of improvement decisions and the effort to include Route 128 in the interstate system.

B. Route I-495

No economic or other analysis was undertaken in deciding to build Route I-495 beyond preparing

a cost estimate to secure federal funding. The decision was based on meeting Federal guidelines for interstate funding and the construction jobs that would be generated.

The future alignment of I-495 was laid out as a line on 1:2000 topographic maps of the area. To estimate costs, a preliminary profile of the roadway was drawn in order to estimate cut and fill quantities, the number of bridges, and interchanges. When the national interstate cost estimate was subjected to cost justification analysis in 1964, Massachusetts preserved most of its $1.1 billion allocation because other states had only estimated cost on a per-mile basis.

IV. Project Objectives Achieved and Results after Investment

The impact of Route 128 on land and property values near interchanges has been studied extensively. No such information is known to be available regarding Route I-495, but clearly development has taken place along the I-495 corridor since it was built although not to the same extent as in the case of Route 128.

A. Route 128

Since no quantitative economic objectives or performance criteria were presented as justification for construction of Route 128, a comparison of expectations and results is not feasible. Changes in population, jobs, and firms located on or near Route 128 are reported in the 1957, 1958, 1973-4 and 1992 studies, but the studies have too many different assumptions to allow meaningful comparisons.

The 1957 and 1958 studies first established that highway interchanges and local zoning had a beneficial effect on the growth of local economies. The following paragraphs will briefly summarize some of the findings of the 1957-58, 1973-4, and 1992 studies. The findings of the studies support the conventional expectation that improved accessibility means economic growth at the local level; the studies also provide estimates of the magnitude of growth.

Transportation Results - In 1973, Route 128 functioned as a vital artery connecting parts of Massachusetts to each other, to the Massachusetts Turnpike, providing direct access between the eastern to the western parts of the state, and to neighboring states. Just as originally proposed, it links residential areas to recreational destinations such as the North and South Shores, Cape Cod, Maine, and New Hampshire summer and winter. It was, and still is, a major collector link for Logan Airport, New England's major air travel and air cargo gateway.

As a highway, Route 128 has achieved many of the transportation goals set out for it. If anything, traffic forecasts have proved consistently low compared to actual demand, especially on the more heavily traveled 4-lane segments between Peabody and Wellesley. In 1957-8 over half of the employees at industrial parks along the highway used it for commuting; this enabled them to come from further away during the average 20-minute commute. Today, over 90 percent of employees of businesses located along Route 128 live within 20 miles and commute an average of 30 minutes each way between work and residence.

What was unexpected about Route 128 was that by making cheaper land accessible within a trip of reasonable length to regional resources such as downtown, universities, and Logan Airport, it would become a catalyst for economic development of the Boston region and an economic growth generator in its own right.

Economic Results - Results of the available analysis will be briefly summarized based on the various studies.

1957-8 Studies The 1957 and 1958 studies documented the effects which accompanied the construction of Route 128 in opening relatively cheap land for industrial and residential development. Using Needham and Lexington as case studies, their findings supported the general expectation that Route 128 had beneficial economic effects on communities at interchanges. They document the fact that communities which encouraged the location of industry by supportive zoning near interchanges, usually within 2-3 years of roadway construction, saw their economic base grow faster than those which did not. They suggest that the tax revenue of these communities increased much faster than the demand for services because industrial facilities were built first. This is certainly the case for Waltham, Newton, Lexington, Burlington, and Needham.

On a regional basis, the 1957-8 studies reported the following:

> "After accounting for loss of value and employment at sites vacated by Route 128 industries, the net gain [sic] to the metropolitan area represented by these industries was estimated at $80,000,000 and 11,700 in job opportunities, as of September 1957." (Source: MIT, op.cit.)

> "The increase in average sales price of residential property in both Needham and Lexington, since Route 128 was opened to Route 9 in 1951, has exceeded the inflationary trends as measured by the Boeckh index of residential costs." (Source: MIT, op.cit.)

The magnitude of these property value increases is quite large, as can be seen from Table I-1.

Table I-1: Selected Property-related changes in Lexington for the "Adjacent" zone within 1 mile of new Route 128 interchanges versus "Control" areas further away.

Criterion	"Adjacent" Zone	"Control" Zone	Difference
Assessed Valuation	180%	85%	2.12x
Val. Change within 1 mile	25%	18%	1.39x
Occupancy Permits	538%	112%	4.80x
Housing Density	37%	27%	1.37x
Housing Sales Value	132%	79%	1.69x
Route 128 Proximity Effect[a]	20%	0%	1.20x

a. Comparison of sales prices in zones adjacent to Route 128, using "Boechk" inflation index.
Source: Section V, Route 128 Study, Bone 1957

Results for Needham are similar but slightly lower because areas near Route 128 interchanges were already somewhat developed. For example, sales values which closely tracked the Boeckh construction cost index for the Boston region as a whole, show Needham zones adjacent to Route 128 to have exceeded its "Control" Zone sales indices by 16% where the similar measurement in Lexington was a 20% increase, attributable to proximity to Route 128. The most striking thing about the performance indices in the Route 128 area is their magnitude: Between 1951 and 1958, the average value of an acre within a mile of Route 128 rose from $1000-$1500 to $8000.

It is not surprising that the study concludes:

> "Although many factors influence residential building activity and the prices of houses, no detrimental effect of Route 128 on either could be found. Such evidence as could be isolated indicates that the highway has accelerated development and enhanced the values of nearby residential properties." (Source: MIT, op.cit.)

Figures I-7 and I-8 illustrate the changes in residential sales numbers and prices for Lexington and Needham.

1974 Study A Massachusetts Department of Commerce and Development 1974 analysis of the period from 1955 to 1973 compared the number of companies along Route 128, the ratio of employee to company, the type of operation and other information related to the economic development along what was then called "The Golden Semi-Circle." From 1955, the total businesses in the area grew from 39 to 1805, with more recent growth emphasizing the service sector of the economy (offices, distribution and warehousing), as is the case nationally (See Table I-2).

Table I-2 Distribution of businesses along completed sections of Route 128 from 1955 to 1957. Source: Section V, Route 128 Study, MIT 1958)

Year	Manufrg	R&D	Warehouse	Distribution	Office	Total
1955	-na-	-na-	-na-	-na-	-na-	39
1957	-na-	-na-	-na-	-na-	-na-	140
1958	-na-	-na-	-na-	-na-	-na-	209
1960	-na-	-na-	-na-	-na-	-na-	258
1961	-na-	-na-	-na-	-na-	-na-	396
1962	-na-	-na-	-na-	-na-	-na-	574
1967	210	123	82	119	263	797
1973	329	150	169	321	836	1,805

Figure I-7: Changes in Residential Land Values in Lexington, 1951-1957 (Adapted from Bone, 1957)

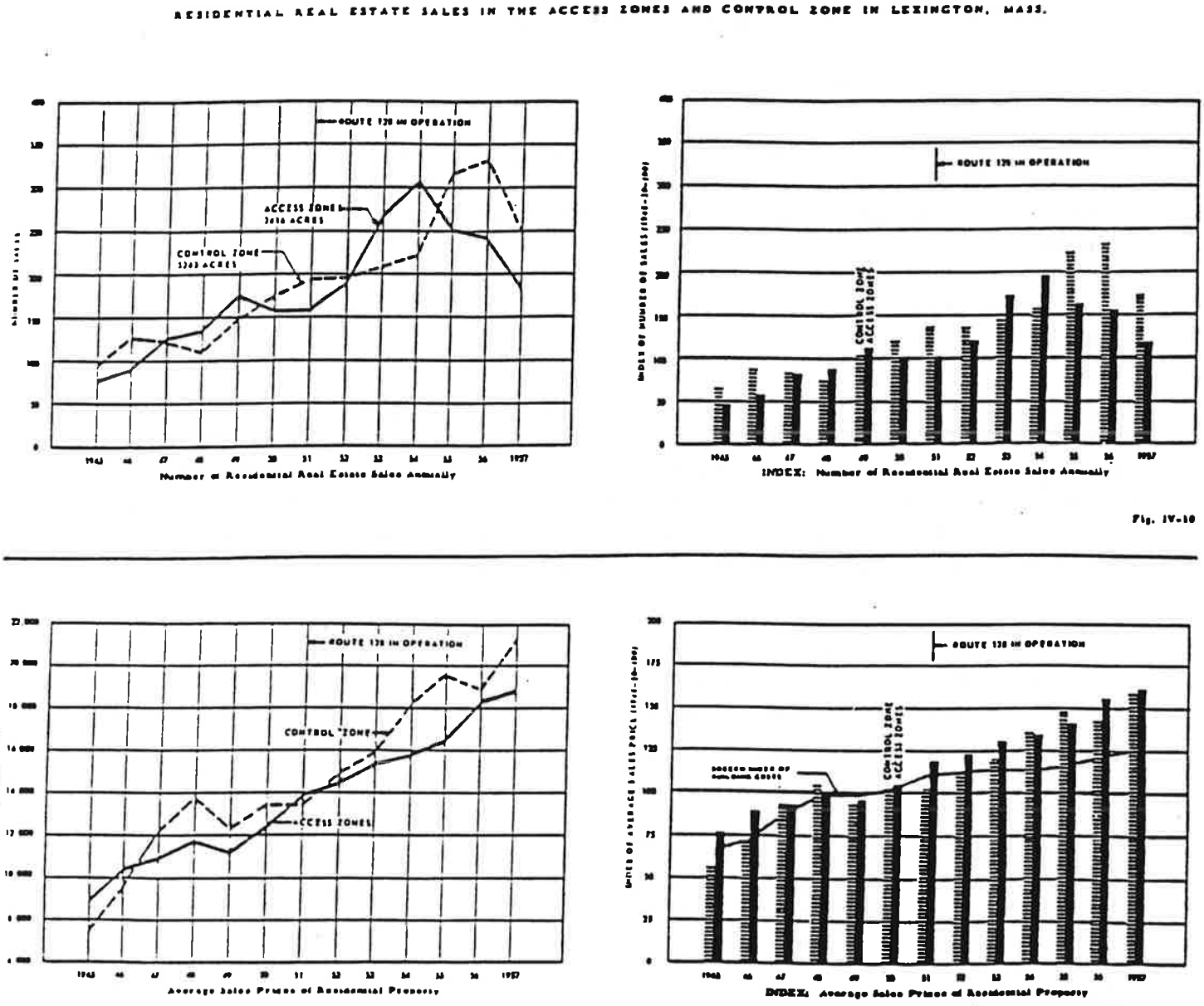
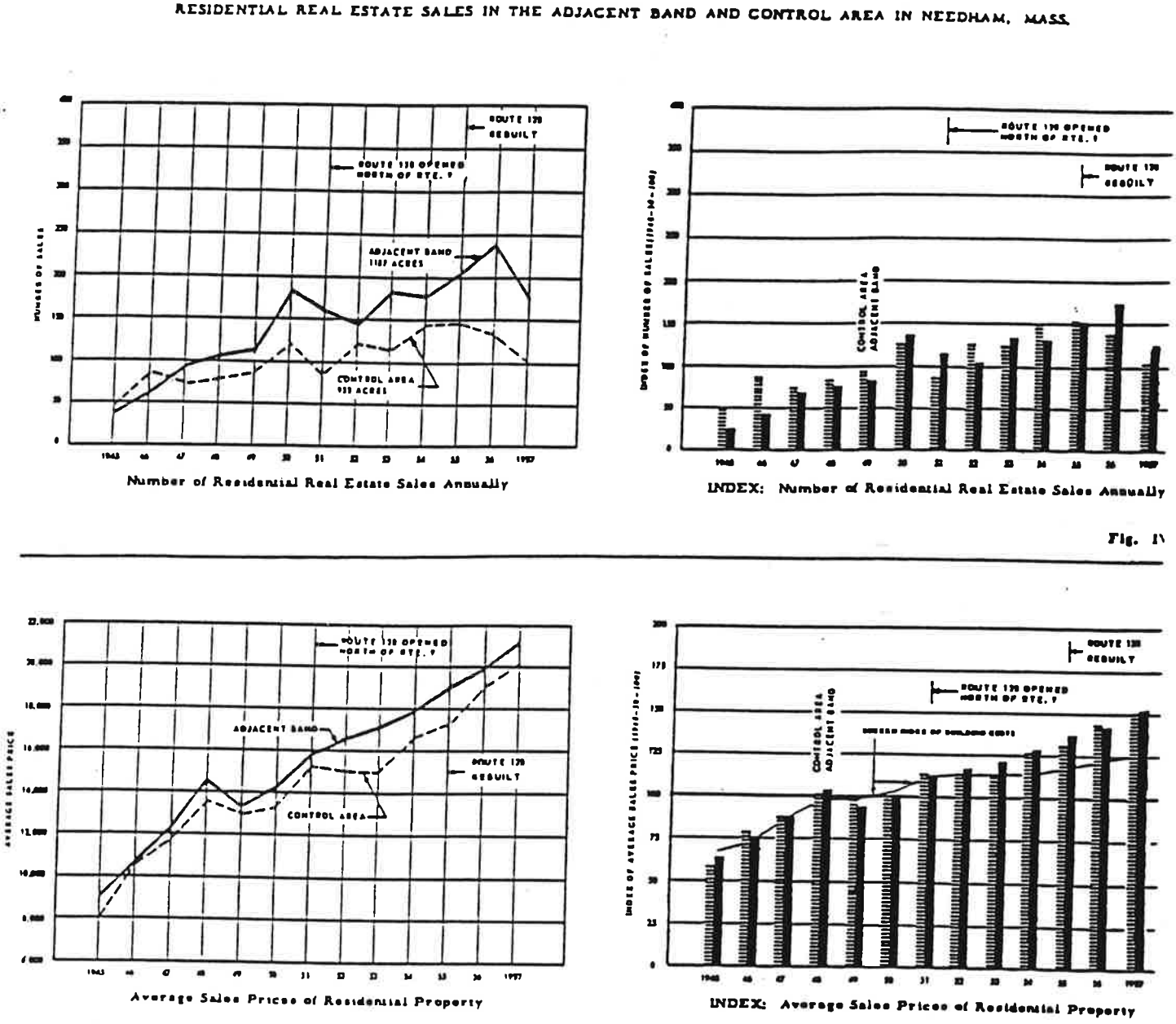


Figure I-8: Changes in Residential Land Values in Needham, 1951-1957 (Adapted from Bone, 1957)



1992 Study As noted earlier, the 1992 MAPC study only presents land use and employment figures aggregated at the town level and does not attempt to compare these figures to the economy of Massachusetts as a whole or to groups of communities not served by Route 128. This makes it difficult to compare its findings with those of the earlier studies.

However, the 1992 findings provide qualitative support for the continued effect of Route 128 on economic growth of the area it serves. For example, it concludes that employment along the corridor has continued to grow during the past two decades at an even faster rate than after the highway was first built. The study notes that from 1951-1970 each acre of developed land along Route 128 added 18 people to the work force, since 1971 that number has averaged 74 per acre.

According to the 1992 study, most of the land zoned for development has already been developed. This suggests that redevelopment of existing rather than vacant parcels is occurring. The 1992 study also observed that shopping malls developed after a population market was established. Once again, however, communities which modify zoning to accommodate such development, e.g. Peabody and Burlington, seem to benefit more from tax revenue increases because zoning enables them to choose where the physical impacts of development will be concentrated. For example, Burlington and Waltham deliberately chose to encourage development along Route 128 in a way which did not harm the existing character of their residential areas and main shopping streets.

Overall, the study communities saw employment increases from 0.51 employees/square mile in 1951 to 2.29 employees/square mile in 1988 in the 370 square miles of abutting communities. In the same period, population per square mile went from 1,509 to 2,161, respectively. Community by community results are summarized in Table I-3.

B. Route I-495

From the early stages of the proposal, developers and utilities saw economic value in knowing the probable location of interchanges. Planning and engineering staff who worked on the project remember frequent inquiries about the progress of roadway plans and traffic studies. It did not take long for other developers to appreciate the origins of Cabot, Cabot, & Forbes's success developing industrial and office parks near Route 128 interchanges in the early 1950s; they and others hoped to repeat that success on the remaining miles of Route 128 and the new I-495. The utilities were interested in interchange locations for more pragmatic reasons. They wanted to minimize the costs of utility relocations.

Both planning and engineering staff who worked on the project felt that, in time, Route I-495 would develop in a way similar to Route 128. Presumably this would happen as both population and the economy grew and as congestion near Route 128 caused an exodus to cheaper, accessible land. This would repeat the pattern by which congestion and property value pressures in the area within Route 128 caused people and businesses to move out from Boston and its inner suburbs. It is not clear whether there is a boundary beyond which the existing modes of transportation can no longer support the extension of the low-density development pattern characteristic of the Boston metropolitan region.

An excellent study entitled The Demographics of Commuting in Greater Boston was completed in 1989 by the Massachusetts' Central Transportation Planning Staff (CTPS). It documents some of the major changes in the Boston metropolitan region's population, housing and employment distribution between 1950 and 1987. It demonstrates the impact of Route 128 and then Route I-495 on the economic development of the area. Figures I-9 and I-10 summarizes changes in community populations by decade, from 1950 to 1987.

CTPS (1989) notes that while the Boston region gained 750,000 jobs between 1960 and 1980, 75 percent of these new jobs were created in the suburbs made accessible by the new highways. The report documents the fact that growth in population, housing and jobs followed the completion of new highway segments. Its basic findings describe the economic impacts of both Route 128 and I-495:

> "The most striking feature of this map [change in population 1950 -1960] is the alignment of the towns showing growth along the most recently completed highways. Every town that gained more than ten thousand inhabitants lies directly on a major route, and virtually all towns gaining at least five thousand are near to one of the new highways." (p.29)
>
> "Naming the growth areas by the roads along which they are aligned highlights again the effect that the highway network has had in the shaping of the region. In the population maps, the critical role that the highways play in spurring suburban population growth was pointed out, and it is clear from this map that access to a major highway is a virtual prerequisite for suburban job growth as well." (p. 51)
>
> "The dramatic spreading out of the population in the past four decades, stimulated by the construction of the regional highway network has had a major effect on commuting distances. Housing availability, but more importantly, housing price differentials helped to explain why population is shifting toward the fringes of the area." (p. 65)

The process occurs in concentric rings as the highways make cheaper land accessible; growth is followed by a stabilization of economic indices within a developed ring and growth in the next outer ring. This pattern has continued in the Boston area through the 1990s. Figure I-11 graphically demonstrates the increase in population along Route 128 and the segments of I-495 that were completed first. Tables I-3 and I-4 demonstrate the link between highway openings and changes in population on communities directly on the alignments.

Route 128 through Burlington was completed between 1950 and 1960. By the end of that decade, its population had grown 95% .

Figure I-9: Completion of highways in the Greater Boston region (Source: "Demographics of Commuting in Greater Boston", CTPS, 1989).

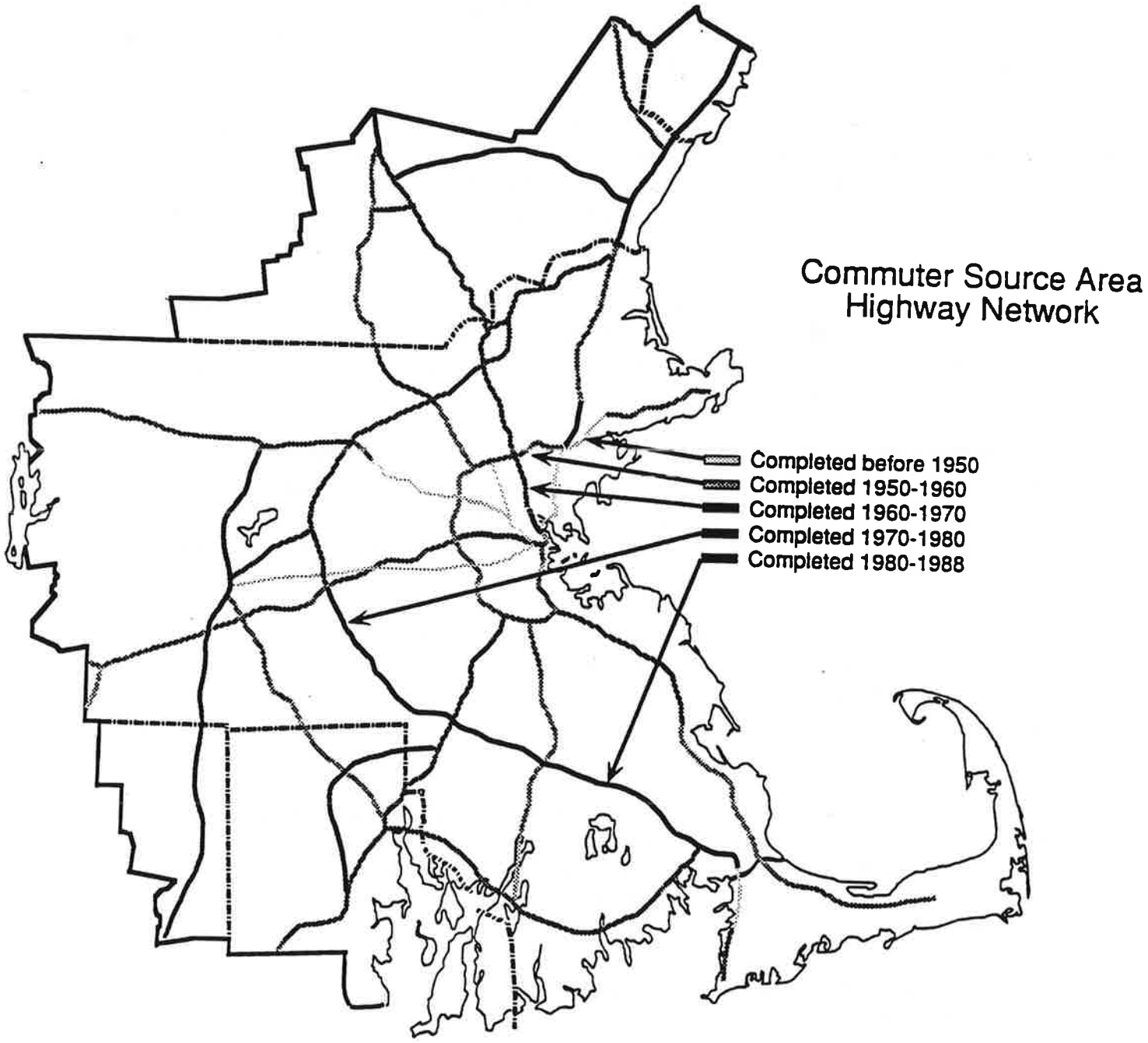


Figure I-10: Changes in Population Density in Greater Boston region, 1950-1987 (Source: "Demographics of Commuting in Greater Boston", CTPS, 1989).

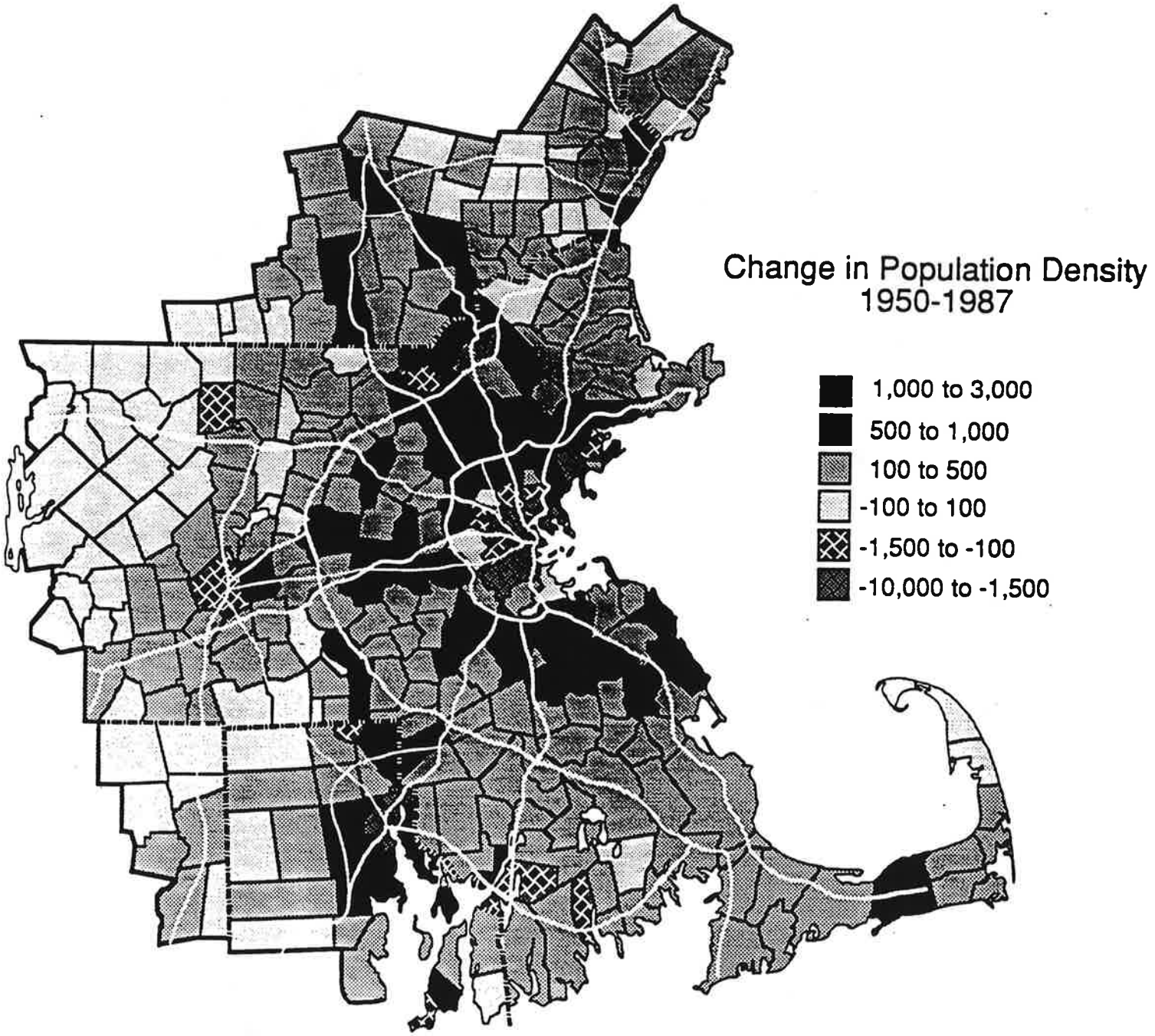
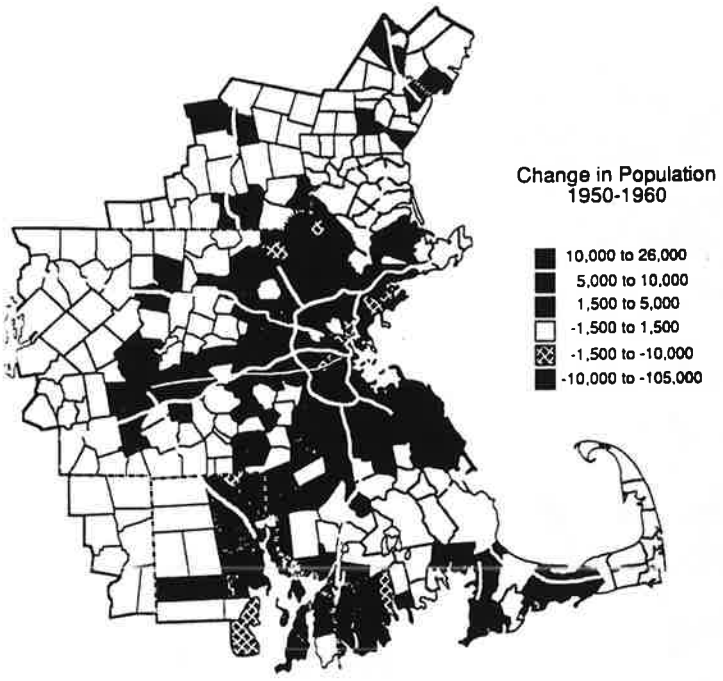
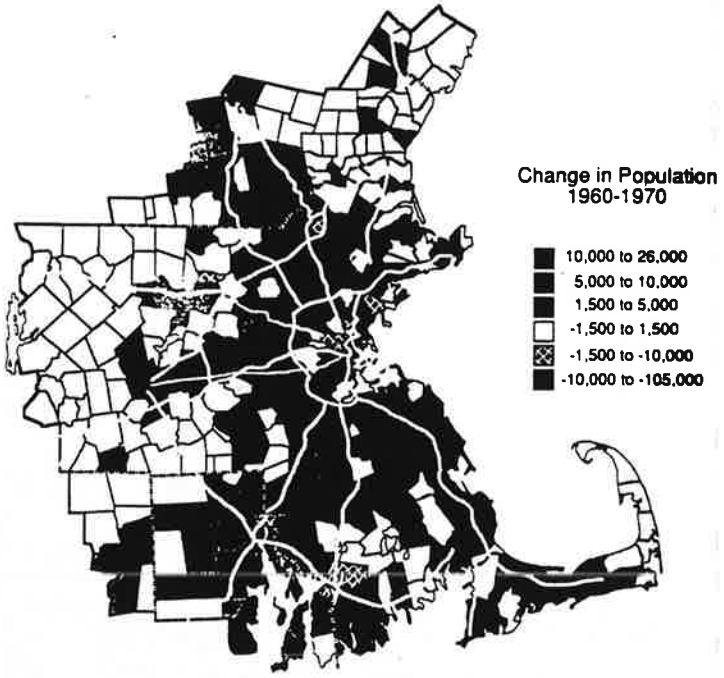
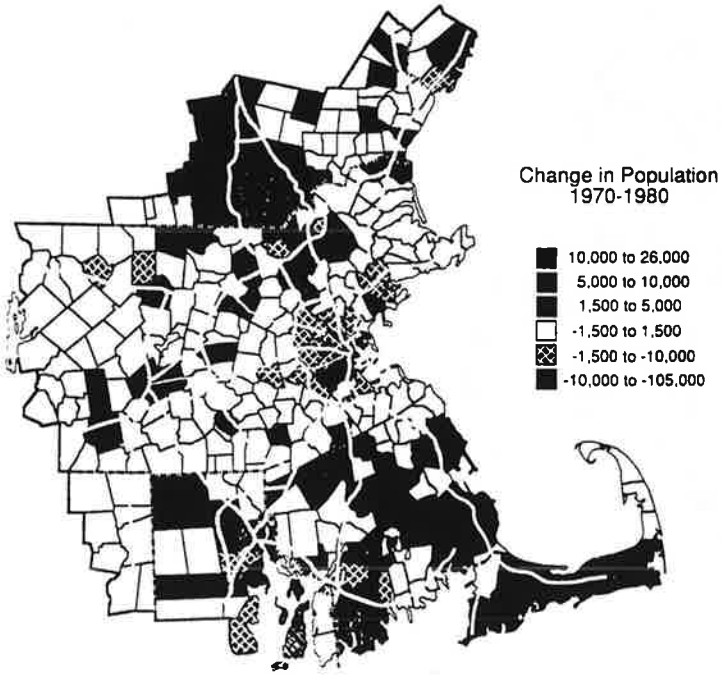


Figure I-11: Changes in Population of the Greater Boston region, 1950-1987 (Adapted from Demographics of Commuting in Greater Boston, CTPS, 1989)







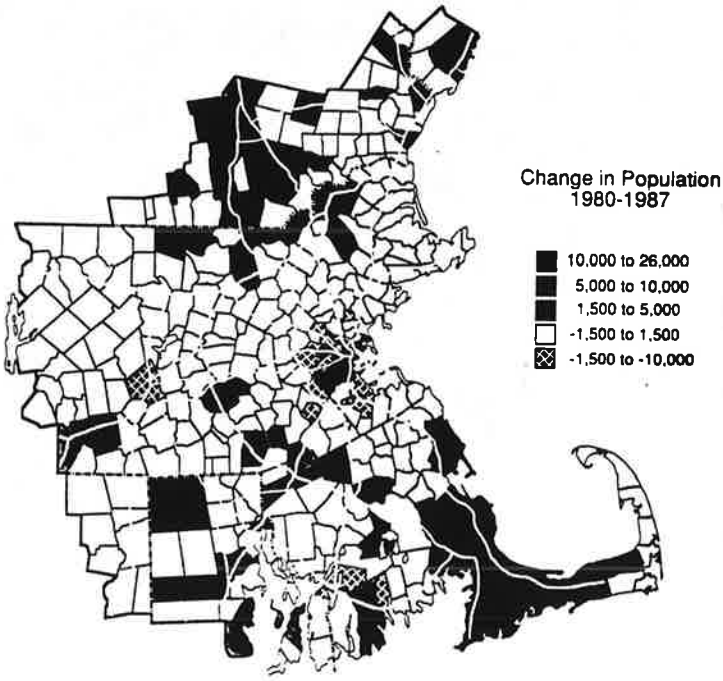


Table I-3 Population Increase in Communities on Routes 128 and I-495, US Census

Community on Route	1940	1950	1960	1970	1980	1990
Burlington on Route 128	2,275	3,250	12,852	21,980	23,486	23,302
Westborough on I-495	3,443	4,011	9,599	12,394	13,619	14,133
Franklin on I-495	5,348	6,391	10,530	17,830	18,217	22,095

Route I-495 through Westborough was completed between 1960 and 1970. By the end of 1970, its population had grown 29% and 14% more by 1990. These increases are significant but smaller than for route 128. In the case of Franklin, Route I-495 was completed yet later, between 1970 and 1980. Franklin grew 2% between 1970 and 1980 and another 21% through 1990. Thus in those towns or cities surrounding the portions of the highways built after the 1960's, the population growth rate was not as dramatic as for those towns surrounding the portions of the highways built earlier.

V. Lessons from Case Study

Quantitative economic analysis of returns on state investment did not cause, make, or break the decisions to build Routes 128/I-95 and I-495. The only significant economic analysis used in studies until the 1970s was relatively pro-forma estimation of the value of travel-time savings. For example, the 1948 Master Highway Plan devotes only 2 of 130 pages to economic analysis; the almost exclusive focus is on estimating the value of travel time savings, and that is done in a sketchy, almost hypothetical way. There clearly was no sense that it was even important to attempt serious economic comparisons of courses of action such as whether to add a lane in a given section of the roadway. It was generally assumed that highway construction and improvements would benefit both local and regional economic growth and development. There is no evidence that these expectations of economic performance were articulated in a quantitative manner.

The history of the motivations for building and justifying Routes 128 and I-495 suggest that detailed economic analysis of their potential regional effects played no role in decisions to build them. There was no conceptual framework for dealing with the changes in land use associated with changes in accessibility due to the combination of new roads, cheap land, and cheap automobiles. In the case of Route 128, the 1957-1958 analyses suggest there was little understanding of the potential effect of transforming Boston's until-then radial roadway system into a hub, spoke, and wheel system of limited access highways. This change in the distances that could be reliably traveled within reasonable times in the Boston area appears, in retrospect, to have been extremely important to the economic development of the area.

The studies confirm the transportation planning assumption that ease of regional access is a major locational factor for commercial and industrial enterprises. They also demonstrate that people move in order to live within a reasonable commute of work, i.e. the average commuting time was

Table I-4: Route 128 Communities: Population and Employment Densities, 1951 & 1988. *(Source: MAPC, 1991)*

COMMUNITY	AREA	POPULATION PER SQ. M.		EMPLOYMENT PER SQ. M.	
	(SQ. M.)	1951	1988	1951	1988
Gloucester	27.8	905	1,025	256	446
Essex	13.3	135	222	11	78
Manchester	7.8	368	678	38	182
Wenham	7.9	208	509	9	80
Beverly	14.9	1,939	2,460	477	1,019
Danvers	12.9	1,227	1,898	246	1,664
Peabody	16.5	1,372	2,839	473	1,355
Lynnfield	10.2	385	1,109	44	313
Reading	10.0	1,401	2,259	155	647
Wakefield	7.5	2,618	3,363	488	1,651
Stoneham	6.2	2,134	3,671	237	1,260
Woburn	12.9	1,589	2,905	247	2,923
Burlington	11.8	275	1,922	7	2,947
Bedford	14.0	374	904	20	1,845
Lexinghton	17.1	1,014	1,675	72	1,100
Lincoln	14.3	170	541	8	125
Waltham	12.4	3,805	4,552	1,449	5,178
Weston	16.9	297	627	18	203
Newton	17.9	4,581	4,594	899	2,715
Wellesley	9.9	2,076	2,686	255	1,939
Needham	12.4	1,316	2,223	225	1,588
Dedham	10.6	1,744	2,239	173	1,425
Westwood	11.1	526	1,135	29	795
Norwood	10.3	1,615	2,720	552	1,938
Canton	9.4	794	1,970	302	2,124
Milton	13.1	1,710	1,954	90	426
Randolph	9.8	1,019	2,995	129	1,043
Quincy	16.7	5,020	4,949	1,514	2,500
Braintree	13.7	1,691	2,509	255	2,306
TOTAL	369.2	1,509	2,161	327	1,467

approximately 20-30 minutes in 1927 and 1962 (See Figure I-12). In other words, although it is rarely accurately quantified, travel time has significant economic value for both people and goods. It is a useful, and perhaps underappreciated, analytic tool for transportation investment decisions.

By 1974, there were over 1,200 different firms, employing over 85,000 people in the communities along Route 128, compared to less than 25,000 employees in the late 1950s. Such growth could clearly not have occurred without the connectivity between radials that Route 128 provides. In fact, the transportation planners of 1948 expected that the construction of an expanded Route 128 would enhance the economic value of downtown Boston. Initially, it enabled people and businesses to move out of Boston to less costly and less populated areas west of the City; within a decade, it also began to generate both residential and commercial development in the communities to the west of Route 128.

Both the transportation and economic analyses carried out on Route 128 confirm the assumption that highways in general and limited access highways in particular facilitate and redirect economic growth, but that the latter is affected also by many forces independent of transportation decisions. It is not possible to isolate the specific impact of the highway investment, since economic growth is generated and affected by many forces independent of transportation decisions.

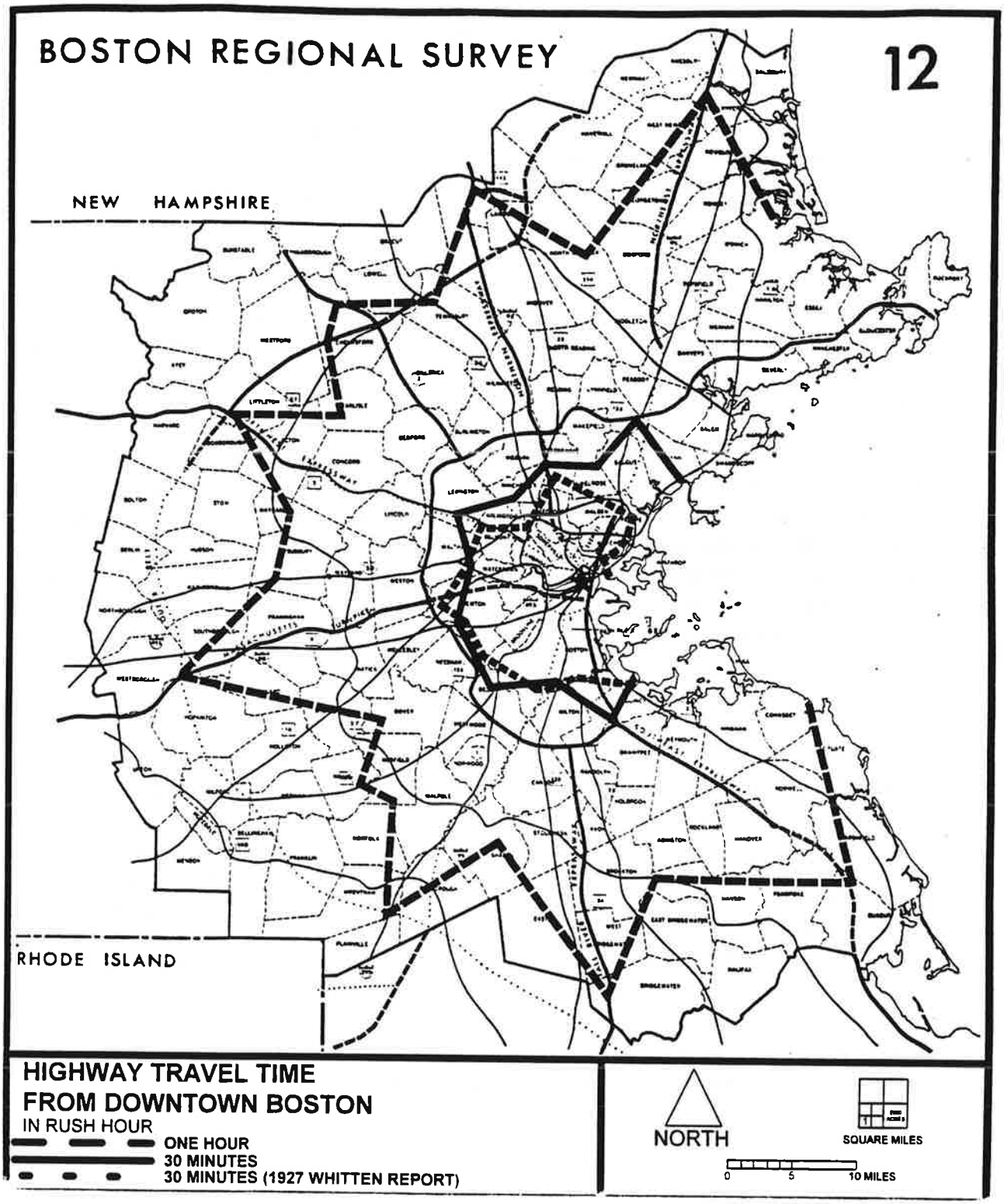
In fact, the ex post analyses conducted in 1957-8, 1974, and 1992 confirm the expectation that the investment in Route 128 was worthwhile to both host municipalities and to the state economy. The analyses of commercial and residential property value changes in Lexington, Needham, and by extension other communities were sufficiently detailed to demonstrate that the economic performance indices of areas within 1 mile of interchanges increased at least 20-30 percent beyond those of areas further away. The history of Route 128 supports a basic observation about the effect of circumferential highways on regional growth. As MAPC puts it:

> "By the 1950s, the newly-constructed highway offered direct automobile access to Boston via intersections with radial highways and development opportunities on land significantly less expensive than in or near the City." (Source: Metropolitan Area Planning Council; Route 128 at a Glance: An overview of trends in the Route 128 Corridor, draft document 1991)

In general, Route 128 has lived up to its transportation objectives. Even though planners have usually underestimated traffic demand, its roadway capacity is only strained in a few locations. It has also lived up to the vaguer economic performance expectations though neither transportation professionals nor academics have attempted to separate the amount of growth that might be attributed to Route 128 beyond citing overall growth of the regional economy. In many ways, this is not considered a useful question because no decision-making process requires the answer.

Ultimately, roadways are built for many reasons, only one of which is potential economic benefits. Detailed economic analysis has significant data problems, even as a form of retrospective analysis of changes associated with highway improvements. Even in the Boston area, which has sufficiently

Figure I-12
Rush Hour Highway Travel Times from Downtown Boston, 1927 and 1962.
(Adapted from Boston Regional Survey-Highways, MTC 1962)



good records from the 1950s forward to have been selected by FHWA as a model study area, there remain significant challenges in collecting the data that detailed analysis requires to answer questions, e.g. the spatial distribution of commercial and residential property values in communities along Route 128 and Route I-495 between 1940-1990 or the timing of building permits compared to the timing of road construction. In any case, even if these data are assembled, there is no way to know how much the Boston area might have grown if Route 128 or I-495 were not built, although clearly the pattern of development would be different.

In a numerical sense, the transportation objectives of highways such as Route 128 are relatively well known, articulated, and measurable, e.g. traffic can be counted. Economic objectives are not articulated beyond "More growth is good," in part because they raise difficult methodological and policy issues, such as who benefits and who loses from the investment, and in part because such impacts are difficult to foresee. Clearly, some economic analysis is of marginal relevance for local highway decisions. In addition, the available means of economic analysis normally require enormous effort to complete and, for a roadway such as Route 128, which was built over several decades, can be so complex that is not really possible to separate the effects of the highway investment from the many other factors that affect economic and land development. At this time in the history of a highway which is in the mature stage of its life-cycle, such analysis will probably yield only marginal differences between the local costs and benefits of a highway improvement. It can also be argued that rigorous economic analysis has not been applied to Route 128 mainly because it would not add significantly to what needs to be known to make construction decisions.

The major problem with transportation analysis seems to be a fairly consistent underestimation of traffic demand and the resulting congestion. This may in part be due to the absence of articulated *regional* objectives for transportation and economic performance. For example, the state and federal analytic requirements for justifying Route 128 never directed any analyst's attention to how intraregional changes in accessibility might influence its use nor to whether a specific set of widening improvements was a better regional investment than improving a transit line and building a regional transfer/parking facility. It may be that the requirements of the Clean Air Act and its amendments will gradually force transportation analysis to a regional perspective. This may, in turn, provide the information needed to compare the economic implications of alternative ways of satisfying CAAA requirements. However, there is no generally accepted process for articulating and comparing their implications at the regional scale. The annex to this Appendix suggests a methodology that might be useful in comparing the implications of metropolitan transportation decisions.

Another lesson that may be learned from the history of Route 128 is that it takes some time for people in general to understand the nature of ongoing change. Just as the telephone was at first misconstrued as a device to read written documents over long distances, transportation planners only began to grasp how Route 128 was affecting the regional economy in the late 1950s when it had already been in use for some time:

"The desire line patterns illustrate vividly the type of lateral movement made possible by Route 128. Prior to the building of Route 128 a road net did not exist that could accommodate these desires. Thus, traffic has been "generated" by the highway and its adjacent land use changes, an event that was not anticipated when original traffic estimates were made." (Source: Mass Transportation Commission; Boston Regional Survey- Highways; November 1962)

This fact was indirectly acknowledged by the Massachusetts Department of Public Works in one of their guideline documents for Route 128 planning: "Growth has brought many problems, some of which could have been relieved if there had been greater knowledge of its potential impact."

In short, the decisions to build Routes 128 and I-495 were based in great part on the personal beliefs and intuitive knowledge of the decision makers as to how these transportation investments would benefit their region. A significant difference between decisions of this magnitude in the 1950s and today is that they were not subject to the kind of public review made possible by environmental impact statements. EISs have become the mechanism for discussing the general merits of a transportation policy in a public forum, but even then, regional economic impacts are almost always background issues.

Although the various transportation plans which included Route 128 sometimes considered improvements to transit as well as highways, there was no attempt to compare the relative economic growth and development benefits of highways vs transit. Even during the 1970s debates about whether investment in highways should be continued or funds invested in public transportation, the development potential of each mode was not seriously analyzed. In Boston, the debate which culminated in the Boston Transportation Planning Review (1969-1972) was fueled by three themes: that highways destroyed in-town neighborhoods for the benefit of mostly suburban travelers, that investment in public transportation rather than highways might achieve the same goals at less cost, and that mass transportation was less environmentally damaging. But this debate was still primarily focused on radial highways; Route 128 itself was only involved tangentially in pro/anti highway discussions.

In economic terms, the debate was and continues to be about the economics of how best to satisfy transportation demand rather than about the effectiveness of different investments and their implications on the regional economy. Using economic analysis to highlight the regional benefits of different courses of action is not likely to play much of a role in such decisions if the process is based on requirements of mode-specific agencies, unless done in a consistent manner for all modes and all projects.

At first sight, the lack of detailed economic impact analysis for transportation decisions as important as whether or not to build regional highways or transit, may seem cavalier, if not willful. However, a little research reveals that the state of economic modeling and analysis at the time these decisions were made was not sufficiently advanced to provide any significant advantage over rules of thumb.

In 1965, a Highway Research Board panel convened to discuss whether "model building and the computer can solve economic forecasting problems," concluded that numerical prowess couldn't compensate for the fact that economic behavior wasn't understood well enough to develop useful models. Comments from the proceedings summarized in Forecasting Models and Economic Impact of Highways suggest the general consensus about the difficulties involved:

- It is difficult to create economic models if we do not have generally accepted rationales of travel behavior. Participants agreed that there are too many variables that are simply not measurable. As one participant said: "Unlike mechanistic behavior, human behavior does not appear to react to stimuli uniformly, either in different types of environment, or over time." (Source: Forecasting Models and Economic Impact of Highways, HRB #149, 1966)

- Extant models were inadequate for establishing either the capacity of a region to adjust to economic change, i.e. identifying turning points rather than extrapolating known trends, or for clarifying how investments in transportation affect the shape of economic development.

- Extant models did not account for the feedback-loop nature of public and private transportation decisions.

- Models were useful for short-term forecasts and for comparing the implications of policies.

Based on a review of over 30 years of transportation planning experience in the Boston area, these observations still pretty much hold true. Most transportation decisions are made on such a disaggregated basis by communities competing for development tax dollars that regional traffic models are not good guides for long term impacts. Most of the important decisions in locating traffic generators such as shopping malls are driven by the service area analysis of big chain stores looking for coverage of market service areas. Developers compete to meet the department stores' expressed needs with other development tagging along with the anchor tenants. In other words, transportation impacts are not predictable long term because they are event- rather than trend-driven. It may therefore be useful to consider which kinds of models may be most applicable at which stages of land development.

Except for the use of input-output tables in estimating the regional economic impacts of a transportation project, we do not yet have generally accepted or useful economic analysis techniques to provide significant assistance in transportation policy decisions.

The intellectual tradition and circumstances of transportation planning clearly had not prepared anyone for the possibility that the combination of cheap automobiles and roadways that made cheap land accessible would lead to a near collapse in transit ridership. There was little inkling that the ability to achieve a suburban life style combined with the interest of business in avoiding downtown congestion and land prices would result in a change in settlement of the magnitude that occurred after WWII.

In that climate, no amount of economic analysis would have predicted the event. People's decisions simply outran the intellectual framework that sustained transportation and economic policy decisions. Transportation planning based on response to current needs, i.e. extrapolation of current trends, does not encourage perception of events which change the basic patterns of land use or ease of travel. In other countries, such as Canada or Germany, transportation planning is seen as a means of directing and supporting future economic development. This is perhaps a less democratic approach to planning than the US is accustomed to, but it does focus public attention on how transportation decisions shape the future economy of a region.

Current EISs do not provide sufficient economic analysis to determine the reasonableness of a decision to build or not to build a particular piece of infrastructure or to distinguish the economic impacts of one alternative versus another with confidence. If the best our analytic tools can readily tell us is that spending $1 Million on a project will generate 33 jobs in the region, regardless of location within the region, modeling is not going to help us distinguish between, say, choosing Alignment A versus Alignment B in the same corridor. It cannot be said that, in the years since 1948 or 1965, the state of the art of economic analysis has improved enough to be a key element in making transportation policy decisions.

It is tempting to conclude, as our predecessors did, that we don't and can't really know enough to model economic behavior in sufficient detail to make useful forecasts. We use economic models to compare the probable future effects of transportation project alternatives on the basis of extrapolating known trends. Yet, as the histories of Route 128 and Route I-495 show, the most significant economic impacts are those associated with the changes that these highways introduced into the economic fabric of the region, namely how they made cheap land easily accessible. People were then able to deal with congestion in neighboring communities, in this case Boston and its inner suburbs, by avoiding it. Perhaps we should stop trying to approximate future economic behavior with deterministic models. It may be more useful to explore whether we can compare transportation projects on the basis of how much opportunity they open up for movement of people and goods or for land development for a given dollar of expenditure. To be useful, economic analysis tools need to provide information about the differences of alternative investments so that the public and the decision-makers can compare their choices.

ANNEX

Service Market Potential as an Alternative Form of Economic Analysis for Transportation

We know that, in a general sense, new roadway infrastructure promotes both short and long-term economic growth and development. We also know that it is difficult to do convincingly qualitative analysis as a tool for selecting or prioritizing roadway improvements and that it often is not the basis of make-or-break decisions about these projects. Given the practical and political concerns that state officials might worry about if rigorous economic analysis were introduced into transportation planning decisions about highways such as Route 128, a different kind of "economic" analysis than setting performance objectives may be easier to predict, accept and, hence, more useful in reaching decisions.

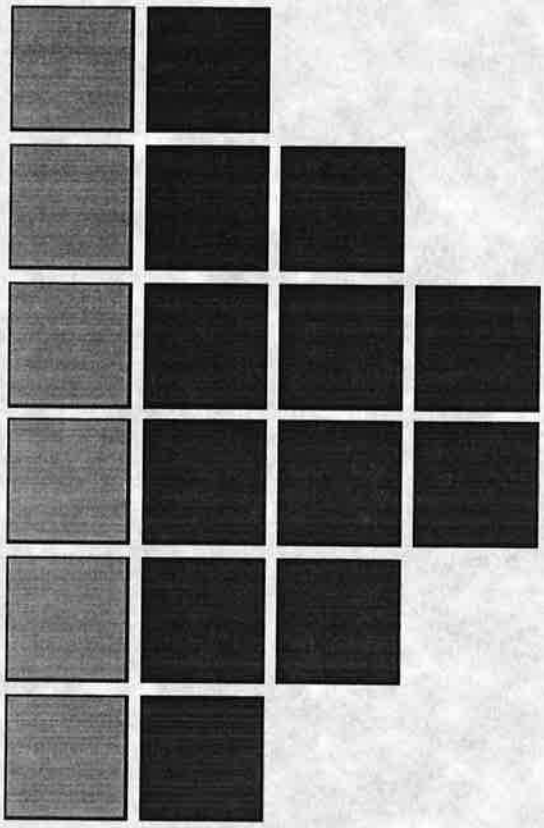
Part of the difficulty associated with economic analysis is agreeing on what it involves. Transportation officials have little patience with detailed analysis that reveals small differences in performance because it emphasizes the subjectivity of roadway location and improvement choices. Both experience and the literature suggest that roadways have a life cycle. There are also relatively good historic records about the percent of developed vs. developable land by community, building permit histories, commodity shipping records, population and business censuses, and in most metropolitan areas origin/destination and travel time surveys. Economic analysis often requires long range forecasts which, however carefully derived, cannot predict innovations. It can be argued, at least in the case of the Boston area, that innovations in computers, software, medicine and defense-related industries and the decline of heavy manufacturing were essentially unknowable from the 1930s to the 1950s when Route 128 was planned and built. Finally, Geographic Information System (GIS) software for transportation purposes is relatively mature. This combination of elements makes it possible to analyze and compare the potential market penetration of roadway projects before they are built.

The essence of this approach is to use existing data and GIS software to estimate the size of markets served by new infrastructure within half-hour and one-hour travel times and relate these figures to stage of life-cycle. It is quite similar to the location studies now carried out by many service industries. Travel budget time contours may vary for commuters and for commodities by metropolitan area, but it is well established that they encompass a surprising number of economic activities within a region. Indeed, it can be argued that they define an economic region. For example, in the Boston area, 95% of regional employment and housing is located within one hour's driving time of downtown; the same area is almost exactly Logan Airport's passenger and cargo service area. A GIS system such as that established by Massachusetts's Central Transportation Planning Staff for the study of commuter origins and destinations in the Boston area has demonstrated the capability to define such travel time contours.

This method could establish the extent to which alternative roadway improvements or systems enhance accessibility for more people and/or to larger developable areas. This information would enable transportation planners and the public at large to compare the economic *potential* rather than

performance of proposed highways or alternative modes of travel in an easy to understand visual format. This is probably more useful in transportation decision making than the kind of economic analysis which would forecast that community $\underline{x}$ would see a 3% increase in tax revenue over 20 years while community $\underline{y}$ would see a 4.5% increase in that same time period.

In short, one of the lessons that can be learned from the Route 128 and I-495 experiences is that it may be both easier and more telling to estimate the development potential brought by improved accessibility than to estimate individual economic indicators. Transportation policy decisions are generally driven more by large distinctions than small differences in performance. A service area/market accessibility approach might well be useful in establishing the regional transportation implications of decisions.



Appendix J

Case Study IX:

Border Crossings - The Laredo, Texas Port of Entry

LOUIS BERGER INTERNATIONAL, INC.

APPENDIX J

CASE STUDY:

BORDER CROSSINGS - THE LAREDO, TEXAS PORT OF ENTRY

I. Investment Description

The nation's foreign trade has been increasing in importance over the last two decades, growing from 12% of GNP in 1970 to 22% in 1990. The growth of international trade is highlighted by the recent agreements and ongoing discussions regarding the creation of a few major multinational markets (NAFTA, Europe, Asia-Pacific, Southern Cone countries of South America-Mercosur).

Mexico is the United States' third largest trading partner. In the 5-year period from 1987 to 1991, US exports to Mexico increased by 145 percent, and they doubled from 1989 to 1994, even before the NAFTA agreement became effective. Imports have also grown rapidly, and the devaluation of the peso in late 1994 has resulted in significant growth in northbound trade.

The border between the United States and Mexico extends over 2,000 miles from the Pacific Ocean to the Gulf of Mexico. The Texas-Mexico border, defined by the Rio Grande River, accounts for over half this distance, stretching from Brownsville to El Paso. As of May, 1991, there were 40 ports of entry along the US-Mexico border, 24 of them in Texas. The city of Laredo (Webb County, Texas) is the second largest US inland port of entry and the largest on the Mexico-US border. It is located on a direct route that connects key industrial zones in the US Midwest to the principal industrial areas of Mexico.

The Laredo, Texas Port of Entry was selected as a case study of transportation investments that are aimed at expediting and accommodating the fast-growing international trade at the US border in Mexico. The case study will be used to discuss how ports of entry at the border crossings can impact the economy of the region they serve, and in particular, how multinational liberalized trade and/or free trade areas can affect transportation infrastructure investment requirements at the border area.

The economy of the Mexico border area historically was centered on agriculture, manufacturing, banking, retail, and trade. In 1964, Mexico initiated the "maquiladora" concept, under which US manufacturers were allowed to locate plants in industrial parks along the border, ship basic components for assembly in Mexico without the usual assessment of import duties, and ship the finished products for distribution in the US. The border economy has since been dominated by the maquiladora industry, growing from 57 maquiladora plants employing 4,257 people in 1957 to 2,014 plants employing 468,392 workers in 1990 (CTR 7-1312, p. 5). Furthermore, after Mexico began pursuing export diversification and a more open economy in the early 1980s, and particularly after it joined the GATT agreement in 1986, US-Mexico trade has grown rapidly. With the approval of

NAFTA, the world's largest trading block has been created, and trade across the border can be expected to grow further as the tariffs and regulatory obstacles that have constrained it are removed.

Increases in US-Mexico trade and transborder traffic prompted several US agencies to question the adequacy of the existing border transportation infrastructure, and in particular highways and railroad bridges and the infrastructure associated with border inspections. In Texas, where the majority of US border crossings into Mexico are located, it has been estimated that meeting current capacity needs alone will require a $2 billion investment in highways and border crossings[1]. In addition, with the growing importance of intermodal traffic, railroad infrastructure at the border also requires expansion.

For border communities like Laredo with high trade volumes and large numbers of vehicles going across the border, new bridges and connecting infrastructure not only help alleviate traffic congestion; they can also create employment, generate economic activity, attract tourism and trade, and boost the local economy through retail sales and bridge toll revenues.

The Laredo Port of Entry Infrastructure

The infrastructure of a border-crossing port of entry consists of three major components: the highway or railroad bridge or border crossing itself, the connecting transportation infrastructure, such as highway and/or railroad facilities connecting the border crossing to the major transportation facilities in both sides of the border, and the international inspection facilities.

Border Crossings - Bridges

There are presently three international highway bridges and one railroad bridge in the Laredo area. The Convent Street Bridge (also known as Bridge I) and the Juarez-Lincoln Bridge (dubbed Bridge II) are located within the Laredo core area, while the third international highway bridge, known as the Solidarity Bridge or Colombia Bridge, is about 25 miles to the northwest of the center of the city. The existing railroad bridge, owned by the Texas & Mexican Railroad, is also located in the core area. Figure J-1 shows the location of the existing bridges.

The original Convent Street Bridge (Bridge I) was destroyed in a flood in 1954, and the current bridge I was built in 1956. Its inspection facilities are probably the oldest in use on the Texas-Mexico border and were completely renovated in 1991. Bridge I has four lanes for crossing vehicles and two sidewalks for pedestrian crossings. It is the only pedestrian crossing and is the closest to downtown shopping areas.

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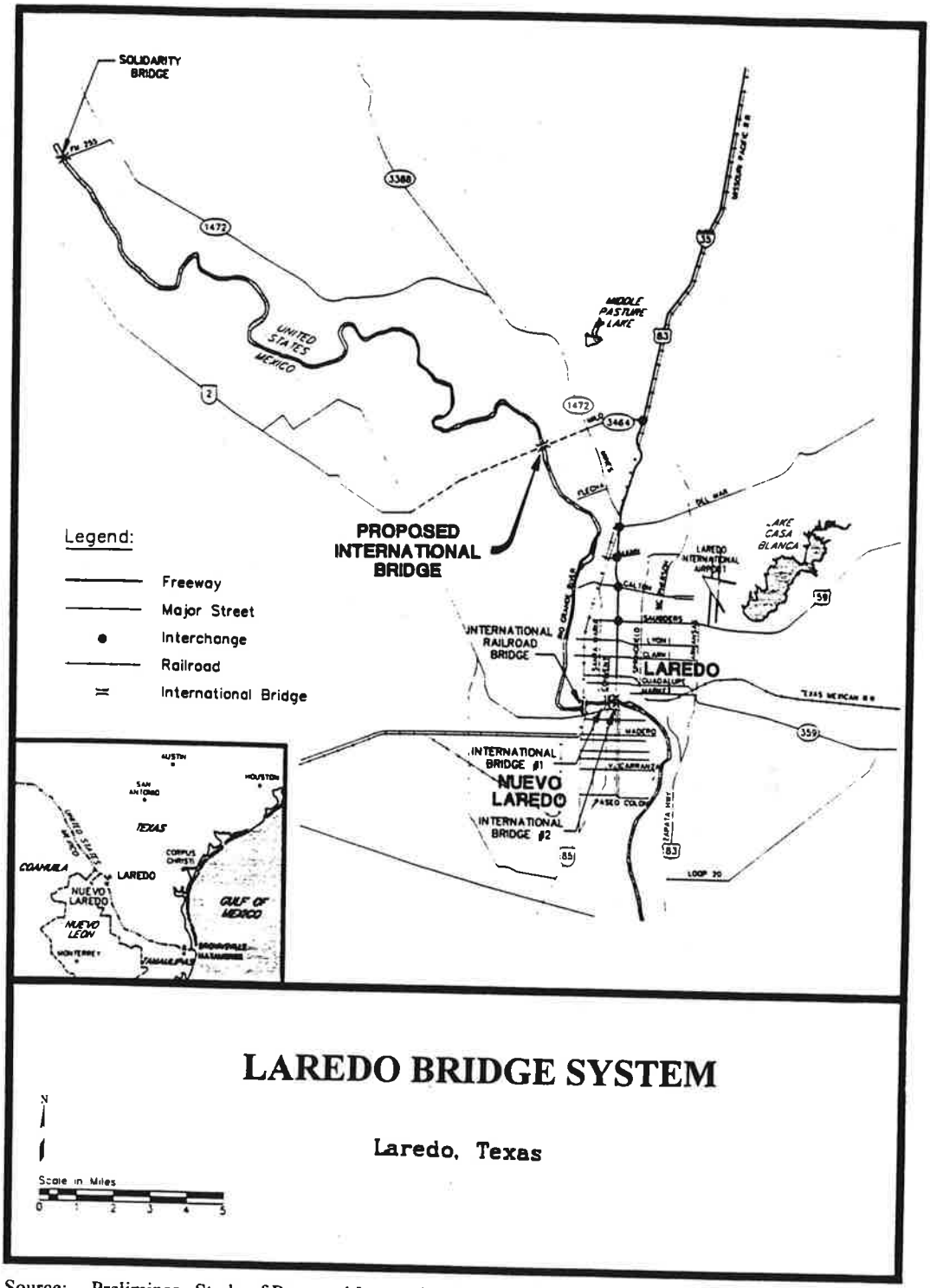
1 "US-Mexico Trade - Survey of Border Infrastructure Needs" US General Accounting Office, Washington DC November 1991.

Figure J-1



Source: Preliminary Study of Proposed International Bridge, Laredo, Texas," Wilbur Smith Associates, Inc., October 1991.

The Juarez-Lincoln Bridge, or Bridge II, was opened to traffic in 1976 and is accessed directly from the major highway into the Laredo area on the US side, Interstate I-35. The bridge has six-lanes, three in each direction, with the rightmost lane in each direction dedicated to trucks. During periods of heavy southbound traffic, four lanes are used for southbound traffic. Pedestrians are not allowed on this bridge.

Completed in less than one year, Laredo's third international bridge began operations in August 1991. Solidarity Bridge is located in Laredo's western extraterritorial limits and is accessed from FM 1472 (Mines Road). The bridge has eight lanes for vehicle traffic and two for pedestrians. Unlike Bridges I and II, which cross into Nuevo Laredo in the state of Tamaulipas, the Solidarity Bridge links Dolores, Texas with the town of Colombia, in the State of Nuevo Leon.

The proposal for construction of the third highway bridge was made to the US by the State of Nuevo Leon, representing the first time that Mexico has initiated plans and sought US participation for a border crossing. The city of Laredo initially opposed this project, fearing diversion of traffic away from the city. However, faced with the possibility of a state-built, toll-free facility, Laredo decided to take part in the project. Laredo then annexed a strip of land following Mines Road up to Dolores and met the US portion of the bridge cost with a bond issued in 1990.

Table J-1 shows the estimated cost and funding sources for the US portion of Bridges I and II and the Solidarity Bridge. No estimates were obtained of the Mexican costs for Bridges I and II, but the total costs for the Mexican portion of the Solidarity Bridge, including connecting infrastructure and inspection facilities, were approximately $33 million.

Table J-1: Cost and Source of Funding for US portion of Laredo Bridges

COST (Completion Date)		SOURCE OF FUNDING
Bridge I	$ 3 million (1956)	City of Laredo Revenue Bonds
Bridge II	$ 9 million (1976)	City of Laredo Revenue Bonds
Solidarity Bridge	$12 million (1991)	City of Laredo Revenue Bonds

Source: Texas-Mexico International Bridges and Border Crossings - Existing and Proposed. January 1995. DOT.

The cost of the bridge itself is a relatively small portion of the total infrastructure costs of a border crossing. As noted above, besides the bridge, connecting roads and inspection facilities are also required. In the case of Bridge II, TxDOT spent $16 million for the IH35 approach roadway. For the Solidarity Bridge, the US Government, the City of Laredo, and the State of Texas covered the additional $22 million cost for highway connections, customs, INS, and other inspection facilities. Table J-2 summarizes the total US project cost and sources of funding for the Solidarity Bridge.

Table J-2: Solidarity Bridge: Total Estimated US Cost and Funding Sources (000)

ITEMS	TOTAL COST	GSA	CITY	STATE
FM 1472 Extension to Bridge Site	$1,333*	0	0	$1,333*
FM 1472 Widening and Reconstruction	$7,978*	0	0	$7,978*
City of Laredo Toll Plaza and Export Facilities (initial phase 20 acres; ultimate phase 75 acres)	$6,288	0	$6,288	0
General Services Administration Facilities (initial phase 20 acres; ultimate phase 75 acres)	$12,731	$12,731	0	0
Bridge Structure and Approaches	$4,996	0	$4,996	0
TOTAL	$33,325	$12,731	$11,283	$9,311*

* Current information on the State's cost provided by TxDOT indicates a cost of $2.388 million for the extension to the bridge site and $18.038 million for the FM 1472 widening and reconstruction.

Source: An Application for a Presidential Permit to Construct an International Bridge, Nuevo Leon, Mexico and the State of Texas, USA, submitted by the City of Laredo, August 1989.

The three highway bridges are jointly owned and operated by the City of Laredo through the Laredo Bridge System (LBS) and by the Mexican government through the Camino y Puentes Federales de Ingresos y Servicios Conexos (CAPUFE). All the bridges are toll facilities, with the toll schemes differing for northbound and southbound traffic. The toll in the northbound direction, collected by CAPUFE before the vehicles cross the bridge, is based on vehicle classification. For commercial vehicles, the toll is based on the number of axles and does not differentiate between loaded and empty trucks.

The tolls in the southbound direction are collected by LBS before vehicles cross the bridge. The toll scheme is also based on vehicle classification, and for commercial vehicles the toll *does* differentiate between loaded and empty trucks.

The tolls collected southbound go to the city of Laredo and are used to pay off bonds and fund city projects. In 1991, approximately 16 percent of bridge revenues were set aside for street reconstruction.

The railroad bridge crossing the Rio Grande at Laredo is a one-track bridge owned by the Texas Mexican Railways Company. On the US side, Union Pacific has in recent years completed a $29.5 million intermodal and classification yard called Port Laredo, outside of the Laredo urban area. The border station facility consists of a single-story building that houses the US Customs office. On the Mexican side, there is a small office belonging to the Ferrocarriles Nacionales de Mexico (FNM) that handles Mexican customs. Trains as well as block of rail cars are delivered to the middle of the bridge, where US traffic is picked up by the Texas Mexican Railroad and/or Union Pacific Railroad, and the Mexican traffic is picked up by FNM.

Border Crossings - Connecting transportation infrastructure

Figure J-2 shows the major highways on the Texas - US border, including Laredo. On Mexico's side, Nuevo Laredo, Laredo's twin city, is served by the following two-lane highways:

(a) Mex 85 and Mex 1 connecting to Monterrey to the South; and

(b) Mex 2 running along the border connecting Nuevo Laredo with Reynosa to the southeast and with Piedras Negras in the northwest.

Ferrocarriles Nacionales de Mexico (FNM), the government-owned railroad company, provides single-track service from Nuevo Laredo to central Mexico, through Monterrey and Saltillo.

The principal highways and railroads leading from Saltillo, Reynosa, Piedras Negras and Monterrey, converge on the Laredo area to meet the major US roads that fan outward to the urban centers and seaports of Texas. The latter roads include:

(a) Interstate Highway 35, a multilane divided expressway connecting Laredo to San Antonio, Dallas and central portions of the US (the number of lanes along IH35 vary from 4 to 10 lanes);

(b) US Highway 83, a two-lane highway providing access along the Texas border from Brownsville to Laredo and northward to Abilene and western portions of the country;

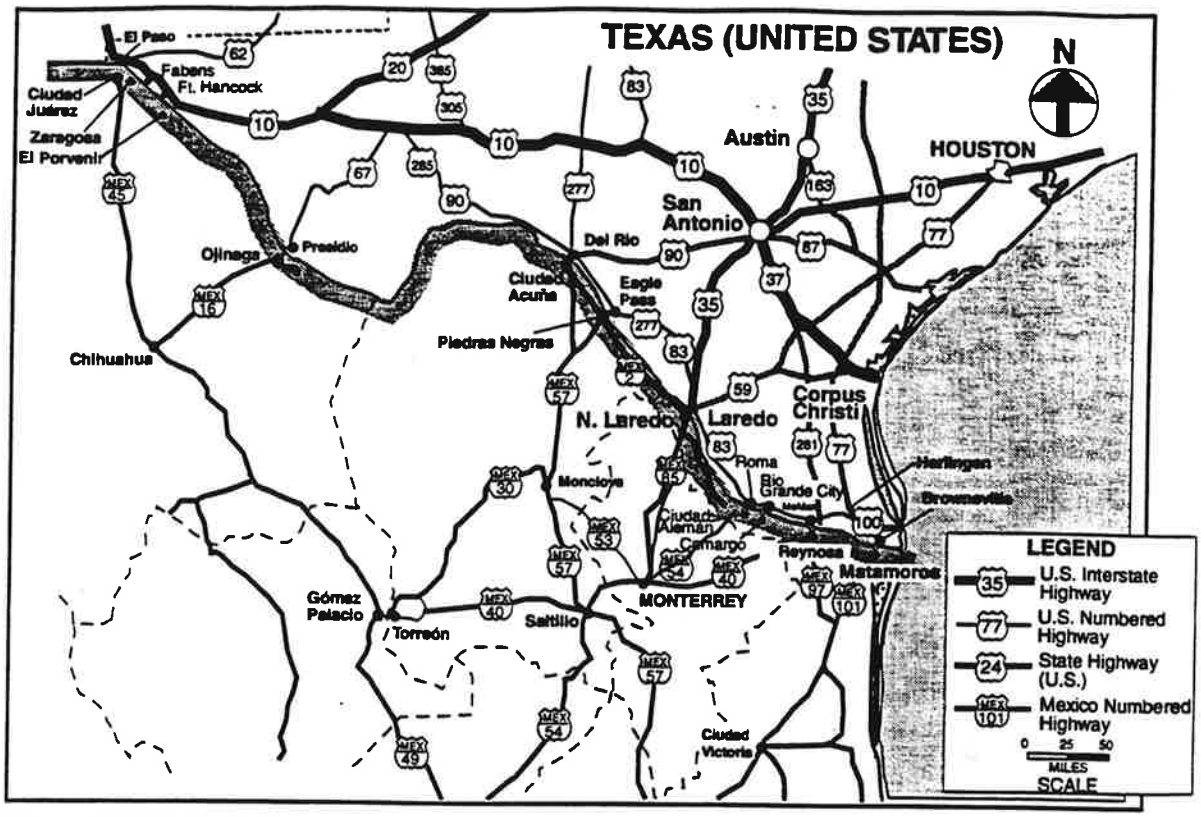
(c) US 59, a primary route to Houston and southeast areas of the US;

(d) US 59 and State Highway 44, the primary route to Corpus Christi;

(e) State Highway 359, a secondary route to Corpus Christi; and

(f) FM 1472 (Mines Road) to the west.

Figure J-2: Texas-Mexico Border Highway Infrastructure



Source: "Transborder Traffic and Infraestructure Impacts on the City of Laredo, Texas," C. Said, R. Harrison, and W.R. Hudson. Research Report 1312-1, November 1993, p.23.

At the present time, about thirty four motor freight carriers provide intrastate service in the Laredo area. In addition, the city is serviced by licensed carriers that provide international service to Nuevo Laredo, and by a considerable number of specialized and exempt motor carriers authorized to transport bulk commodities, heavy equipment, perishable products, and exempt agricultural products.

Laredo is also served by two major railroad companies: the Texas-Mexico Railroad, which connects to the deep-water Port of Corpus Christi; and the Union Pacific Railroad, which provides freight services to all of the US and Canada.

Border Crossings - International Inspection Facilities

At all 3 existing highway bridge crossings, there are customs inspection facilities, including primary vehicle inspection points and secondary inspection spaces for noncommercial vehicle traffic. Bridge II and the Colombia Bridge also include an import lot with docks for truck inspections. Northbound commercial loaded trucks must use either Bridge II or the Colombia Bridge. The US General Services Administration is responsible for the customs and other border inspection facilities on the US side of the border.

On the Mexican side, there are also inspection points for automobiles and trucks. Southbound trucks using Bridge I use three booths for random selection, and selected trucks proceed to the import lot of Laredo Bridge II. Empty and loaded southbound trucks can use any of the three bridges.

Planned Investments. Notwithstanding the recent construction of the Colombia-Solidarity Bridge, the city of Laredo and private interests are planning the construction of additional international border crossings between Laredo and Nuevo Laredo, including Bridge IV (some have labeled it as Bridge III since the Colombia bridge is located farther away from the center of the city) and a new railroad crossing in Laredo.

The City of Laredo has conducted studies and private interests also commissioned a consultant study to conduct feasibility analysis of a fourth bridge in the Laredo area (Bridge III), located at the extension of Milo Road (FM 3464). In 1991, the City of Laredo filed an application for a Presidential Permit to construct the fourth international border crossing, to be known as Bridge IV or Laredo Northwest International Bridge. The application was approved on October 7, 1994. The proposed eight-lane bridge, estimated at $25 million, will be connected to FM 3464 and FM 1472 on the US side, and with Mex 2 and Mex 85 on the Mexican side.

A new railroad bridge crossing is also planned by Union Pacific Railroad and FNM, including construction of new railroad connections in both Laredo and Nuevo Laredo. The new bridge would connect to the current rail line near Mines Road, approximately 2.7 miles from the crossing. On the US side, the Union Pacific RR will finance the entire cost, including the bridge, right of way, and track, at an estimated cost of $63 million. A Presidential Permit for this new railroad bridge crossing was approved in May, 1995. Union Pacific also has future plans for an additional investment in the Port Laredo intermodal and classification yard.

In addition to the proposed fourth bridge, other planned investments in the Laredo area include the construction of Loop 20, between IH-35 and US 59; extension of IH-35 from four to six lanes; and widening of US 83. Efforts are underway to increase border crossing efficiency, by introducing new technologies to expedite movements and reduce delays.

Another project to improve access to the Colombia bridge has been proposed by Camino Colombia, Inc., a corporation comprised of Laredo land-owners and businessmen, involving the construction of a 22 mile limited access road as a private toll facility connecting the Colombia Bridge and I-35/US83.

Table J-3 and J-4 summarize the estimated US cost of Bridge IV and other planned highway investments to improve connections to international crossings.

II. Investment Objective and Decision Making Process

Laredo is the largest US port of entry for trade with Mexico, handling about 38% of all trade between the two countries. In 1994, Laredo handled 59.4 percent of all loaded trucks crossing the Mexico-Texas border and 67.6% of all loaded rail car crossings. Imports to the US through the Laredo District of US Customs increased to $49.5 billion in 1994, while exports have reached $50.8 billion.

Table J-3: Laredo Northwest International Bridge (Bridge IV)
Total Estimated US Cost and Funding Sources (000)

ITEMS	TOTAL COST	GSA	CITY	STATE
CITY FACILITIES Bridge Structure and Approach Earthwork Federal Facilities Toll Plaza and Export Lot	$11,200	0	$11,200	0
STATE ACCESS ROAD Loop 20 extension, Drainage	$1,500*	0	0	$1,500*
FEDERAL FACILITIES Toll facilities and Import Lot Area	$9,000	$9,000	0	0
TOTAL	**$21,700**	**$9,000**	**$11,200**	**$1,500**

*Currently, TxDOT estimates $4 million for the Loop 20 extension

Source: An Application for a Presidential Permit to Construct a New International Border Crossing Texas, USA, Tamaulipas, Mexico, submitted by the City of Laredo, February 1994.

The main objective of transportation infrastructure investment at the Laredo port of entry has been to accommodate growing US-Mexico trade as well as the development of the maquiladora plants, trucking terminals, warehouses, etc., associated with that increased trade. Since the late 1960s, trade between the US and Mexico has been growing at a rapid rate, with Texas as the leading state for exports to Mexico. In addition, Laredo handles much of Mexico's trade with Canada, Europe, and the Far East, reflecting shipper's preferences for the lower cost and higher efficiency of US ports and land transportation services. Compared to other ports of entry, Laredo handles mostly continental long-distance traffic, with less emphasis on local maquiladora traffic.

However, growth of maquiladora industries is also a driving force behind the increase in cross border traffic in Laredo. Maquiladora plants established by US and foreign firms use low-cost Mexican labor to assemble export products ranging from automobile parts to integrated circuit boards, television components, hospital supplies, garments and food items. According to the Laredo Development Foundation, in 1987, there were 79 maquiladoras plants in the border area using the Laredo port of entry. By 1992, there were 78 maquiladora industries in Nuevo Laredo alone, and there were about 200 maquiladoras in the border area using the Laredo port of entry, including most of those located in Nuevo Laredo, Tamaulipas, and Nuevo Leon.

Table J-4: Estimated Costs of Planned Investments in Laredo Area

Items	Cost *in Million of $*	Status
Construction of US Loop 20 from IH 35 to US 83.		
Phase I: Const. 2 lane rural roadway from IH 335 to 1.68 mi. North of US 59	$5.5	Completed
Phase II: Const. 82 ft. curb and gutter section from 1.68 mi. north of US 59 to Spur 400	$6.7	Construction began March 1995
Phase III: Const.5 lane curb and gutter section from Spur 400 to SH 359	$4.5	Construction began March 1995
Phase IV: Upgrade to a 4 lane curb and gutter section from SH 359 to US 83	$1.5	Estimated Letting Date - Aug. 1995
Widening IH 35 to 6-lanes from Park St. to 1.0 mi. north of Del Mar Blvd.	$13.6	Estimated Letting Date - Aug. 1995
Widening US 83 to a four lane divided highway from 3.1 mi. south of Loop 20 to 6.0 mi. south.	$5.0	Estimated Letting Date - FY 1997
FM 1472 Improvements		
Phase I: Widen existing facility from FM 255 to 3.2 mi. East of FM 255	$2.2	Completed
Phase II: Construct a 92' Curb and gutter section from IH 35 to 3.2 mi. north of IH 35	$5.7	Completed
Phase III: Widen to a four lane divided highway from 3.2 miles east of FM 255 to 3.4 miles north of IH 35.	$10.1	Construction began February 1994 (76% completed)

Source: "Texas-Mexico International Bridges and Border Crossings," January 1995
Texas Department of Transportation.

Bridge traffic information obtained from the LBS and US Customs shows that cross-border truck shipments through Laredo grew from 207,907 trucks in 1986 to 452,386 trucks in 1990 and about 909,000 in 1994 . These impressive increases in bridge traffic between Nuevo Laredo and Laredo are expected to continue, since the northern border of Mexico had an expanding base of industries and maquiladora plants. Although the significant increases in truck traffic on the international bridges could to a large extent be attributed to the growth of the maquiladora plants, eventually NAFTA is expected to result in a growth in trade between the two countries that should result in a wider hinterland for the ports of entry handling border crossings.

Moreover, ambitious regional plans for Nuevo Leon should result in additional development and increased trade opportunities. The Trust for Development of Northern Nuevo Leon (Fideicomiso para el Desarrollo del Norte del estado de Nueva Leon o FIDENOR) has formulated a comprehensive plan, named 14-XXI, for the redirection of urbanization centered on Monterrey to fourteen emerging cities in Nuevo Leon. Many of these cities lie along Mex 85 and the planned tollway between Monterrey, Reynosa and Laredo, connecting to Anahuac and Colombia.

The Comprehensive 14-XXI Plan, together with the favorable trade climate between the US and Mexico, and the growth of the maquiladora industries should increase demand for crossings between the two countries in the Laredo area. This expectation of increased traffic was the main objective for building new border crossings in the Laredo area.

In the case of the Solidarity Bridge, several benefits were anticipated. First, the new bridge would enhance the healthy economic climate and trade between Mexico and the US. The infrastructure to encourage increased trade was deemed critical to the continued well-being of both Laredo, which had a higher unemployment rate than the State average, and the cities in the state of Nuevo Leon. The development of additional industries in Nuevo Leon was a key aspect of the planned 14-XXI strategy, which included as a priority the development of a new US-Mexico border crossing.

Secondly, the new Colombia border crossing would act as a catalyst to new commercial and industrial development adjacent to the bridge site. The open rural land at Colombia would allow orderly growth and development to proceed following the development of comprehensive plans for the area.

Finally, opening a third crossing would further expand opportunities for additional development of the tourist trade. Laredo and Nuevo Laredo (Los Dos Laredos) are one of Texas most popular tourist attractions. In the early 1990s, more than 16 million people used the Laredo Bridges for travel to and from "Los Dos Laredos," and prospects for continued growth in travel were excellent. Moving through traffic, particularly heavy truck traffic away from the downtown crossings, increases the area's attractiveness for tourism.

With the passage of NAFTA, it is expected that cross-border traffic will increase at an even higher rate in the future. Thus, efforts are also being pursued to increase border crossing efficiency, through increased use of new technology and operational improvements to expedite movements and reduce delays.

The objectives of the proposed new bridge (Laredo Northwest International Bridge or Bridge IV) are somewhat different from those of the Colombia-Solidarity Bridge. It has been proposed in accordance with the urban transportation plan for "Los Dos Laredos." The main objectives of this proposed bridge are expediting freight movements, relieving truck congestion in the two downtown crossings, and separating truck traffic from the automobile and pedestrian traffic that is anticipated will continue to dominate the border crossings at Bridges I and II. The plan includes development of truck routes to service industrial areas so that most commercial traffic can bypass downtown and the roads used by residents and tourist visitors. A significant shift in land use has already established large trucking terminals and warehouses in areas with easy access to the proposed bridge location.

Similarly, the proposed new rail bridge is aimed at taking rail freight traffic out of the urban center, with an expected reduction of 90 percent of Union Pacific train traffic and operations in downtown Laredo. It is anticipated that the new rail crossing would also result in shifting a majority of switching activities away from the downtown rail yard to Port Laredo, north of downtown, thereby substantially reducing delays at rail crossings, reducing noise at residential areas near the present yard, and improving Laredo's ability to attract new business due to its improved transportation infrastructure.

b. Decision Making Process

In general, although any border community can put in a request for construction of a new bridge, it is not a simple matter to have a project approved and funded by the governments of both countries. Many approvals and clearances must be obtained. The following paragraphs summarize some of the required approvals (not in any particular sequence).

On the US side, the first step in the approval process was solicitation of a Presidential Permit in accordance with the International Bridge Act of 1972 and applicable executive orders. Prior to the International Bridge Act, approval to construct an international bridge was granted by an Act of Congress. A recent state law requires Texas Transportation Commission approval of a proposed international bridge between Texas and Mexico before the local sponsor applies for a Presidential Permit. This law does not affect projects whose sponsors have already obtained or submitted a Presidential Permit application.

A Presidential Permit is issued by the Secretary of State or his designate. The State Department acts as liaison between both federal governments. In the US, the process involves the collaboration of both Federal and Texas state agencies, and may take several years, especially for the review of environmental impacts. Federal agencies participating in this coordination and approval process include Department of the Treasury, (US Customs Service), Department of Justice (US Immigration and Naturalization Service), Agriculture (Animal and Plant Health Inspection Service), Food and Drug Administration, US DOT (Federal Highway Administration, Federal Railroad Administration, US Coast Guard), Department of Commerce,, Environmental Protection Agency, Department of the Interior (Fish and Wildlife Service), and Department of Defense.

After the Presidential Permit is issued, the sponsor must obtain a permit from the US Coast Guard. The U.S. Section of the International Boundary and Water Commission (IBWC) must grant its

approval as well.[2] In Mexico, approval to build an international bridge is usually not granted until all U.S. permits have been secured.

Funding for a bridge on the US side is usually provided by the local community itself. State and local governments generally provide the connecting highway infrastructure, while federal agencies provide the inspection facilities. In recent years, Mexican states have been given more autonomy by their federal government regarding bridge projects. In addition, private investment sources have been allowed to participate in the funding and operation of these projects.

Although there are quite a few organizations that must approve a new crossing at the Federal level, three other entities are key to the decision making process: the Metropolitan Planning Organization (MPO), the Texas Department of Transportation (TxDOT), and the City of Laredo.

The MPO is a planning organization of city, county, and state representatives, established to satisfy Federal requirements. The MPO prepares and periodically updates a long-range (20 year) plan (LRP) for the metropolitan area. For the city of Laredo, where the metropolitan area covers approximately the city limits, the MPO is staffed by the City. As required by the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), the MPO also plays a vital role in the preparation of a Transportation Improvement Program (TIP). The TIP lists projects to be carried out over a 3-year period, including all projects within the metropolitan planning area requesting federal highway or transit funding. The TIP also includes a financial plan that demonstrates how the TIP can be implemented. The TIP is updated at least once every two years.

TxDOT, in accordance with the requirements of ISTEA, and in coordination with the MPO, maintains a 10-year Project Development Plan (PDP) for all planned transportation infrastructure projects.

At the city level, the main policies, goals, and objectives for infrastructure planning are summarized in the City of Laredo Comprehensive Plan. This city plan, covering both land use and transportation requirements, guides public and private decisions regarding new developments. The tools for implementing this plan are the city zoning and subdivision ordinances and the Capital Improvement Program (CIP). The CIP guides public investment over a 5-year period, with the first year covered as part of the annual budget. Figure J-3 shows the US entities involved in Laredo's transportation infrastructure planning. The binational character of the effort involved in planning a border crossing means that in addition, agreement must be reached with the appropriate Mexican agencies and funding obtained to be able to implement a cross-border improvement.

Clearly, there are many agencies involved in the decision-making process for the construction of border infrastructure improvements. A proposal to establish a coordinated bi-national process along the entire US-Mexico border has been endorsed by both countries and the details of how such a process should be conducted is presently being studied. The cities of Laredo and Nuevo Laredo have

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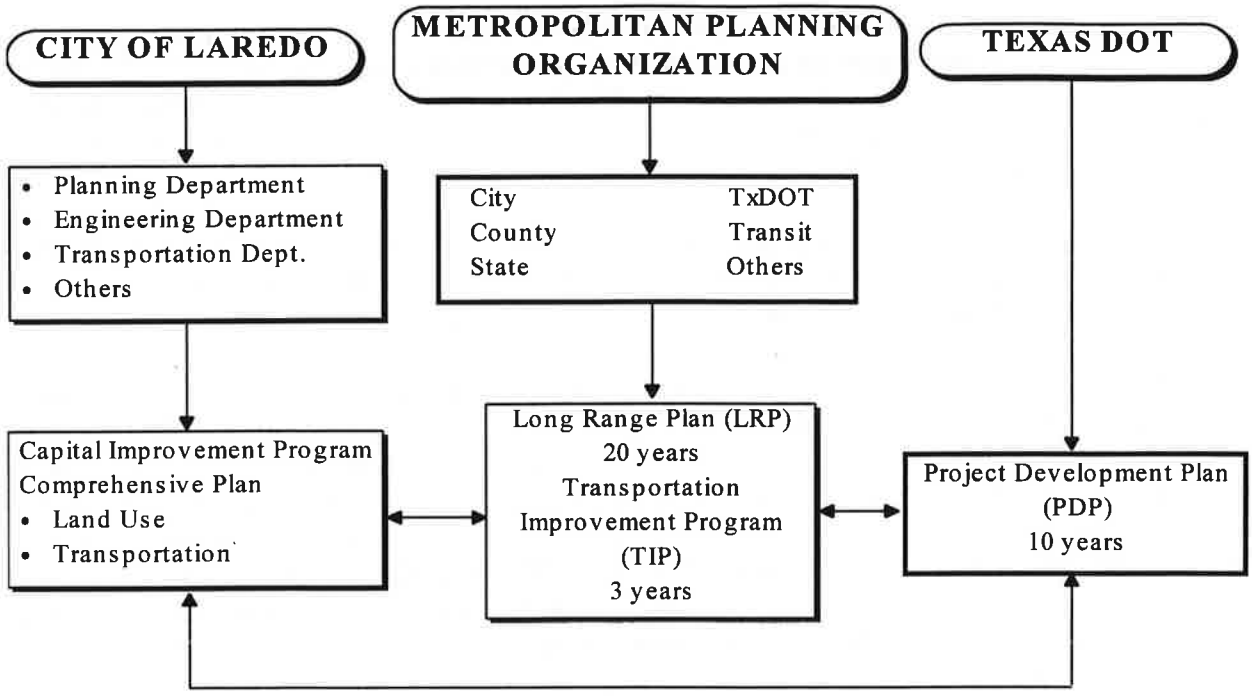
[2] Information on approval process as provided by Henry Nevares, Director, International Relations Office, TxDOT

Figure J-3: Entities Involved in Laredo's Transportation Infrastructure Planning



Source: "Transborder Traffic and Infrastructure Impacts on the City of Laredo, Texas," Said, C., Harrison, R., Hudson, W.R. CTR, Bureau of Engineering Research, University of Texas at Austin, November, 1993.

began such a coordinated process and have jointly prepared an "Urban Plan of Los Dos Laredos" in 1994.

III. Analysis and Methodology used for Project Evaluation prior to Investment Decision

A number of studies were conducted over the years to analyze and obtain approval of the investments in border crossings at Laredo (a list of the most notables are shown in the References at the end of the Appendices). The main studies were carried out by agencies or groups interested in pursuing a specific project and presenting the justification for that project. As such, the available studies and reports emphasize the analysis required to present justifications necessary to obtain funding or approval of permits.

The basic planning methodologies applied included analysis of the implications of Origin/Destination studies and related traffic forecasts with 20-year time horizons. Analysis prior to investment decisions focused on developing traffic and revenue estimates and determining the financial feasibility of a new bridge crossing. In developing the forecasts, various assumptions were made with respect to increases in total truck and non-truck traffic to reflect population and GDP growth, as well as development of maquiladora industries. In addition, the forecasts reflect assumptions with respect to diversion of traffic to proposed bridges from the existing crossings.

In the case of the Solidarity Bridge, financial experts analyzed the historical traffic trends on toll bridges from 1981 to 1986. Data on various traffic categories, estimated population and economic growth in Laredo and in the industrial centers in northeastern Mexico were utilized for traffic assignments and to estimate growth of vehicle crossings.

In the late 1980's and early 1990s, traffic at Bridges I and II was increasing as a result of trade expansion. Routing heavy traffic through the center of Laredo over Bridges I and II led to sporadic and severe congestion. Table J-5 below shows the total traffic for the LBS.

Table J-5. Laredo Bridge System: Total Traffic per Fiscal Year

Fiscal Year	Total Vehicles	Pedestrians	Tonnage (MT)
1980-81	5,485,000	3,283,000	3,060,000
1985-86	5,660,000	3,127,000	2,221,000
1986-87	5,678,000	3,099,000	2,589,000
1987-88	6,148,000	3,307,000	3,861,000
1988-89	6,723,000	3,368,000	5,152,000
1989-90	6,594,000	3,157,000	7,271,000
1990-91	6,606,000	3,207,000	9,554,000
1991-92	7,043,000	3,718,000	12,663,000
1992-93	7,138,000	3,917,000	13,493,000
1993-94	7,432,000	3,715,000	15,525,000

Source: City of Laredo

A study conducted by TxDOT in 1987[3] regarding international bridge traffic congestion in Laredo identified four elements that affected the capacity of vehicular flow at the two bridges: total number of lanes, toll collection, customs inspection, and the adjacent street system both in the US and in Mexico. At that time, the ten lanes between the two bridges appeared to handle traffic volumes adequately. Toll collection did not seem to present any major capacity problem. However, the staffing level of the US Customs activities had limited actual capacity for Bridges I and II. In addition, the street system adjacent to the bridges had a limited capacity for future growth. Access to Bridge I was limited by the narrow, downtown streets serving the bridge from both Laredo and Nuevo Laredo. Although Bridge II had excellent access from IH-35, the road infrastructure from Nuevo Laredo was not yet developed, and what existed was substandard.

Financial projections were based on a moderate growth of 5 percent for non-freight traffic, and a doubling of the amount of freight over the next 12 years, as well as a shift of 75 percent of freight traffic from Bridge I to the new Solidarity bridge. Table J-6 below presents the results of the financial analysis.

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[3] Texas Department of Highways and Public Transportation A Report on International Bridge Traffic Congestion October 1987.

The construction of the Solidarity Bridge, however, was not pursued solely based on the traffic demand or financial analysis. The project was an important initiative for the Mexican government

Table J-6. Solidarity Bridge: Financial Analysis

ITEM	VALUE
Estimated Cost	$11,283,000
Required Bond Issue	$12,000,000
Bond Term	20 Years
Bond Earning Period	19 Years
Interest Rate	7.0%
Coverage	
Maximum (First Year) Interest by:	1.89
First Year Gross Revenue	1.53
First Year Net Revenue 1/	
Level Debt Service by:	
Average Annual Gross Revenue	1.93
Average Annual Net Revenue 1/	1.63

1/ Inclusive of Maintenance and Operations Costs

Source: An Application for a Presidential Permit to Construct an International Bridge, Nuevo Leon, Mexico and the State of Texas, USA, submitted by the City of Laredo, August 1989.

and the state of Nuevo Leon. It was the first priority of a larger development strategy and as such was part of a comprehensive development plan enunciated in the 14-XXI plan of FIDENOR, which in addition to the bridge included the following investments:

- A new highway to the city of Monterrey, Nuevo Leon.
- Construction of the Anahuac-China industrial highway and other infrastructure to encourage urban development in four Mexican medium size cities.
- Intense agricultural and cattle breeding development in Northern Nuevo Leon.
- Industrial and agricultural development in Lampazos and Sabinas Hidalgo, Nuevo Leon.
- A regional development approach to connect to other nearby Mexican states.

Many of these other projects on the Mexican side are still in the planning stage. Similarly, on the US side, access connections have been improved to I-35, but a direct link from the Colombia Bridge to the Interstate System to the north still does not exist, so that using the Colombia Bridge requires a longer and not as direct a route. A proposal to construct a 22 mile limited access road as a private toll facility connecting the Colombia Bridge and I-35/US83 has been proposed by Camino Colombia, Inc., a corporation comprised of Laredo land-owners and businessmen. The proposal would provide a more direct, high speed connection to the Colombia Bridge, but traffic estimates indicate it would not attract much volume. For this purpose, this connection has been opposed by the city and other local interests.

In the case of the proposed new bridge (Laredo Northwest International Bridge or Bridge IV), the analysis and justification are somewhat different from those of the Colombia-Solidarity Bridge. As noted previously, this new bridge has been proposed in accordance with the urban transportation plan for "Los Dos Laredos." The justification for the new bridge is primarily based on achieving the city's tourism and urban development objectives, and not as was the case with the Solidarity Bridge, in increasing bridge-crossing capacity. One of the main objectives of the proposed bridge IV is separating truck traffic from the automobile and pedestrian traffic that is anticipated will continue to dominate the border crossings at Bridges I and II. The plan is intended to encourage most commercial traffic to bypass downtown and the roads used by residents and tourist visitors.

IV. Project Objectives Achieved and Results After Investment

In the 1990s, increased US-Mexico trade and cross-border production sharing have contributed to spur Laredo growth, so that the city became the fastest growing city in Texas and the second fastest growing city in the US. Table J-7 summarizes the economic development of Laredo from 1990 to 1994.

Table J-7. Laredo: Economic Activity

	1990	1991	1992	1993	1994
Employment	48,000	50,300	53,500	56,800	61,900
Unemployment Rate	12.2%	9.4%	9.6%	8.4%	8.2%
Trade with Mexico (billions):					
Exports	$29	$33	$41	$42	$51
Imports	$31	$31	$35	$40	$50
Truck Shipments					
Southbound	261,000	347,000	457,000	478,000	48,000
Northbound	191,000	183,000	213,000	252,000	360,000

Source: City of Laredo Bridge System, US Customs, and "Laredo: Bordering the Future - The 1994 Charts," Laredo Development Foundation.

Judging from the above evolution, it appears that the investments in the border crossings facilities at Laredo, have responded to the requirements of economic growth in the area.

In the case of the Colombia or Solidarity Bridge, when it was approved, it was anticipated that the investment in additional infrastructure in the Texas-Mexico border would enhance transportation efficiency and at the same time attract the lucrative revenues associated with international border crossings. However, until the remaining connecting links are implemented and the planned complementary developments are pursued, it is unlikely that the Colombia Bridge will attract the anticipated volumes or perform financially as forecasted.

The Colombia Bridge has not attracted significant volumes and is not operating at or near its full potential[4]. The additional travel distance (19.5 miles from the intersection of FM 1472 and IH35 to the bridge, and a similar longer distance from the bridge to Mex 85) is a principal explanation for the above situation. This additional distance becomes a greater drawback because of the inadequate connecting highway infrastructure on both sides of the border. At the time the bridge started operations, FM 1472 was deteriorating and too narrow to appropriately handle truck traffic. Finally, the scarcity of customs brokers at or near the bridge has deterred freight crossings. On the US side, the connecting infrastructure to the Colombia Bridge has improved significantly since the bridge opening, with the completion of FM 255 and the near completion of FM 1472. Eventually, once all the planned development strategies that were the basis for the construction of the bridge are implemented, and once the highway connections are completed, the bridge is likely to attract additional traffic.

In a recent project[5] undertaken by the University of Texas, in cooperation with the Texas Department of Transportation and the Texas Turnpike Authority, two complementary concepts useful in binational transportation planning have been proposed: sector analysis and super-crossing. Sector analysis - a concept based on major traffic diversion areas - provides aggregated revenue and/or demand estimates that address regional (as against site-specific) demand and capacity issues. The super-crossing concept, developed to address post-NAFTA projected commercial traffic, is based on ISTEA guidelines intended to foster multimodal and intermodal facilities. The Solidarity Bridge has the potential of eventually becoming such a Super-crossing as post-NAFTA demand increases over the long-term.

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4 From October 1991 to October 1992, it accounted only for 2.7 percent of southbound freight crossing and 0.6 percent of total southbound vehicle crossings.

5 Overview of the Texas-Mexico Borders: Assessment of Traffic Flow Patterns, by the Center for Transportation Research, University of Texas, in cooperation with the Texas Department of Transportation and the Texas Turnpike Authority, April 1994.

V. Lessons From Case Study

The transportation infrastructure of the Mexico border crossings and the Laredo port of entry primarily serves the growing trade between the two countries. These transportation and related facilities also make possible the operation of the maquiladora plants and other industrial development in the border region, which are aimed at taking advantage of available opportunities to produce goods in this continent cheaper than in other areas of the world. As the economies of the two nations move towards further integration, there will be a continuing need to improve the transportation infrastructure at the border.

There are a limited number of ports of entry to handle the increasing trade flows across the border. In a border crossing or port of entry along the Texas border such as Laredo, the major investment that influences development along the border and affects the capacity and the efficiency of trade flows is the construction of the bridge crossing itself. However, other associated inspection facilities and connecting infrastructure are essential to adequately handle international trade needs across the border efficiently and without delay. Just as seaports and airports are in competition to attract cargo and development to their regions, so do different ports of entry compete with each other for industries, warehousing, and trade. In some cases, ports of entry actually compete with seaports and airports in both countries, since in today's increasingly global economy, some cargo destined for Mexico from Europe or Asia moves through US seaports and airports, and vice-versa.

Recent trade increases between the two countries reflect the national policies to move towards creating a Free Trade Area. Foreign trade already represents an increasing share of GDP, and eventually with NAFTA, can be expected to result in growing flows across the border, which can increase jobs and the competitiveness of the North American economies in the new global economy. Based on the history of construction of transportation infrastructure at the Laredo port of entry, the following lessons can be drawn as to its relationship to economic expansion:

- Although a major portion of border crossing demand is locally based, overall demand is significantly affected by binational trade trends. Such trends can result in rapid growth or cause significant unanticipated changes in the flow patterns, such as those due to border delays, currency exchange fluctuations, and other global competitive factors.

- Adequate transportation infrastructure and efficient border processing operations (e.g. customs, drug enforcement and immigration inspection) are competitive factors for industry and trade-related business site selection and affect the production and distribution of goods throughout the US.

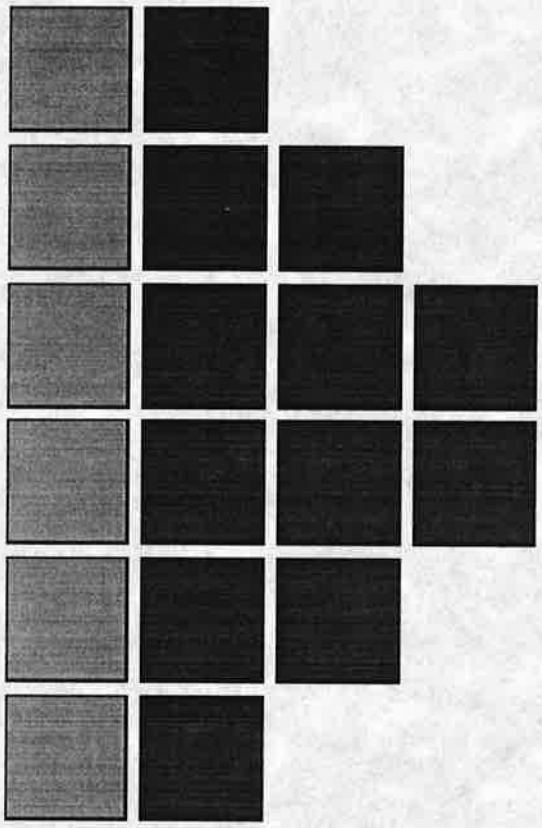
- For a local area along the border like Laredo, an investment in transportation and related infrastructure is a key ingredient to attracting employment and economic growth to the region. Laredo has become the second fastest growing city in the US mainly due to its strategic location along the border at a time of rapid growth in bilateral trade, but also because of its continuing efforts to improve the transportation

infrastructure and thereby, respond to, plan for, and stimulate increased demand. Some of the infrastructure may be underutilized initially, due to lack of immediate connections or the time it takes to fully implement long-term development plans, but the available infrastructure adds considerable value to the area's strategic location.

- Although bridge crossing capacity has been increased in response to growth in trade, the delays in the implementation of access connections to the Colombia bridge point out the importance of a more coordinated bi-national process leading to transportation infrastructure decisions. Such a bi-national process is being proposed along the entire US-Mexico border. A process where infrastructure needs and priorities could be assessed in a coordinated manner, with the participation of private and public interests from both sides of the border would, provide a mechanism to consider comprehensively the potential bi-national importance and the economic development impact of projects, as well as the needs of long-distance traffic serving international trade.

- Increased traffic across the border can also bring about negative impacts, such as congestion, that affect local businesses. Laredo officials and private interests have recognized the importance of not only assuring adequate highway capacity across the border, but also of accommodating rail movements away from the downtown area, separating commercial vehicle traffic from passenger vehicles and pedestrians, and providing highway bypass routes around the congested downtown area. These kinds of improvements help assure that trade flows can be handled as efficiently as possible, while minimizing local impacts.

- Although historically most of the transportation infrastructure at the border crossings was a result of demand for increased international trade, as the area has grown local development objectives have become increasingly important in determining transportation needs, such as the city's objective for Bridge IV of separating commercial traffic from tourist and pedestrian traffic.



Appendix K

Case Study X:

Dredging of Port Access Channels
Baltimore, Maryland

LOUIS BERGER INTERNATIONAL, INC.

APPENDIX K

CASE STUDY:

DREDGING OF PORT ACCESS CHANNELS: BALTIMORE

I. Investment Description

Ports and inland waterways are major elements of the nation's transportation infrastructure. The federal government is responsible for all waterways in the nation, and state and local jurisdictions, through government agencies or independent public authorities, invest in ports mainly for the purpose of attracting jobs and economic development to their areas. Typically, these ports compete with other ports in the region for cargo in their local hinterland, and with ports around the nation for cargo bound for farther inland destinations. From the national perspective, ports are a key factor in maintaining the nation's competitiveness for exports. They are particularly important as the nation's economy becomes more closely integrated into the global economy.

Because ports throughout this country collectively handle a high percentage of U.S. exports and imports, uncluttered channels and waterways are vital to maintaining and increasing the competitiveness of US exports. It is estimated that ninety-five percent of U.S. overseas trade moves in and out of U.S. ports. There are over 25,000 miles of navigation channels linking American communities to each other and foreign ports. The maintenance of safe, efficient and cost-effective navigation channels is vital to the economic well-being of our nation.[1]

During 1993, U.S. ports handled 411.3 million short tons of exports, and 649 million short tons of imports.[2] A port system includes

- the marine terminals where cargo is loaded and off loaded from the vessels that transport it to and from foreign or other domestic ports,
- the land access routes (highways and railroads) connecting the marine terminals to the origin or destination point of the cargo in the US, and
- the access channels or water transport routes that link the port to the ocean.

A port employs a large number of cargo-handlers, vessel crews, freight forwarders, truckers, railroad workers, bankers, insurance providers, and others, who typically represent a significant portion of the economic activity in the local area of a large port. Not only do ports have a large impact on local economies, but many also have regional, state, and national economic significance.

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[1] *World Dredging, Mining & Construction*, November 1993, as quoted in Transportation Research Circular 247, p. 7.

[2] Waterborne Commerce Statistics Center, New Orleans, LA.

Ports are in direct competition with one another for the cargo within their hinterland, and are always seeking ways to expand their service area, thereby attracting greater volumes which can be served profitably by larger vessels. These larger vessels can help achieve greater economies of scale, which benefit shippers, producers and consumers. An efficient and modern port capable of handling all sizes and categories of vessels and commodities affords the greatest potential for increasing business.

In order to keep ports functioning and increase market share, dredging is a critical effort. Clogged channels with limited depth affect the capacity or efficiency of large vessels, and even prevent the passage of some larger vessels, since such vessels either cannot arrive or depart the port fully loaded. When vessels can only use a port partially loaded, their unit costs increase. Dredging of ports and their access channels is thus an essential activity to assure the competitiveness of the nation's products and to maintain the flow of international commerce in and out of the United States.

Dredging involves the subaqueous excavation of soils and rocks in the access channels from the ocean to the port terminals. The overall process involves excavation, transportation and disposal or use of the material removed. Dredging can be undertaken for maintenance of the existing channels, or for deepening. In most ports, major sections of the navigation routes from the ocean to the port terminals have naturally deep water and therefore, require no dredging. However, some segments need to be dredged periodically to maintain navigation. Regular maintenance dredging then is aimed at maintaining adequate depths for vessels presently engaged in domestic and overseas trade. Channel deepening is undertaken to allow ships of greater size to call on a port, thereby improving the economics of shipping and allowing larger loads per vessel voyage.

A complex process, dredging is not typically considered by some as a transportation investment and is little understood outside of the group of experts and specialists who work on such projects, both in terms of its importance to the nation's or an area's economic well being and its environmental impacts.

The waterborne transportation system has always been viewed as essential to national security, in addition to its major role in domestic and foreign trade. The Federal government has been responsible for operating, maintaining and improving most of the nation's navigable waters throughout our history. The US Army Corps of Engineers (COE) is the lead agency responsible for the dredging of the nation's main navigable waterways.

A 1993 Dredging and Disposal Survey by the Harbors and Navigation Committee of the American Association of Port Authorities (AAPA) documents the authorized depth of major US ports and their dredging requirements (see table K-1). The survey, however, indicates that actual depth was not always the same as authorized depth, particularly in North Atlantic and New England ports. As can be seen from the chart, California ports have some of the deeper channels in the US. Their actual depth exhibited little, if any, variation from authorized depth. About 100 million cubic yards of material need to be dredged annually to maintain navigation channels in the US. In addition, the AAPA survey identified plans to dredge between 9 and 28 million cubic yards for channel deepening annually over the next few years.

Table K-1: Federally Authorized Main Channel Depths in Major U.S. Ports and Harbors

Region	Main Channel Depths
North Atlantic and New England	35-55
Ohio River/ North Central	23-28
South Atlantic	34-45
Lower Mississippi/Louisiana	20-55
Texas/ Southwest	30-45
California/South Pacific	35-60
North Pacific	34-40

Source: Harbor Navigation and Environment Committee of the American Association of Port Authorities - 1993 Dredging and Disposal Survey, May 1995

This case study of dredging investment reviews the project to deepen the southern access channels to the Port of Baltimore (POB) from 42 to 50 feet and the maintenance program to maintain the authorized depth of 35 feet on the northern approach channels to the port during the late 1980s. Deepening the Port of Baltimore's main or southern channels from 42 to 50 feet while at the same time maintaining the authorized depth on the northern approach channels was chosen as a case study because it represents investments aimed at both

- maintaining safe navigation for existing traffic, and
- attracting new business by allowing larger vessels with deeper drafts to access the POB

Dredging to deepen and maintain the access channels to the Port of Baltimore was also selected as a case study because it is an important issue in improving competitiveness and assuring that US ports can handle the largest and most efficient vessels in international trade, which represents an increasingly larger share of the nation's GDP. It is also an example of the few types of transportation investment that has been based on a traditional economic and benefit cost analysis at the project level. In addition, many of these projects have frequently been delayed for decades due to environmental concerns and/or regulatory procedures, even though the economic analysis demonstrated the high level of benefits that would result from the investment.

The project to deepen the southern or main approach channels to the Port of Baltimore, from the entrance to the Chesapeake Bay in Virginia to the Baltimore harbor maritime terminals was implemented between 1987 and 1990 at a projected cost of $388 million. By the conclusion of the project, however, project costs ended up being *lower* than projected, about $227 million, primarily due to favorable bidding conditions, but also due in large part to the fact that while the affected channels were deepened to 50 feet, they were not widened as much as called for in the initial project

design. Savings were also realized from a drop in fuel prices during the construction phase, since dredging is fuel intensive. Furthermore, additional savings were achieved through an agreement to dispose of excavated material at sites closer to actual dredging locations in Virginia, including use of the dredged material for beach nourishment in Virginia Beach. The Hart-Miller location was used for the channels located in Maryland. Map K-1 outlines the location of the channels that were dredged.

The POB has a second access route to the ocean from the northeast through the Chesapeake and Delaware (C&D) Canal. The importance of the C&D Canal to the navigation network serving the Port of Baltimore is evident in that during 1983, nearly two-thirds of the approximate 3,000 vessel arrivals into Baltimore transited the Canal.

The northern approach route to the Port of Baltimore uses a continuous sea level channel connecting Baltimore harbor to the Delaware river, through the upper Chesapeake Bay and the C&D Canal, saving about 150 miles on a trip between Baltimore and New York and about 100 miles on a trip to Europe (see Map K-2).

There are a number of areas in the Upper Chesapeake Bay where rapid shoaling[3] requires almost constant dredging to maintain the authorized channel depth. Due to environmental restrictions that prevent dredging during certain months of the year, maintenance dredging is generally carried out only once a year. Shoaling in this area can then decrease depths by as much as 3 to 5 feet prior to commencement of the next round of maintenance dredging. This annual maintenance of the northern approach access channels to the Port of Baltimore in the mid-1980s did not prevent the continuing shoaling of channels over the years, so that by the late 1980s, only vessels with a maximum draft of 30 to 31 feet could use this route at certain times of the year, compared to the authorized 35 feet depth. A one-time project at a cost of about $26 million became necessary to bring the channel to the authorized depth and to ensure that regular annual maintenance dredging could maintain the authorized depth year-round.

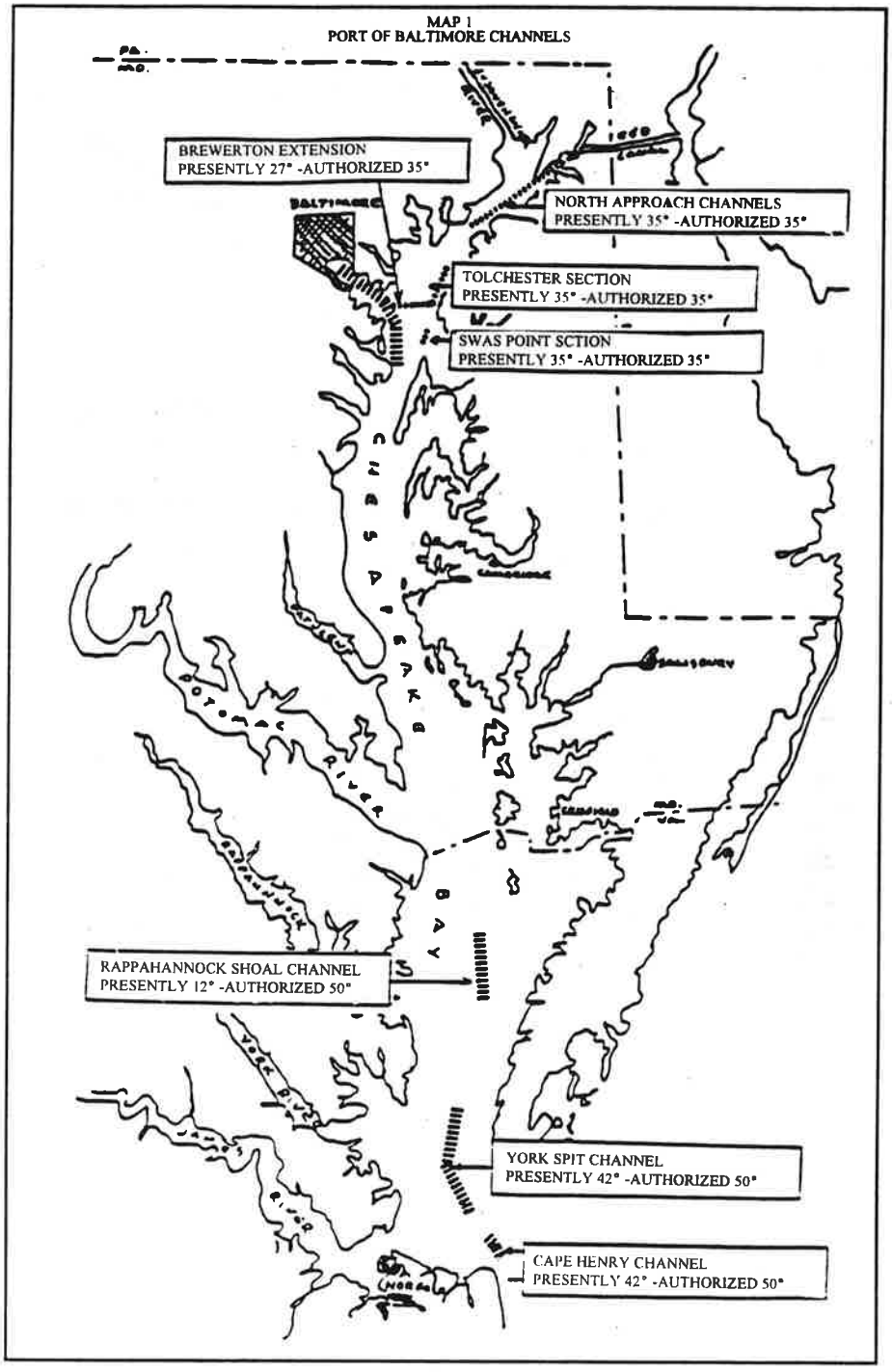
II. Investment Objective and Decision-Making Process

A. Investment Objective of Deepening Southern Access Channels

POB cargo trade can be divided into three types: dry bulk, liquid bulk, and general cargo. Historically, cargo traffic in and out of the POB has been dominated by bulk commodities such as coal, iron ore, grain, sugar, and residual oil. In terms of tonnage, dry bulk commodities accounted for 70 to 80 percent of Baltimore's foreign trade from 1980 to 1985, with liquid bulk and general cargo (steel, lumber, autos, merchandise in containers, etc.) accounting for the rest. In 1984, coal and grain exports, combined with iron ore imports comprised some 86 percent of total dry bulk foreign trade through the POB. In dollar terms, total U.S. exports of coal, the leading export

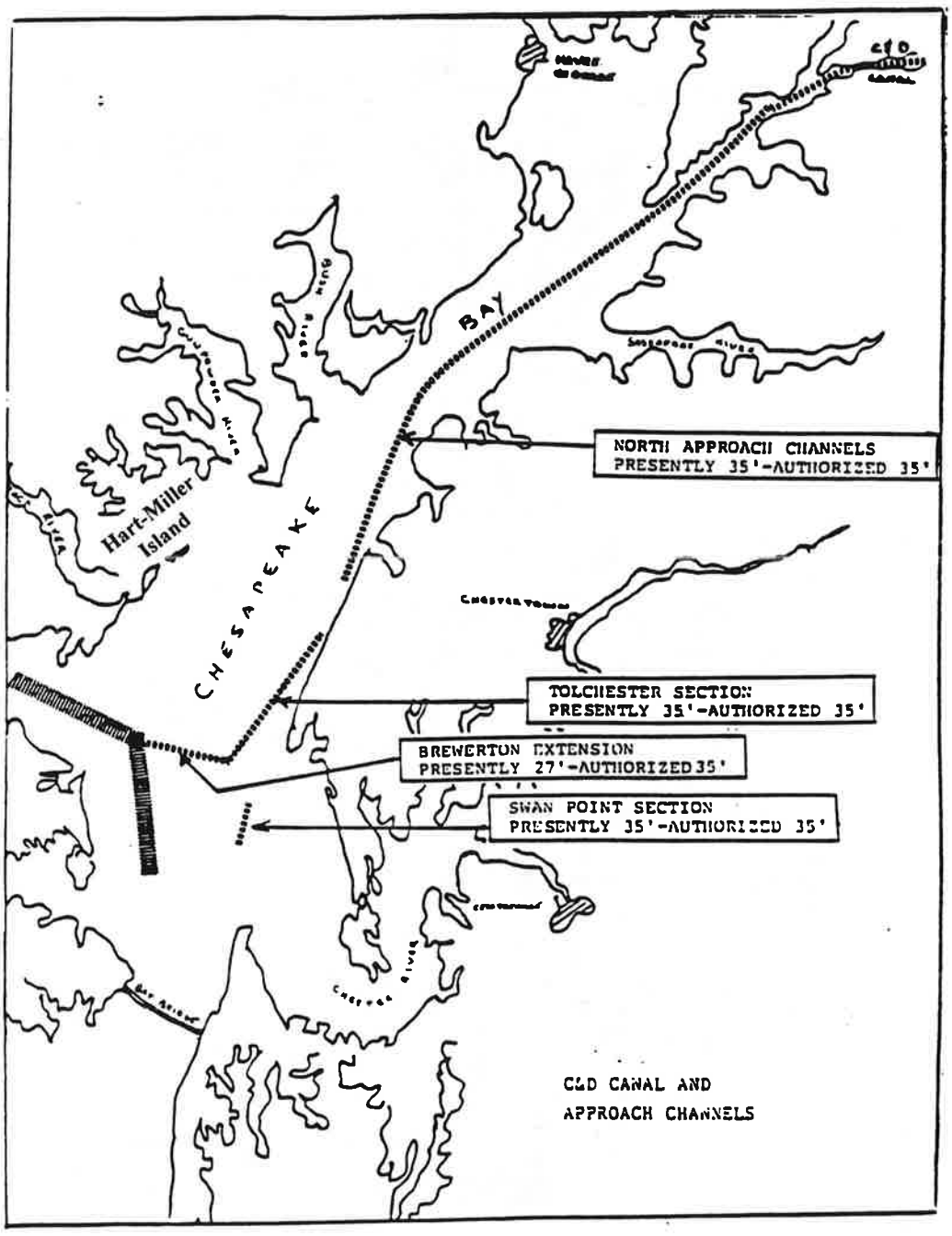
[3] movement of silt and sand materials creating shallower areas

Map K-1 Port of Baltimore Channels



Source: Port of Baltimore Channel Deepening. Feasibility, Status and Financial Issues Maryland Department of Transportation, 1985.

MAP K-2- C&D Canal and Approach Channels



Source: Port of Baltimore Channel Deepening. Feasibility. Status and Financial Issues
Maryland Department of Transportation

commodity through the POB, amounted to $3.196 billion in 1993.[4] The impacts of the lack of dredging to deepen or improve the POB channels, therefore, are not only important to the local area, but extend well beyond the boundaries of the port to include the regions and states where the coal is produced, as well as the nation's overall export competitiveness.

The trend for future shipments of bulk commodities, both domestically and internationally, clearly underscore an emphasis on the use of larger vessels because of their cost savings. Larger ships require deeper drafts, which in turn necessitates deeper water and access channels. Given these trends, U.S. ports must be able to handle larger vessels with deeper drafts in order to remain competitive in the dry bulk trade.

The underlying investment objective for **deepening the POBs main channels** was to increase the port's competitiveness, especially in the dry bulk trade, lowering transport costs by accommodating larger vessels.

All of the major potential users of the deepening project are private dry bulk terminals. The largest potential users of the 50-foot channel were the coal export facilities. The Port of Baltimore has 3 export coal piers with a combined capacity of over 30 million tons annually. The piers at two of the facilities (Consolidation Coal and Bayside Coal) were built in the early 1980s during the coal export boom that followed increases in oil prices, in anticipation of the 50-foot channel deepening project. Therefore, no structural pier modifications were necessary to accommodate vessels with a draft of 50 feet at those piers.

Another major potential user, the Bethlehem Steel Sparrows Point Plant, has a pier used for iron ore imports, also designed so that use by vessels with a draft of 50 feet will not require structural modifications. Other than the two coal terminals and the Bethlehem Steel pier, terminals wishing to make use of the deeper federal channel would have to rebuild their piers, in addition to dredging their private access channels connecting to the federal channel.

The economics of shipping dry bulk commodities, which typically require a full shipload between one origin and one or more destinations, make it more efficient to use larger vessels to reduce the unit costs. Larger vessels provide significant "economies of scale" to ship owners and shippers. The cost per ton can be reduced substantially by increasing vessel size and operating those vessels fully loaded, from about $0.95 daily cost at sea per dead weight ton (DWT) for a 15,000-DWT vessel to about $0.24 for a 150,000-DWT vessel based on 1982 foreign flag costs. Because of the savings involved, the trend has been towards building larger dry bulk vessels. In 1960, there were no dry bulk vessels over 80,000 DWT. In 1982, about 10% of the nearly 5,000 vessels in the worldwide dry bulk fleet were over 80,000 DWT, representing over one third of the total worldwide dry bulk capacity.

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[4] U.S. Bureau of the Census, "U.S. Merchandise Trade," Series FT 900, December 1993.

Larger vessels require deeper water, so while a 15,000-DWT dry bulk vessel requires about 31 ft in draft, a 150,000-DWT vessel requires about 56 ft. Therefore, to remain competitive with other ports and to be able to handle dry bulk cargoes to and from foreign harbors that have deeper ports, the Port of Baltimore needed to deepen its main channels so as to be able to handle the larger vessels fully loaded. With channels deepened to 50 feet, the bulk commodities which make the greatest use of the port of Baltimoren - coal, grain and iron ore - would stand to benefit from the reduced costs made possible by the use of larger vessels.

B. Investment Objective of Northern Approach Channels Maintenance Dredging

In contrast to the objective of the deepening project of the main or southern approach channels, the maintenance project to assure that the authorized depth on the northern approaches was maintained on a year round basis was aimed not at the dry bulk cargo trade, but at **preserving and increasing the competitiveness of the port in the container trade**. As noted, the northern approach route provides a short-cut to the ocean. Container vessels are also growing in size, but typically make more than one stop on the US North Atlantic coast as part of their regular route. The Northern Approach or C&D Canal route is then an essential link for container vessels moving between New York or Philadelphia and Baltimore.

The C&D route offers the steamship lines added flexibility, making it possible for a ship with a draft up to 35 feet leaving Baltimore to proceed directly north without having to backtrack down the Chesapeake Bay. Similarly, a ship with draft up to 35 feet coming from the north can use the northern approach to reach Baltimore without having to travel to the entrance to the bay. With the northern approach shallower than the authorized 35 feet, a large percentage of container vessels had to incur extra costs and delays traveling up and down the Chesapeake Bay in order to call on Baltimore. The $26 million project to restore the 35 feet authorized depth of the northern approach route was thus aimed at reducing vessel costs and trip times to approach the Port of Baltimore, particularly for the port's existing container and general cargo trade. With the size of container vessels increasing and the costs to operate these vessels rising, steamship lines were beginning to consolidate their port calls in order to reduce costs and to increase fleet utilization. Baltimore's inland location and the extra costs involved in moving up and down the bay became a competitive disadvantage that could be minimized through the maintenance dredging project.

C. History of Investment

The proposal to deepen the POB's main shipping channels was discussed since 1958, when the House Public Works Committee authorized the Corps of Engineers (COE) to appraise the need for improvements to Baltimore Harbor. In 1966, the COE recommended deepening Baltimore Harbor's main channels to 50 feet, and in 1968, it began a "public interest review." In 1969, the COE issued their report. Congress approved the project in the 1970 Rivers and Harbors Act. However, environmental concerns, the lack of an appropriate disposal area, cost-sharing issues between the State of Maryland and the federal government, and a series of additional required studies delayed construction for another 17 years.

Over the forty-year period between the initial proposal to study the project in 1958 and construction in the late 1980s, the Channel Deepening Project was studied through the various phases of engineering and economic project evaluation. Environmental controversies regarding the impact of disposal of the dredged material stopped the project in the 1970s.

In response to a state law that prohibited the disposal of dredged material anywhere in Baltimore Harbor, the port proposed building a containment area at a site adjacent to Hart and Miller Islands in the Chesapeake Bay. Soon after the proposal was made to use Hart-Miller Island as the disposal area, objections were raised about the appropriateness of the area as a disposal site. Local opposition to disposal on Hart-Miller Island delayed the granting of the required permits for building the containment dike. Some groups wanted the islands developed as a recreational area while others were concerned with the water quality impacts arising from the dumping of large quantities of contaminated dredged materials. Environmental impact assessments were prepared and a number of public hearings held before the Office of Management and Budget approved the 50 foot deepening project in 1975. However, citizens groups filed suit challenging the COE's decision to issue the permit for construction of the Hart-Miller dike, which in turn prompted appeals.

In 1981, the COE issued a revised General Design Memorandum which provided the basic design and the economic justification on which federal authorization was based. As part of the funding package, the State of Maryland was required to provide the disposal site for the dredged material. By 1982, the permit for construction of the containment area at Hart-Miller Island had been cleared. In January 1983, construction began. The containment site opened in the spring of 1984. Finally, with a disposal site in place, the project to deepen the POB's main channels was ready to begin. However, the start-up of the project was stalled by the Reagan Administration policy not to undertake any dredging projects until its proposal to change federal law to require cost-sharing was approved. The dredging project was thus delayed until after federal legislation requiring nonfederal cost sharing was approved in late 1986.

Throughout the nation's history and until the 1980's, the Federal government fully paid for the maintenance, improvement and operation of the navigable waters. In the early 1980's, no new water navigation improvements were implemented while Congress debated cost-sharing. The 1986 Water Resources Development Act for the first time required that non-Federal sponsors share in the construction costs to deepen and improve channels and harbors. Construction of the project to deepen the Port of Baltimore channels was started shortly after approval of a cost-sharing agreement between the Corps of Engineers and the State of Maryland in 1987. The project was completed in 1990.

At the same time as the project to deepen the southern approach channels was being implemented, the Corps of Engineers undertook the project to restore the authorized depth of the northern approach channels to the POB. The long-needed additional maintenance dredging was expedited as a result of a compromise reached during the Congressional debate that led to the milestone cost-sharing requirements of the Water Resources Development Act of 1986. Although it had previously been estimated to take as long as 8 years due to limited dredging maintenance funding, the project was completed by the end of 1987.

III. Analysis/Methodology Used for Project Evaluation Prior to Investment Decision

Over the four decades of debate regarding the pros and cons of deepening the POB's main channels, there were numerous studies and investigations. The first was a COE study that considered improvements needed to improve Baltimore Harbor. This was followed by another study in 1968, also implemented by the Corps, which reviewed the public interest in such a project from the national perspective and included a benefit-cost analysis, while taking into account other issues such as conservation, aesthetics, water quality, the effects on wildlife, and recreation.

Since the state had the responsibility for designating a disposal area for the dredged material, in 1970, the State of Maryland commissioned the "Trident-Green" Study, which considered 70 possible disposal sites and ended up recommending the Hart-Miller Island site. The COE issued two additional environmental impact statements before undertaking a "Final Plan and Study," including project engineering and design. At one point in 1978, two professors from Johns Hopkins University were asked to do a study on the appropriateness of the Hart-Miller area as a disposal site for the excavated material, who concluded that the disposal area design was safe.

The 1981 COE revised General Design Memorandum estimated over $156 million in annual benefits over a 50-year period from construction of the deeper 50-feet channel. Over 80% of the annual benefits were related to coal exports, with smaller percentages related to iron ore (6.8%), grain (6.4%), sugar (3.8%), and petroleum (2.6%). Part of these COE-computed benefits obviously accrue to areas beyond the Port of Baltimore or the State of Maryland, since the project makes coal mines in other states more competitive in the world coal market.

To determine whether the State should financially participate in implementing the project, beyond the State's prior expenditure to build the Hart-Miller dike, in 1984, the Maryland Department of Transportation examined the impact of deep-water dredging on the state economy. This study, for the first time, looked at the benefits and costs from the *State's* perspective, since Maryland was being asked to fund a major part of the project (approximately 25% of the dredging costs). The study evaluated and quantified the economic benefits and costs from increasing channel depth to 50 feet. Specifically, the Maryland Department of Transportation study evaluated the following:

- the economic benefits and costs to the Port of Baltimore associated with increasing channel depth;
- the degree to which deep-water dredging would attract bulk cargo to the POB;
- the level of employment to be generated as a result of the deepening;
- the value of the employment benefits derived from the investment.

This analysis recognized that while conventional financial analysis is critical in evaluating capital projects, overall economic return takes on equal, if not greater, importance in public sector investments with long life cycles, such as the deepening project. In general, the question to be answered was whether the economic benefits to the State of Maryland derived from the investment would exceed the costs incurred.

The methodology chosen to appraise the state's investment in the channel deepening project was based on Benefit/Cost (B/C) analysis in net present value terms[5]. For the purposes of the channel project, the study incorporated the B/C approach to quantify the economic returns, or benefits, to the community as a whole (rather than purely financial returns) compared to the costs to the community. This was viewed in terms of what the POB would lose if the 50-foot channel Project was not undertaken.

The study considered two discount rates, the one used in 1984 by the federal Office of Management and Budget (10 percent) and the used at the time by the Corps of Engineers for navigation projects (8-3/8 percent). It was felt that when both were considered, the two rates represented reasonably rigorous criteria for appraising the investment.

Project Benefits

The analysis quantified the benefits to the POB and the State of Maryland in terms of increased vessel traffic and associated job growth as a result of the deepening, compared to traffic and employment opportunities that would not be in Baltimore without deeper channels.

By the year 2000, based on analysis and projections by the Maritime Administration, it was estimated that vessels over 100,000 DWT will transport approximately 62 percent of total iron ore, 49 percent of coal, and 21 percent of grain shipments. It was then estimated that as a direct result of channel deepening, POB bulk traffic would increase by an average of an additional four million annual tons as compared to *not* increasing channel depth. About 10-12% of the 37.4 million tons of year 2000 projected dry bulk traffic would thus be attributable to the deepened channel.

The key element in estimating the level of benefits was to determine the volume and mix of dry and liquid bulk traffic which would benefit from the use of larger vessels. The three major dry bulk commodities shipped through the POB, coal, grain and iron ore, were forecast to benefit the most from deeper channels.

Assuming no deepening of the POB's main channels, traffic flows to the year 2020 were projected for the five most important commodities using the POB. For each commodity, three possible forecasts were applied: optimistic, intermediate or most likely and pessimistic. While uncertainty is unavoidable in forecasting, the projections used in the study reflected conservative estimates. For

[5] "An Appraisal of Deep-Water Dredging for the Port of Baltimore," Joe Revis, February, 1985.

example, the "intermediate or most likely" projections for coal exports called for a 5% annual increase until the year 2000 and a 1% steady annual increase through the year 2020, as outlined in Figure K-1.

With deeper channels, total loaded tonnage of bulk commodities in vessels over 100,000 DWTs was projected to increase by 25 percent. However, not all bulk commodities would switch to larger vessels as a result of the deepening. Smaller ships would continue to be used for such purposes and therefore, the increased cargo moving on larger vessels would not result in a full 25 percent increase. In terms of increased cargo as a direct result of deeper channels, it was estimated that ships over 100,000 DWTs would account for approximately 20 percent of the increase in bulk traffic.

With an estimate of increased ship and commodity traffic flows through the POB as a result of the deepening, it was possible to establish employment generating factors to convert the incremental increases in tonnages shipped to a number of jobs generated. Through an economic impact study of the POB which included a series of questionnaires and surveys (similar to the approach described in the case study on the Port of Oakland, see Appendix H), an estimate of the economic impact of the POB was established in 1982. The study, undertaken by Booz-Allen and Hamilton, estimated the impact of direct maritime employment at the port, as well as the indirect employment related to the Port. The results of the 1982 Economic Impact Study are outlined in Table K-2.

The incremental traffic of about 4 million tons associated with the 50-foot channel deepening project was estimated to result in the creation of 1,560 jobs on average over the economic life of the project, or nearly 4 jobs per 10,000 tons handled. These would be jobs that would be lost if the traffic increment would not come through Baltimore.

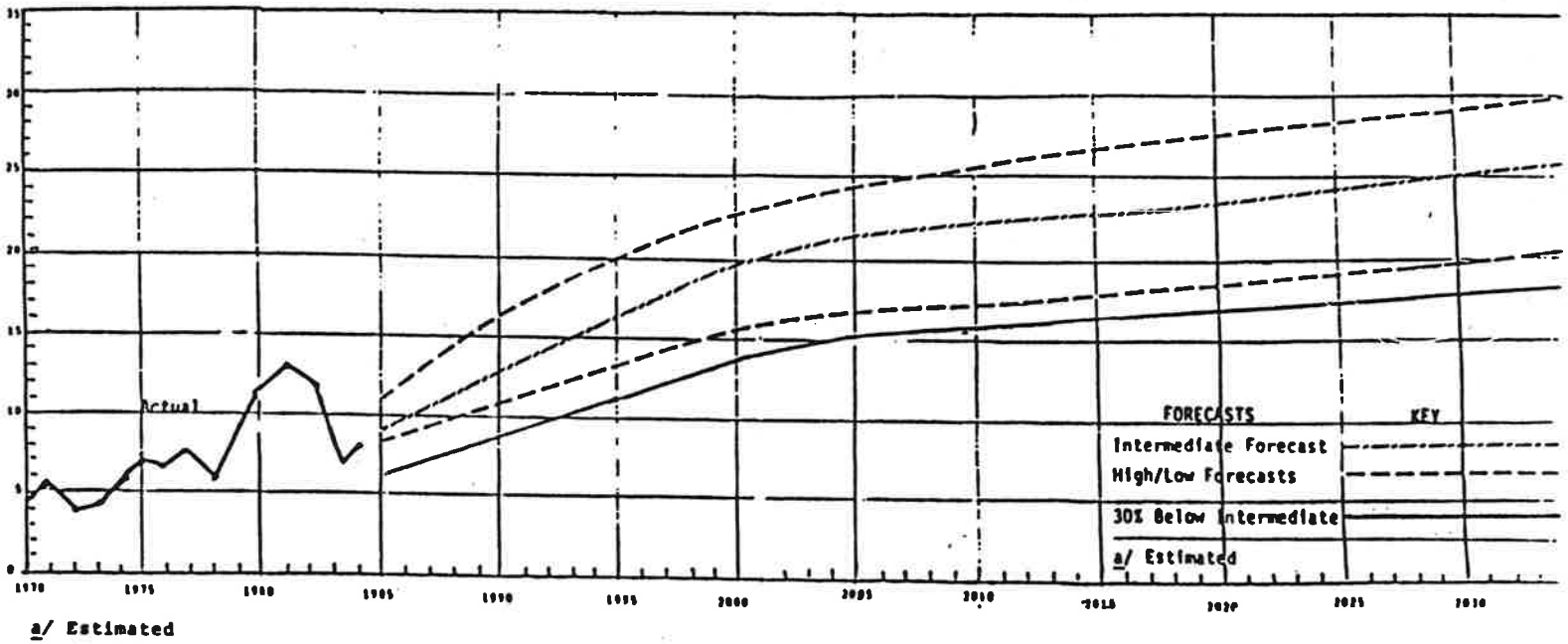
Finally, an estimate of the dollar value per job created as a result of fifty-foot channel was developed based on the results of two Booz-Allen studies and U.S. Department of Labor statistics on average weekly earnings for the relevant sectors. Based on annual earnings of $26,000 per job created, applied to the estimated 1,560 jobs created, the study estimated benefits to the POB and the State of Maryland of approximately $40.56 million by the year 2000.

Project Costs

Maryland's capital and incremental maintenance costs of the fifty foot channel project were considered. In 1984, the estimated capital costs of the channel deepening project were approximately $388 million, with annual maintenance costs approaching $4 million (see Table K-3). This estimate was based on a construction period of 3 ½ to 4 years, and assumed the timely availability of funding. The actual project costs ($227 million), as previously noted, were significantly below estimates, due to favorable bidding conditions at the time the project was initiated.

FIGURE K-1

COAL EXPORT 1970-1984 & PROJECTED FOR 1985-2035
(MILLION SHORT TONS)



Source: Port of Baltimore Channel Deepening. Feasibility, Status and Financial Issues
Maryland Department of Transportation, 1985.

Table K-2: Port of Baltimore
1980 Generated Maritime and Maritime Related Employment

Employment Category	Jobs Created
Maritime Employment	15,906
Shipyard, Coast, Insurance	7,897
Indirect	13,000
Total Maritime and Shipyard	23,783
Total Including Indirect	36,783

Source: Booz-Allen & Hamilton. "The Economic Impact of the Port of Baltimore." March 1982

Table K-3: Port of Baltimore Fifty Foot Channel Project Estimated Costs
(October 1984 Prices) ($000's)

Cost	Amount
Capital Costs: Federal	
Dredging/Engineering/Administration/etc.	293,000
Aids to Navigation	190
Sub Total	$293,190
Capital Costs: Non-Federal	
Private Channel Dredging	12,920
Hart-Miller Construction	52,577/a
Cable Relocation	2,480
Hart-Miller Maintenance During Construction	27,610
Sub Total	$95,587
Total Capital Costs	$388,777
Annual Maintenance Costs	
Hart-Miller After Construction	1,500
Incremental Channel Maintenance	2,260
Total Annual Maintenance Costs	$3,760

a/ Actual Construction costs of $50.54 million between 1982 and 1984 do not include cost of early construction.
Source: Corps of Engineers and Maryland Port Administration and Office of Transportation Planning, Maryland DOT.

Evaluation Results

The results of the state's benefit-cost analysis indicated that the project was a sound investment from the state's perspective (benefit-cost ratio of 2.3 at 8 3/8 % discount rate), if the federal government contributed 75% of the cost. Even under the most adverse assumptions tested at 8 3/8 % discount rate, the investment still had a b/c ratio above 1. Further, if the federal government contributed at least 50%, the project still had a positive return from the state's perspective under relatively optimistic assumptions as to traffic, benefits and costs, but it approached a marginal return under the most pessimistic assumptions (see figure K-2). The state then concluded that to assure that the project would be a sound investment, the state project costs had to be kept under certain limits. An effort was initiated to consider alternatives to lower costs, and an agreed upon first phase (with a narrower channel design) was identified, through the cooperation of the Association of Maryland Pilots. The revised design was one of the factors that lowered the cost of the project by nearly $100 million. This revised design was approved by the COE in early 1986 and formed the basis for the negotiation of the cost-sharing agreement, which resulted in an anticipated State share of $103 million.

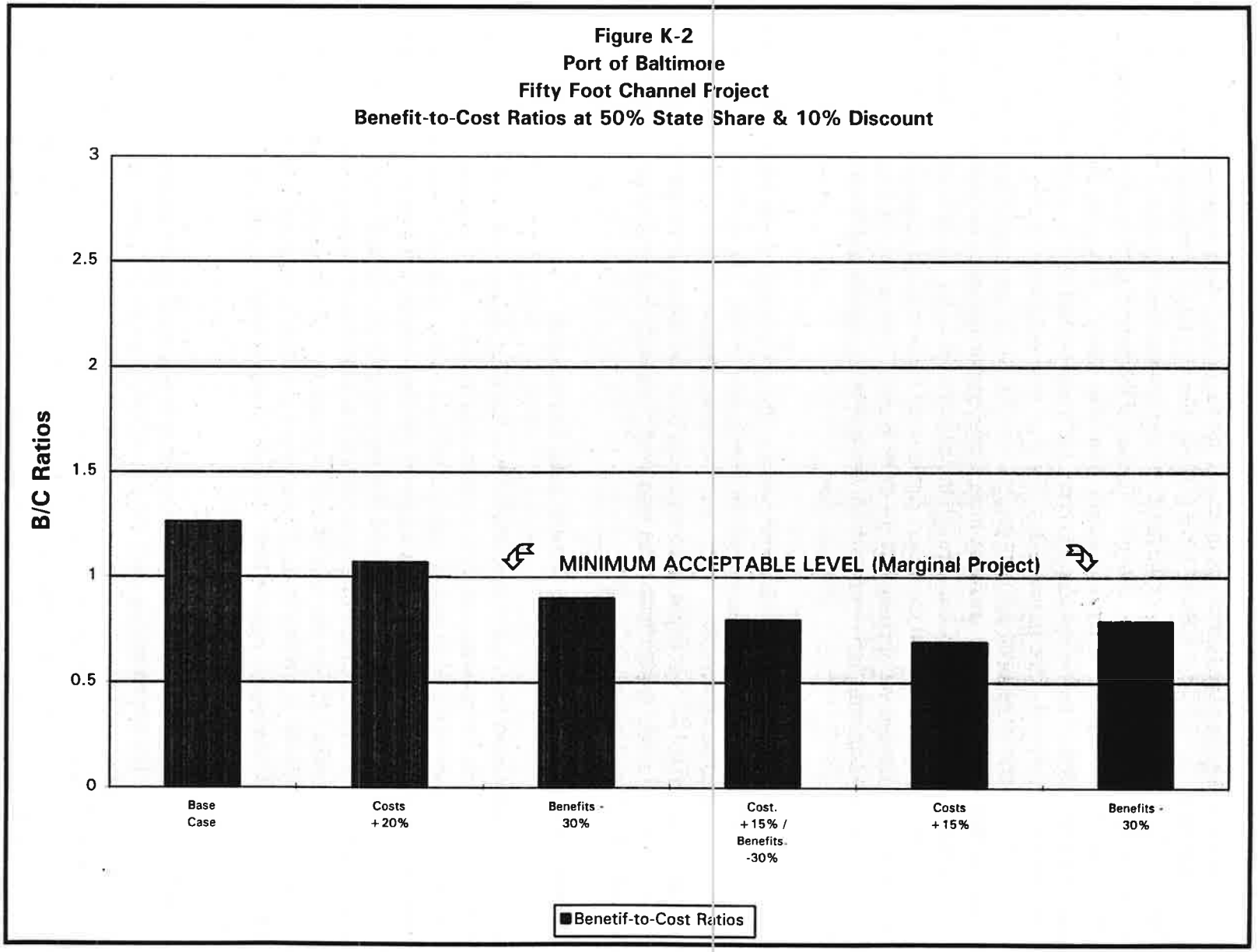
The project to do the additional one-time maintenance of the northern approach route to the POB was also the subject of a COE economic analysis or benefit-cost study. The study was undertaken in 1986 and completed on an expedited basis. It demonstrated that the benefits of achieving and maintaining the authorized 35 foot depth on a year round basis exceeded the estimated cost of $26 million. No additional yearly maintenance other than already regularly budgeted would be necessary once the one-time project was completed.

IV. Project Objectives Achieved and Results After Investment

The two largest coal export facilities, Consolidation and Bayside, deepened their channels within one month of the channel deepening project's completion in anticipation of larger coal shipments. Consolidation Coal also expanded its ground storage facilities so that it can now handle 18 million tons annually at its 100-acre terminal. Since they are able to load 300 tons of coal per inch of draft, larger vessels can now be more fully loaded and dramatic reductions in overall shipping costs can be achieved. The Consolidation Coal terminal handled the largest export shipment in its history in mid-April, 1995, a record 145,511 net tons of coal destined for the Electricity Supply Board at Moneypoint, Ireland. Partly as a result of the 50-feet depth available in Baltimore, as well as high operating costs at its Philadelphia pier, in 1992 Conrail closed its older coal pier in Philadelphia, resulting in increased volumes through Baltimore.

Bethlehem Steel, on the other hand, has not yet increased their channel depth to accommodate larger shipments of iron ore. The one remaining grain elevator in Baltimore, the Indiana Grain Cooperative (now known as Countrymark) elevator in the Locust Point terminal indicated before construction that they supported increasing the channel depth to encourage larger grain shipments. However, Baltimore is not a major grain export port, and is used mainly to fill orders during peak load periods in other ports. As a result, grain export and other dry bulk facilities have not taken advantage of the

Figure K-2
Port of Baltimore
Fifty Foot Channel Project
Benefit-to-Cost Ratios at 50% State Share & 10% Discount



potential benefits as a result of the channel deepening. All in all, a limited number of coal ships have benefitted from the port's greater depths and actual benefits to other commodity shippers have been rather limited to date.

Even though shippers have experienced the benefits of being able to use larger vessels, after a strong first two years following the deepening project completion, coal exports declined in 1993, although they have remained above average levels exported in the mid-1980s. Of the original bulk commodity traffic flow projections for 1985 and 1990, only sugar and iron ore forecasts came close to or exceeded projections. A number of factors have contributed to lower than expected shipments, including global demand and supply of the commodities and internal supply and operations of the companies affected.

Table K-4 provides actual data on annual trade of four major bulk commodities that are handled in the POB. Since project completion in 1990, coal shipments through the POB increased 26 percent in 1991, while 1992 levels were up 10 percent over 1991 figures. In 1993, grain and iron ore movements showed slight increases over 1992 levels. Some of the coal increase is due to deeper channels, but it is still too early to say how much is directly attributable to larger shipments. Most bulk traffic has fluctuated widely since the mid-1980s indicating that it is more dependent on global demand and supply market forces.

While it is still too early to say whether channel deepening will boost dry bulk commodity flows through the POB, many port officials believe that the real benefits of increased traffic have yet to be realized. The project was viewed as having a 50 year life, so that benefits cannot be judged after only a few years in operation. Furthermore, even though the channel deepening project was aimed primarily at increasing dry bulk cargoes moving through the port, the impact of the project on other market segments must also be considered. In a rapidly changing industry, deeper channels are now increasingly becoming important for container vessels, the cargo segment that has the largest economic impact in Baltimore and other ports. Recent production of larger container vessels, capable of handling 5,000 TEU (twenty foot equivalent units) when fully loaded, will favor ports with deeper channels such as Baltimore now has. There are now more than 60 large post-Panamax vessels (vessels too large to use the Panama Canal) in operation or under construction (*The Journal of Commerce*, May 12, 1995, p.1). Many of these new vessels will eventually require 45 feet channels, compared to the present maximum requirement of 40 to 42 feet for container vessels (*The Journal of Commerce*, May 10, 1995, Publishers Notebook).

The deepening of the POB access channels to 50 ft. has thus enhanced the competitiveness of the POB in the container market among North Atlantic ports. While vessels already calling on the POB do not require a depth greater than 42 feet, it is now easier and safer for all traffic to use the port. The port is now ready to handle the new large container vessels as they are deployed, although the connecting channels to the port's container terminals would need to be upgraded.

Table K-4: Port of Baltimore Major Bulk Commodities (million short tons)

Year	Coal	Grain	Iron Ore	Sugar
1984	7.3	2.0	5.8	0.41
1985	7.7	4.6	4.6	0.49
1986	6.9	1.9	6.6	0.49
1987	6.9	1.7	6.9	0.40
1988	8.2	2.5	8.7	0.36
1989	10.3	2.5	7.3	0.61
1990	8.0	2.4	4.5	0.65
1991	10.1	2.2	3.5	0.39
1992	11.1	1.7	4.1	0.61
1993	9.4	2.5	4.2	0.58

Source: Port of Baltimore Channel Deepening. Feasibility, Status and Financial Issues. Maryland Department of Transportation.

Overall, since completion of the deepening project the Port of Baltimore is showing signs of growth. As of the fourth quarter of 1994, the POB had recorded eight consecutive quarters of cargo growth, was gaining market share, and had expanded steamship line services. While it may not be possible to say exactly how many jobs have been generated as a result of the deepening, the amount of overall cargo tonnage moving through the POB has been on the rise since project completion, which equates to more jobs.

V. Lessons From Case Study

An investment to deepen port channels can have a significant impact on regional economic development and competitiveness. Dredging for maintenance purposes preserves present traffic levels, while deepening of waterways allows larger vessels to make use of a port. In turn, this increases business and generates employment opportunities. Such impacts cannot be fully demonstrated or quantified because of the many factors that affect port demand and competition. Although it may be difficult to fully demonstrate or quantify the economic benefits derived from a dredging investment or the lost cargo due to dredging delays, several conclusions can be made:

- Port operations must be viewed in the same context as any other business. In an increasingly competitive industry, ports must pursue opportunities to handle larger vessels with lower unit costs, improve service levels to equal or exceed those of competitors, and minimize costs. The delays in maintaining and deepening the Port of Baltimore access channels affected the port's competitive position and its ability to attract cargo and generate employment.

- As port and vessel technology improves, shippers will expect higher quality of service and lower rates. Deeper and adequately maintained channels are necessary to fully utilize the efficiencies of larger vessels and their loading/unloading systems.

- Without frequent maintenance dredging that assures channels are available year-round at their authorized depth, the efficient movement of goods by vessels is impacted limiting the ability of steamship lines and shippers to fully load vessels and increasing costs.

- Given that current and future trends emphasize the use of larger vessels with greater drafts to transport bulk commodities and containers, and particularly with the advent of 5,000 TEU vessels, ports will need deeper channels to remain competitive and serve the growing requirements of increased foreign trade. The consequences of not deepening harbor channels and waterways to accommodate greater ship sizes will be an inability to fully realize reduced costs and improved productivity, which affects our nation's competitiveness in the global marketplace.

- A balance must be sought between the economic and environmental impacts of dredging port channels. The port of Baltimore deepening project was delayed for many years, and was therefore not completed when it would have produced significant positive impacts during the coal export boom of the early 1980's.

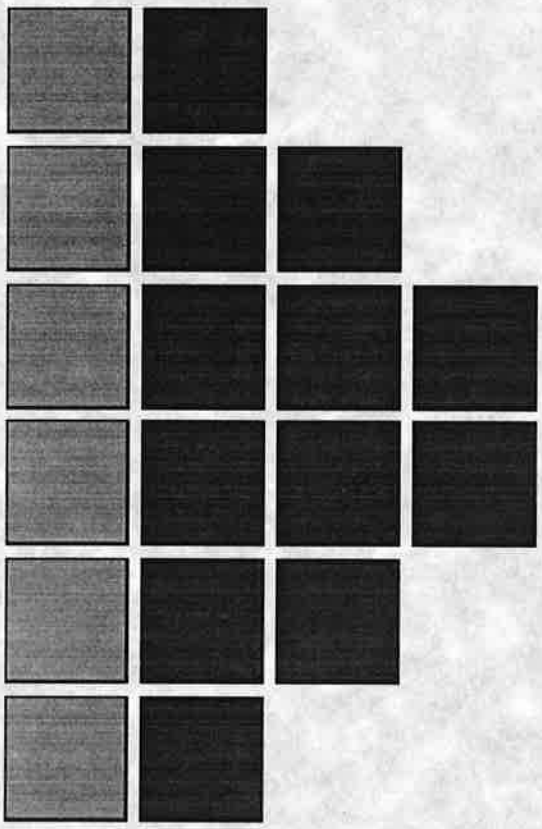
Other ports throughout the nation have also experienced long delays in their channel deepening or maintenance dredging projects, primarily due to environmental concerns related to the disposal of dredged materials. Significant negative economic impacts are associated with such delays. Ports experiencing long delays in their efforts to deepen or maintain access channels include Port Newark/Port Elizabeth, Oakland, Boston, etc. Presently, there is no time-limits for reaching decisions on acceptable disposal methods, nor is there a decision-making framework to balance the economic costs associated with dredging delays versus minimum environmental safeguards for disposal and associated costs. The result is continuing delays and/or uneconomic proposals for disposal.

The Port Authority of New York and New Jersey applied for permits to dredge their berths at Port Newark/Port Elizabeth to 40 feet in 1990 and due to the lack of specific policy guidance on the disposal of dredged material that contains small concentrations of dioxin, the project was delayed. One of the largest steamship lines in the world, Maersk, has publicly stated recently that it might move its headquarters from New Jersey due to the lack of a clear state dredging policy (*The Journal of Commerce*, Publishers Notebook, May 10, 1995). Maersk was being forced to divert approximately 124 containers from each of its vessels entering the port, or about 14,000 containers annually, due to the lack of dredging.

Similarly, the port of Oakland pursued for many years a project aimed at handling the largest post-Panamax container vessels. Construction only began in early 1995. These long delays can be avoided, if a national dredging policy is developed that clearly articulates time limits for project

approval, establishes appropriate standards to safeguard the environment, but also requires identification of economically sound alternatives for dredged material disposal.

In conclusion, the economic importance of dredging port access channels regularly is clear, although not well understood by the public. The importance of these investments to the nation's competitiveness in an increasingly global economy has not generally been well articulated in the public policy and decision-making process, and as a result, there have been delays in project implementation, which affect the nation's export competitiveness.



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