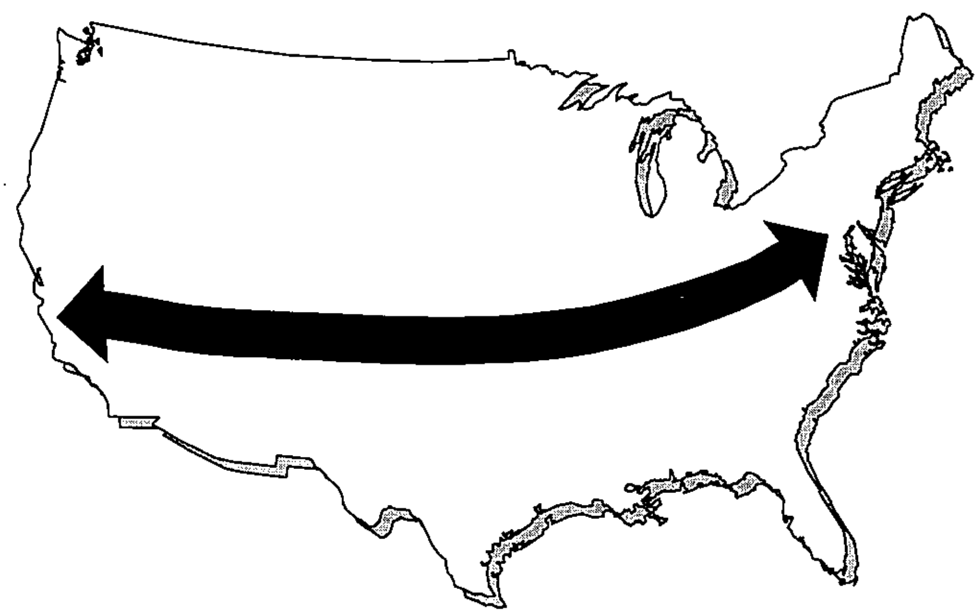
Transamerica Transportation Corridor

Transportation Options for the 21st Century

Feasibility Study



Final Report

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September 8, 1994

Transamerica Transportation Corridor Feasibility Study Steering Committee

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Mr. Michael Jacobs - Volpe National Transportation Systems Center

Dear Steering Committee Members:

We are pleased to submit our final report which presents the results of the feasibility study of the Transamerica Transportation Corridor. The report describes analyses regarding engineering aspects; people and freight demands; economic efficiency; economic development; financial viability; environmental, energy and safety implications; and institutional requirements. The feasibility of various alternative transportation concepts is reported along with our findings and conclusions. The report notes that the Super Highway concept shows the most promise as a new coast-to-coast facility.

While the study focused upon the feasibility of a coast-to-coast facility, the report recognizes that further analyses may find that some individual segments are more feasible than others. These segments may be desirable from a state or regional perspective.

We sincerely appreciate the opportunity to work with and for the Steering Committee.

Yours sincerely,

WILBUR SMITH ASSOCIATES

James L. Covil, P.E.
Senior Vice President
Transportation Policy & Planning

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Acronyms

AAR	Association of American Railroads
ATIS	Advanced Traveler Information Systems
AVCS	Advanced Vehicle Control Systems
AVI	Automatic Vehicle Identification
AVL	Automatic Vehicle Location
B/C	Benefit/Cost Ratio
BEA	Bureau of Economic Analysis
CVO	Commercial Vehicle Operations
EMS	Electromagnetic Suspension
ETTM	Electronic Toll and Traffic Management
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
HCP	Hydraulic Capsule Pipeline
HSGT	High Speed Ground Transportation
HSR	High Speed Rail
ICE	Intercity Express (high speed train)
IRR	Internal Rate-of-Return
ISTEA	1991 Intermodal Surface Transportation Efficiency Act
IVHS	Intelligent Vehicle-Highway Systems
KM	Kilometers
KM/H	Kilometers per Hour
LCV	Longer Combination Vehicles
MAGLEV	Magnetic Levitation
MPH	Miles per Hour
MPO	Metropolitan Planning Organization
MSA	MetropolitanStatistical Area
NHS	National Highway System
NPV	Net Present Value
NTS	National Transportation System
O&M	Operations and Maintenance
REMI	Regional Economic Models, Inc. (econometric model)
ROW	Right-of-Way
STRACNET	Strategic Rail Corridor Network
TGV	Train à Grande Vitesse (or Train of Great Speed)
TTC	Transamerica Transportation Corridor
US DOT	United States Department of Transportation
VKmT	Vehicle Kilometers of Travel
VMT	Vehicle Miles of Travel
WIM	Weigh-in-Motion

Transamerica Transportation Corridor
Transportation Options for the 21st Century
EXECUTIVE SUMMARY

The fiscal year 1991 U.S. Department of Transportation Appropriations Act provided funding for an "Interstate 66 Feasibility Study." The study is also referred to as the Transamerica Transportation Corridor Feasibility Study. This report summarizes the results of the study.

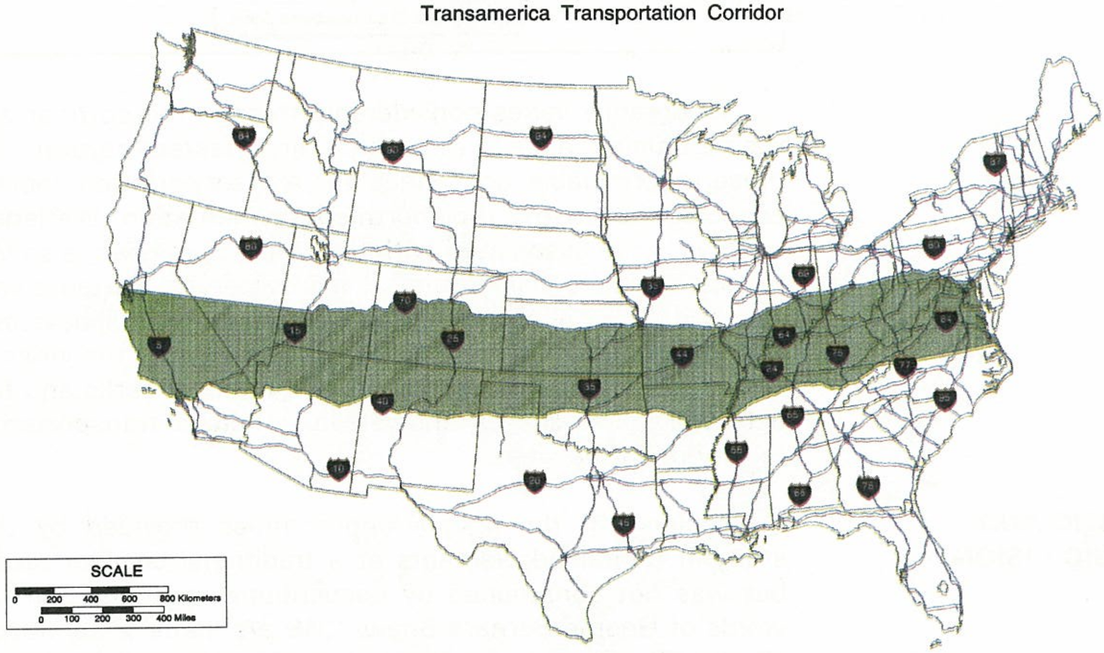
THE CORRIDOR

For the purposes of this study, the Transamerica Transportation Corridor was defined as a transcontinental route extending from the East Coast to the West Coast. The study corridor is generally located between I-70 and I-40, as shown in Exhibit 1. It has an eastern terminus in the Commonwealth of Virginia and a western terminus in southern California. The corridor includes, but is not limited to, an area in Kentucky which is centered on the cities of Bowling Green, Columbia, Somerset, London, Hazard, Jenkins, and Pikesville as called for in the 1991 Appropriations Act.

Exhibit 1

U.S. INTERSTATES & CORRIDOR LIMITS

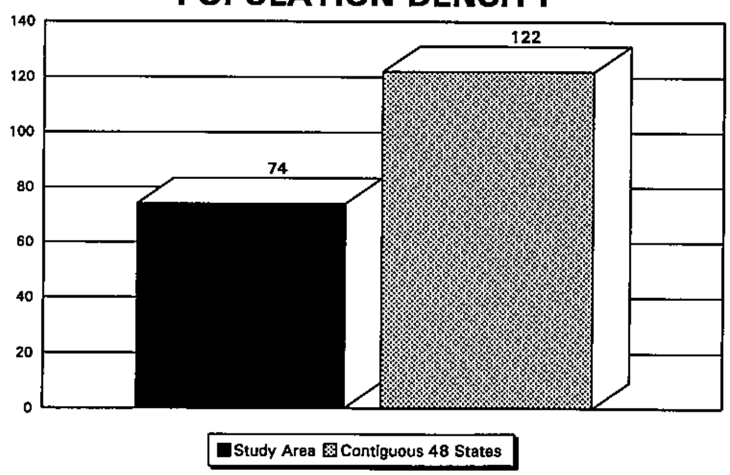
Transamerica Transportation Corridor



The dimensions of the corridor are roughly 4,800 km (3,000 miles) long and between 400 and 560 km (250 and 350 miles) wide. Within this corridor area, there is a great diversity of conditions. While there are some major communities in the corridor, it has an average of 40 percent fewer persons per square mile than the U.S. as a whole and is situated generally between most of the major U.S. urban areas (see Exhibit 2).

Exhibit 2

POPULATION DENSITY



Topography varies considerably through the corridor and the mountain ranges in the eastern and western portions will present formidable challenges for a transportation facility, especially because of their north-south orientation. Wetlands, such as those associated with the Mississippi River, also will require special consideration. Land ownership patterns vary also and the large parcels in the western states will have certain advantages. On the other hand, lands under the jurisdiction of Indian Tribal Governments and national parks and forests will constrain the choices for where a transportation facility might be sited.

FUTURISTIC AND STRATEGIC VISION

Because of the unique opportunities provided by this study, it contained elements of a traditional corridor study, but was not constrained by conventional methods. In the words of George Bernard Shaw, *"We are made wise, not by the recollections of our past, but by the responsibility for our future."* Within this perspective, the study explored the future and a full range of alternative futures. It explored new and emerging technologies, analyzed "strategic" transportation concepts that might complement our highway, rail, waterway and aviation systems, and considered whether such concepts might be warranted in the defined corridor.

Within this context, the study was "strategic" in nature, with visionary and research elements. It was not concerned with specific alignments.

In summary, this study determined whether or not another east-west, coast-to-coast Interstate-type highway is needed and appears feasible; it also analyzed more advanced transportation systems and concepts.

POTENTIAL FUNCTIONS OF THE CORRIDOR

The prospective functions of a new transportation facility in the Transamerica Transportation Corridor should be consistent with national policy. As defined by the Intermodal Surface Transportation Efficiency Act (ISTEA), this policy is currently:

> *"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 people and goods in an energy efficient manner."*

Further, ISTEA declares that the National Highway System shall promote economic development; support international commerce; provide improved access to ports and airports; contribute to increased productivity; be adaptable to "intelligent vehicles," magnetic levitation systems and other new technologies wherever feasible and economical; and help implement national goals relating to mobility. If implemented, the Transamerica Transportation Corridor would logically be a key element of this national transportation system of the future. Indeed, the Transamerica Transportation Corridor was identified in ISTEA as one of 21 high priority corridors to be included in the National Highway System. The submission of proposed NHS routes to Congress in December 1993 did not identify a specific location for the corridor pending completion of this feasibility study.

21st CENTURY OPPORTUNITIES

This study of the Transamerica Transportation Corridor had a time horizon of 30 to 50 years in the future, i.e., the period of 2020 to 2040. Given this perspective, the Steering Committee decided that the study should consider not only a conventional interstate highway concept but also other concepts involving emerging transportation technologies.

In order to facilitate the definition and assessment of the full range of possibilities, potential transportation concepts were sorted into three basic categories:

1. Mode and technology options;
2. Joint use options; and
3. Corridor options.

As shown in Exhibit 3, the mode/technology options were further grouped in three categories.

NETWORK INTEGRATION OPPORTUNITIES

The ability of passenger and freight traffic to access the Transamerica Transportation Corridor is dependent on the feeder system provided. A system of feeders will provide local, regional and even international access to the corridor. The corridor's low density dictates that trips must be attracted from large metropolitan areas that border the corridor. They include, for example, metropolitan areas such as Cincinnati, Memphis, St. Louis, Kansas City, Denver and Albuquerque along the northern and southern edges of the study area.

A "transportation spine" concept was adopted as a fundamental aspect in this study. Under this concept, the Transamerica Transportation Corridor would be located between the major activity centers, providing connections through a feeder system extending north and south. Exhibit 4 illustrates this concept. These regional connections can include existing facilities as well as proposed facilities.

A transportation spine concept in reality will be connected to a larger network. As the state highway network is integrated with the interstate system, a nationwide high speed rail network, for example, could be integrated with the Transamerica Transportation Corridor facility. Exhibit 5 illustrates high speed rail systems proposed by the American

Exhibit 3
TRANSPORTATION CONCEPTS

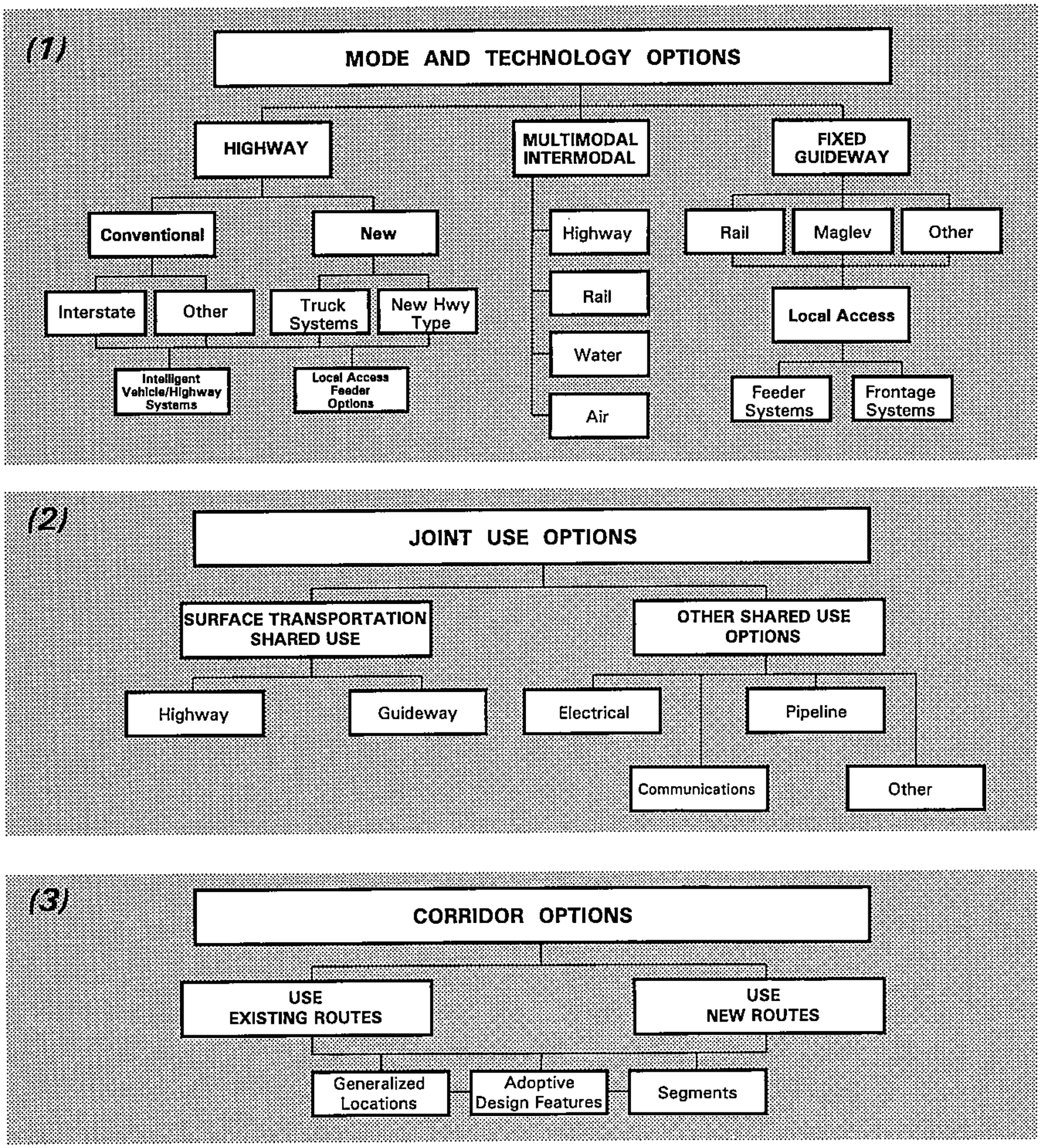
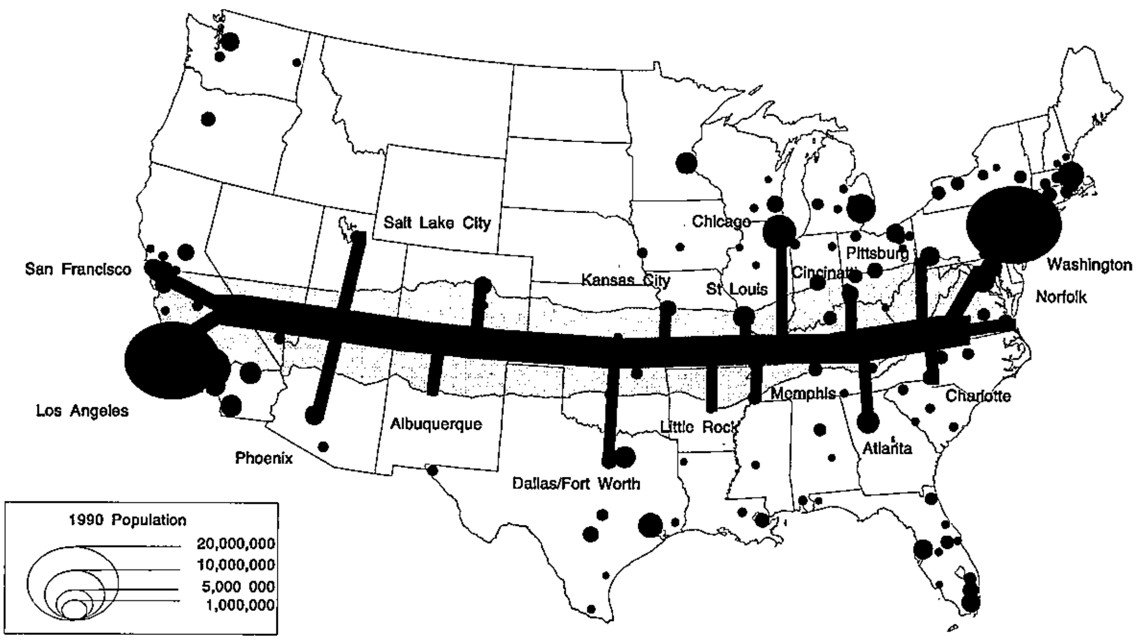


Exhibit 4
TRANSPORTATION SPINE CONCEPT



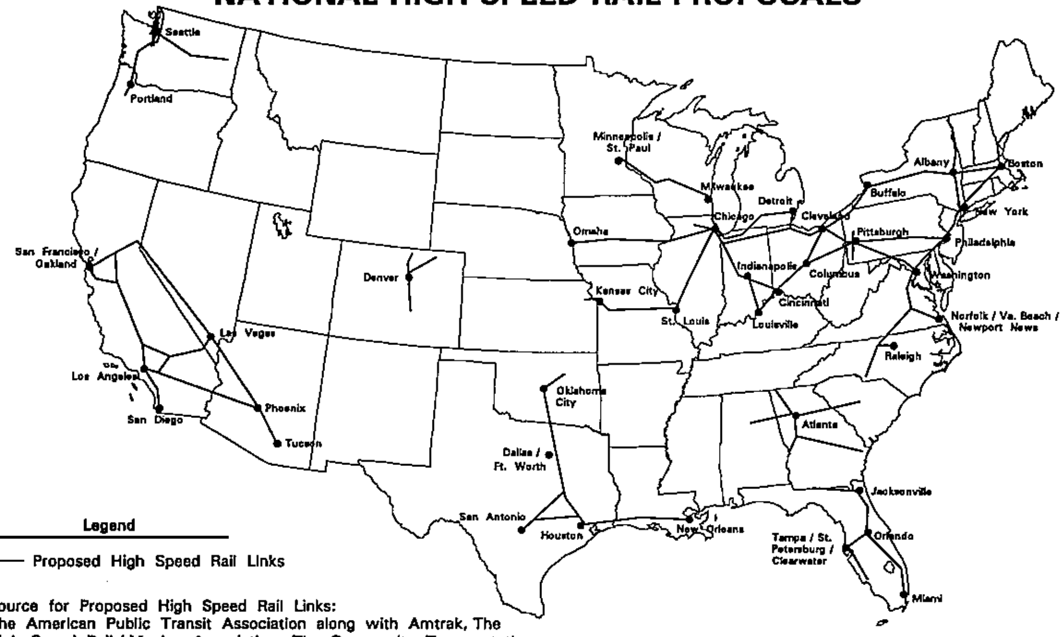
Public Transit Association along with Amtrak, the High Speed Rail/Maglev Association, the Community Transportation Association of America, and others. The Transamerica Transportation Corridor could be connected to this proposed system in two ways. The Transamerica Transportation Corridor could be developed as a highway option with intermodal connections to a high speed rail network. Alternatively, it could be developed as a high speed rail facility and work as an east/west spine to the various rail segments illustrated.

SCREENING OF TRANSPORTATION ALTERNATIVES

The most efficient approach to handle the wide range of transportation concepts addressed by the study was to apply a "sequential screening and evaluation process," where all options were initially considered, and the least viable were rejected. Initially, the various concepts were organized into some 19 specific transportation alternatives. As the study analyses proceeded, the number of alternatives were gradually reduced and the alternatives were refined. This structured process resulted in the identification of four principal alternatives which were subjected to detailed study.

Exhibit 5

NATIONAL HIGH SPEED RAIL PROPOSALS



Legend

—— Proposed High Speed Rail Links

Source for Proposed High Speed Rail Links:
The American Public Transit Association along with Amtrak, The High Speed Rail / Maglev Association, The Community Transportation Association of America and others, 1993.

Alternative A: Conventional Interstate-type Highway

The main features of this alternative are:

- Built to Interstate standards
- Somewhat higher speeds than other interstate highways because urban areas are not penetrated
- Includes basic level of Intelligent Vehicle/Highway Systems (IVHS) technologies
- Longer combination trucks (LCVs) accommodated

Alternative B: Upgraded Rail

This alternative features:

- Tilt train technology
- Speeds ranging from 200 to 220 km/h (125 to 135 mph)

Alternative C: Super-Highway and Truckway

Features of this alternative include:

- Vehicle speeds up to 240 km/h (150 mph)

- Substantial deployment of IVHS technologies, including Advanced Vehicle Control Systems (AVCS)
- Separated truck roadway
- Two versions of this alternative were studied, viz.:
  - C1: The TTC would be the only coast-to-coast Super Highway
  - C3: The TTC would be one of three coast-to-coast Super Highways. The other Super Highways were assumed to be north of I-70 and south of I-40.

<u>Alternative D: Very High Speed Fixed Guideway</u>

This alternative is distinguished by the following features:

- Considers both high speed rail (D1) and maglev (D2)
- Design speeds from 200 km/h (125 mph) in mountainous terrain to over 480 km/h (300 mph) in flat terrain
- Electrically-powered trains on primarily new alignments

CORRIDOR APPLICATIONS

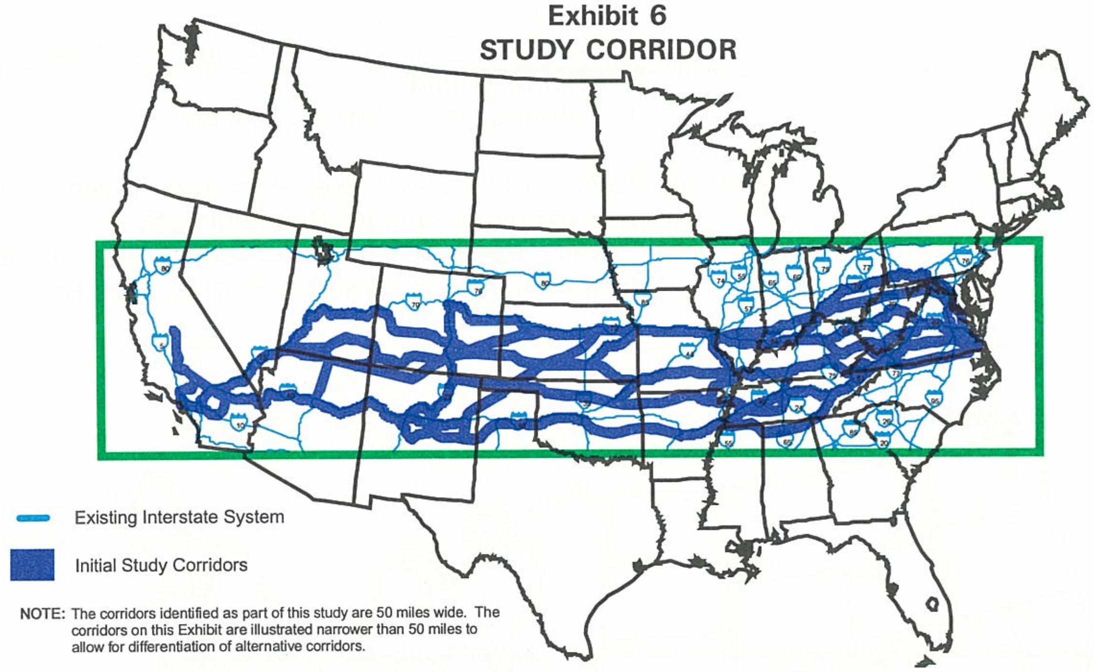
Representative locations were identified in which the various transportation alternatives could be applied within the Transamerica Transportation Corridor. This included a review of the various opportunities and constraints associated with conditions and features in the TTC study area. The locations thus identified were designated "Analysis Corridors" because they are intended to represent reasonable applications of the transportation technologies without trying to determine, at this stage, the "best" locations. While subsequent detailed location studies may reveal more suitable alignments, the Analysis Corridors are sufficient for purposes of this study's assessment of expected costs, benefits and impacts of implementing candidate technologies within the designated TTC study area.

Corridor segments were the building blocks for defining Analysis Corridors. These segments are depicted in Exhibit 6. Based on these segments, locations were identified which suited the particular technologies associated with the four principal Transportation Alternatives.

Three Analysis Corridors were chosen as follows:

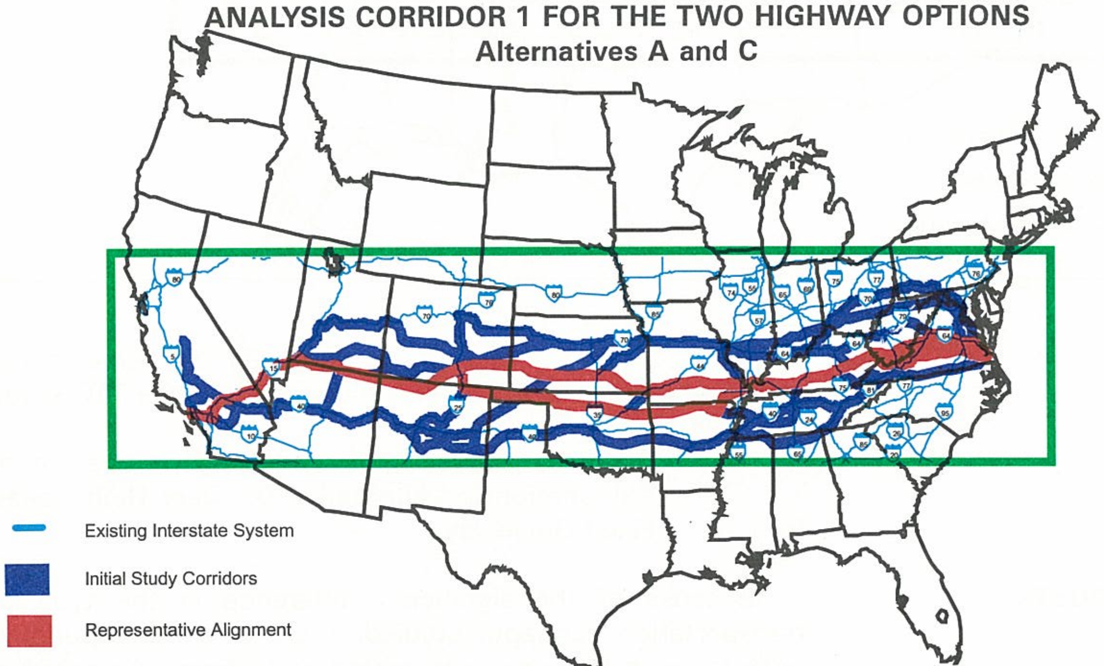
- Analysis Corridor 1 is located generally in the center of the TTC study area. See Exhibit 7.

Exhibit 6
STUDY CORRIDOR



NOTE: The corridors identified as part of this study are 50 miles wide. The corridors on this Exhibit are illustrated narrower than 50 miles to allow for differentiation of alternative corridors.

Exhibit 7
ANALYSIS CORRIDOR 1 FOR THE TWO HIGHWAY OPTIONS
Alternatives A and C

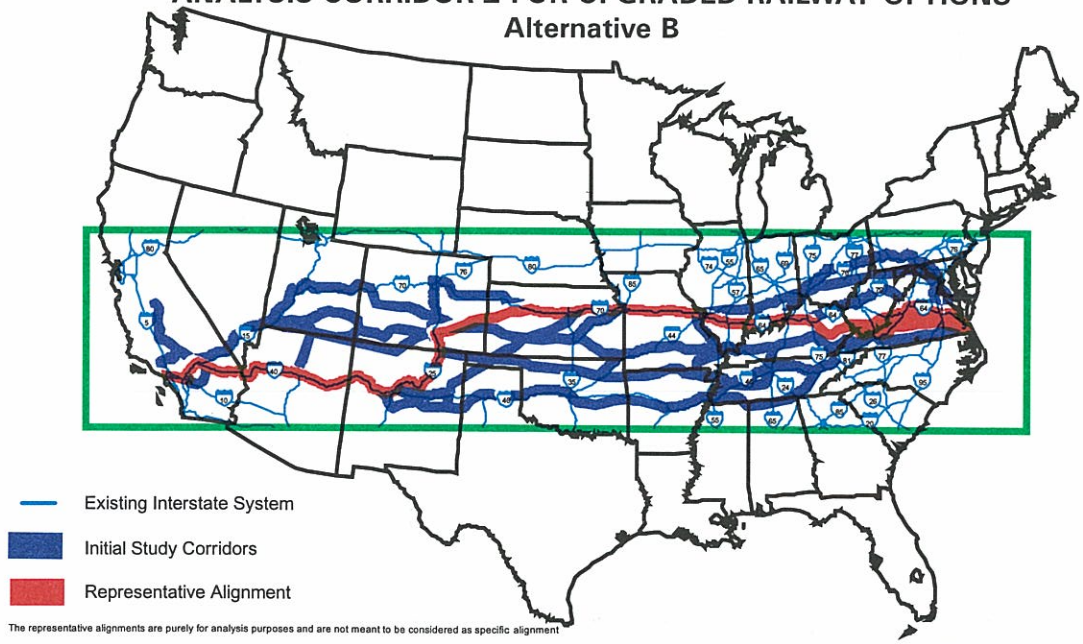


The representative alignments are purely for analysis purposes and are not meant to be considered as specific alignments.

  - It was considered to be representative of a potential location for:
    - Alternative A: Conventional Interstate-Type Highway, and
    - Alternative C: Super Highway.

- Analysis Corridor 2 was selected to take advantage of existing rail rights-of-way. See Exhibit 8.
  - It was considered to be representative of a potential location for Alternative B: Upgraded Rail.

Exhibit 8
ANALYSIS CORRIDOR 2 FOR UPGRADED RAILWAY OPTIONS
Alternative B

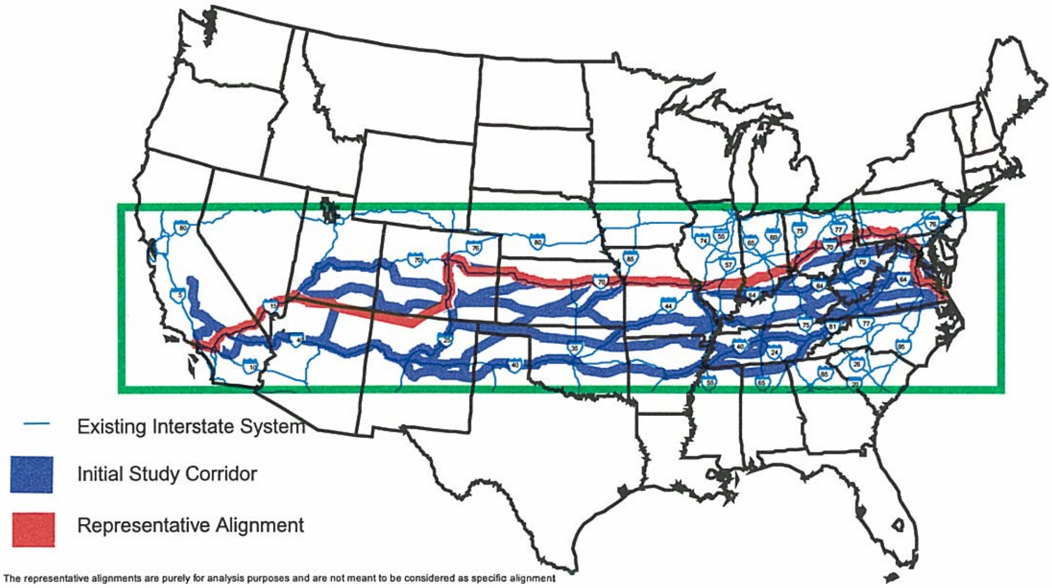


- Analysis Corridor 3 was located to serve major population centers on the boundary of the TTC study area. See Exhibit 9.
  - It was considered to be representative of a potential location for Alternative D: Very High Speed Fixed Guideway.

CAPITAL COSTS

Because of the significant difference in the type of transportation concepts studied, there is a corresponding wide range in the costs associated with them. As noted in Exhibit 10, Alternative A: Conventional Interstate-Type

Exhibit 9
ANALYSIS CORRIDOR 3 FOR VERY HIGH SPEED FIXED GUIDEWAY
Alternative D



Highway, has the lowest capital cost for the full coast-to-coast facility. The Alternative C: Super Highway concept involves a high initial capital cost because it embodies an 8-lane cross-section to accommodate both instrumented cars and trucks, as well as vehicles which are not equipped to use the AVCS technology.

Capital costs for Alternative D: Very High Speed Fixed Guideway, also are quite high. The capital cost for a steel wheel technology is roughly comparable to the Alternative C: Super Highway cost. If a maglev technology is employed, capital costs would be about 50 percent higher than for a steel wheel technology.

TRAVEL DEMANDS

Forecasts were developed to estimate the number of people and amount of freight which would use the four principal transportation alternatives as follows.

Highway Alternatives

The demand for travel of the Super Highway would be much greater than a conventional Interstate highway due to both travel time savings and the increased convenience afforded by instrumented vehicles with automated vehicle control. The Advanced Vehicle Control System (AVCS)

Exhibit 10
CAPITAL COSTS FOR TTC ALTERNATIVES

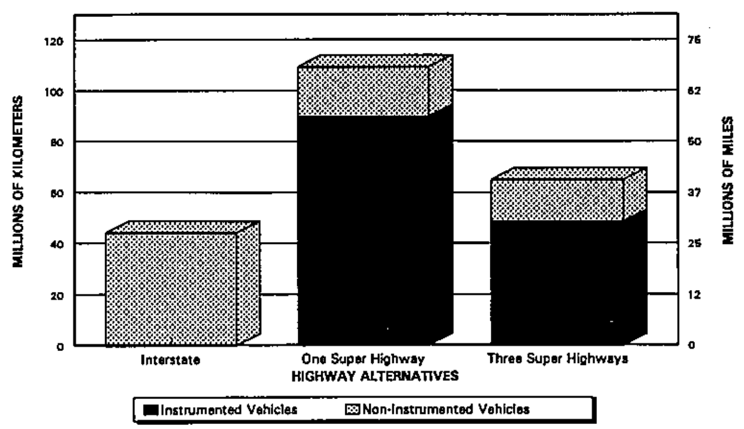
TRANSPORTATION ALTERNATIVE	CAPITAL[1] COST ($ billions)
A: Interstate-Type Highway	$18
B: Upgraded Railroad	33
C: Super Highway	53
D1: High Speed Rail	51
D2: Maglev	78

(1) 1993 dollars.

technology would permit people to sleep, read or work during their journey.,

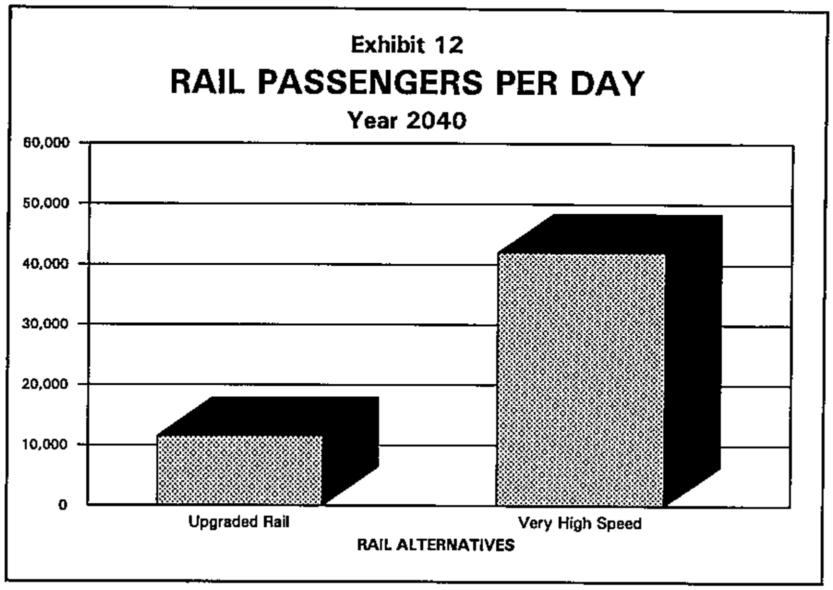
Two Super Highway alternative options were evaluated: one that would be the first and only East/West facility of its kind and another that is one of three similar coast-to-coast facilities. The Study's forecasts show that the competition of two other Super Highways would have a significant impact on demands. See Exhibit 11.

Exhibit 11
PASSENGER VEHICLE USAGE PER DAY
Year 2040



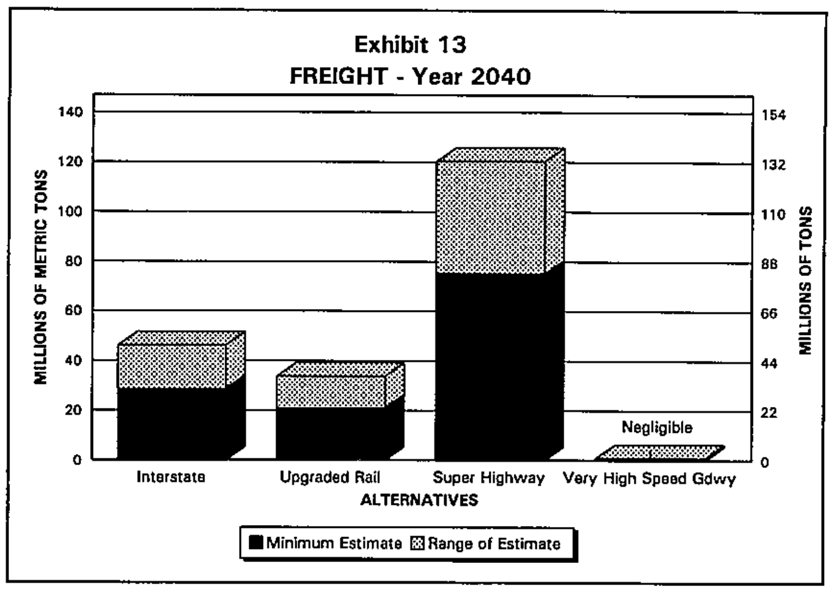
Rail Alternatives

The demand for travel for the Very High Speed Rail alternative would be much higher than conventional rail due to its faster travel speeds. See Exhibit 12.



Freight

As shown in Exhibit 13, the Super Highway would serve the greatest amount of freight transport of all the four alternatives considered.



ECONOMIC FEASIBILITY

A major public investment such as one of the new TTC alternatives could be "economically feasible" if the economy is better off with the TTC than without it. Economic benefit is defined as "an increase in the prosperity and incomes of people and institutions." Such increases occur in either of two ways:

Travel Efficiency — Transportation cost savings that result from improvements to a corridor are true benefits to the Nation. When travellers experience time savings, greater safety, or reduced vehicle operating costs, their gain is not offset by losses to other people. Cost reductions make resources available for other purposes. If the effective increase in income brought about by the project exceeds its cost, the project is said to be "efficient." It makes the Nation economically better off.

Attraction of Resources/Corridor Economic Development — Reduced transportation costs in the corridor, relative to costs at other locations, can encourage economic activity to shift to the corridor. If output increases in the area, the increased output will require more resources (land, labor, materials, capital) which can mean that more people are employed and net income within the area increases. If the TTC investment enables the attraction of additional business in the corridor (new firms, or expansion of existing firms), then the transportation investment can aid the economic development process, to the benefit of the corridor area — but at a loss to the rest of the U.S.

Travel efficiency improvements benefit users of the transportation facility and others with no corresponding losses to others. They are, therefore, net gains to the nation. Resources attracted to the improved corridor are, in essence, transferred from other locations in the U.S. because they will be more productive in the improved corridor. These transfers are not net gains to the Nation; increases in income and property values along the corridor occur at the expense of other people elsewhere.

Economic Efficiency Assessment

All of the five major alternative concepts create very large travel benefits. However, when the high costs associated with this project are considered, none of the alternative concepts are found to be feasible. As shown in Exhibit 14, the C1: Super Highway alternative comes the closest to being

Exhibit 14
NATIONAL PERSPECTIVE
TRAVEL EFFICIENCY FEASIBILITY FINDINGS[a]

TTC OPTION	NET PRESENT VALUE[b] ($ billion)	INTERNAL RATE OF RETURN	DISCOUNTED BENEFIT/COST RATIO[a]
A: Interstate-Type Highway	($5.9)	4.8%	.68
B: Upgraded Railroad	($34.9)	-4.5%	.49
C1: One Super Highway	($3.3)	6.7%	.94
C3: Three Super Highways	($23.4)	4.1%	.57
D: High Speed Guideway[c]	($47.1)	-1.2%	.18

NOTES: (a) An economically feasible TTC would have positive NPV, an IRR of 7.0% or greater, and a B.C ratio of 1.0 or greater.
(b) Discounted at 7%.
(c) Based on the steel wheel technology.

SOURCE: Wilbur Smith Associates

economically justified on the basis of travel efficiency benefits.

Sensitivity Analyses

The National perspective feasibility test is based on a number of calculations and estimates, many of which are approximations. Ten sensitivity tests were conducted, to determine the extent to which study findings are dependent on these approximations. The results of these tests are presented in Exhibit 15 and show that under certain assumptions, the two highway alternatives may be economically feasible.

Economic Development Effects

A new transcontinental transportation facility in the TTC should help the communities in the corridor to develop economically by attracting firms and economic activity to them and by helping them compete with other communities in the U.S. By creating a new transportation facility, and by reducing transportation costs in the region, the TTC would become more economically attractive and competitive, thereby attracting new industries and tourists to the corridor (at the expense of other regions of the U.S.) and encouraging existing corridor industries to expand.

The Study estimated the economic development gains that would occur as a result of the TTC transportation facility.

Exhibit 15
TRAVEL EFFICIENCY SENSITIVITY RESULTS
(Benefit/Cost Ratios)

	A: UPGRADED HIGHWAY	B: UPGRADED RAILWAY	C: SUPER HIGHWAY		D: HIGH SPEED GUIDEWAY
			C-3	C-1	
Study's Benefit/Cost	0.68	0.49	0.57	0.94	0.18
1. 25% Less Capital Cost	0.89	0.56	0.75	1.24	0.23
2. 25% More Capital Cost	0.55	0.44	0.46	0.76	0.15
3. Capital Cost for a B/C of 1.0 ($ billion)	$11.9	$0.00	$30.0	$50.1	$4.3
4. 4% Discount Rate	1.16	0.62	1.03	1.68	0.32
5. 10% Discount Rate	0.45	0.40	0.35	0.59	0.11
6. No Additional Consumers Surplus	0.68	0.48	0.32	0.53	0.15
7. Constant Time Value	0.56	0.49	0.50	0.83	0.17
8. 1 year Benefit Lag	0.71	0.52	0.70	1.16	0.26
9. 25% More Benefits	0.85	0.62	0.71	1.17	0.22
10. 25% More Benefits and 25% Less Capital Cost	1.12	0.70	0.94	1.55	0.28

SOURCE: Wilbur Smith Associates.

Three measures of economic development impacts were developed and the results are summarized in Exhibit 16.

The Super Highway is expected to have the greatest economic impact on the TTC region. The Alternative C1 Super Highway is estimated to attract over 220,000 jobs to the region (excluding TTC construction jobs). All of the options would create value added in the corridor amounting to many billions of dollars.

While these impacts are sizable, they represent an increase of only one percent or less of total jobs and value added to the total already in the corridor area. In addition, the value added and jobs impacts primarily represent a redistribution of jobs, and money, from elsewhere in the U.S. Investment in transportation is a very expensive way of creating permanent jobs.

Exhibit 16
ECONOMIC DEVELOPMENT IMPACTS

TRANSPORTATION ALTERNATIVE	VALUE ADDED 1993-2040[a] ($Million)	WAGES 1993-2040[a] ($Million)	NUMBER OF JOBS[b]	
			2001	2040
A: Interstate-Type Highway	50,086	31,369	80,811	70,627
B: Upgraded Railroad	63,145	44,052	130,227	52,630
C1: One Super Highway	171,453	90,624	243,994	220,700
C3: Three Super Highways	133,177	76,459	218,386	131,791
D: Very High Speed Guideway	90,842	63,449	200,813	60,500

(a) Discounted at 7 percent. Constant 1993 price levels.
(b) Includes TTC construction jobs in 2001; excludes construction jobs in 2040.

FINANCIAL VIABILITY

Analyses were undertaken to assess project costs relative to potential project revenues, to identify funding options, and to determine funding requirements for each of the principal transportation alternatives. These analyses determined that toll (if assessed) and fare revenues would offset a significant portion of the TTC costs (between two-thirds and three-fourths of the cost of the C1: Super Highway alternative). However, revenue requirements for the various alternatives still would present enormous costs to be covered by Federal, State, or other sources. Increasing the transportation budgets of the corridor states to fully cover the TTC costs is not realistic given current expenditure trends and existing needs. The study concluded that these funding needs could not be met by the states alone and that a national commitment to the TTC would be needed.

CONCLUSIONS

Based upon the Study's analyses, a number of conclusions emerged, as follows:

- While the study's travel demand analyses show a significant variation in volumes at different locations in the corridor, they do not, on the whole, indicate a pressing need for a coast-to-coast TTC at this point in time.
  - Nevertheless, there may be traffic congestion on parallel facilities in certain segments of the TTC which could be relieved by provision of a new

facility in the corridor. This topic was not examined as part of the current study.

  - Additionally, it is possible that costs to improve parallel existing routes could be reduced if the TTC were implemented.

- The low population densities and challenging physiographic and land ownership patterns in the corridor detract from the feasibility of the TTC.

- There are various ways to enhance the feasibility of the TTC. A very important opportunity would be to develop a TTC facility that enjoys higher speeds and improved safety for all vehicles and also has the ability to serve larger and heavier trucks than is possible with existing interstate highways.

  - Future technologies, particularly those associated with Intelligent Vehicle-Highway Systems (IVHS) have considerable promise, particularly since the TTC could be designed from the beginning to incorporate them. It will be more challenging and costly to retrofit existing facilities to accommodate these emerging technologies.

- The TTC does not meet economic feasibility criteria, generally because of its high costs and low travel demands in some segments.

  - The most feasible technologies (the Super Highway concept) are in the development stage, making costs and benefits difficult to estimate.

  - If future IVHS research reveals ways to reduce the cost assumptions of this study, it is quite possible that a coast-to-coast Super Highway in the TTC would achieve economic viability.

- Even if the TTC is economically feasible, it would be an extremely expensive project. It could not be funded under current funding programs, even if tolls are imposed.

- The Study shows that the corridor would benefit from the economic development that would accompany construction and use of a new coast-to-coast facility.
  - Nevertheless, these benefits would be at the expense of economic development elsewhere. That is, they would be transfers to the TTC because of the advantages the new facility would offer.
- Study findings regarding a coast-to-coast facility do not mean that individual segments of the corridor would not be desirable from a state or regional perspective.
  - Additional analysis of individual segments could find that some of them are feasible.
  - These segments may provide linkage to the National Highway System and/or key elements of a state's transportation system.
  - Ultimately, if segments are built and as technologies advance, review of the overall corridor may be warranted.
- The Study's economic analyses are based upon a number of estimates (e.g., costs, usage) and assumptions (e.g., discount rates, value of time, etc.). A series of sensitivity tests show that there are circumstances under which the TTC would be economically feasible.
  - Within the range of variation examined, there are more favorable circumstances under which the highway alternatives (conventional Interstate-type highway and Super Highway) would achieve economic feasibility.
  - Even under considerably improved circumstances, the rail alternatives would not achieve economic feasibility.

Chapter 1
INTRODUCTION

The fiscal year 1991 U.S. Department of Transportation Appropriations Act provided funding for an "Interstate 66 Feasibility Study." The study is also referred to as the Transamerica Transportation Corridor Feasibility Study. This report documents the results of the study.

BACKGROUND

Preliminary information about the proposed study was initially provided by the Federal Highway Administration (FHWA) to the states within the general study corridor. In February 1991, an organizational meeting was held to determine the extent of interest in the study by the affected states. Representatives from 14 states attended, and 11 states subsequently agreed to contribute matching funds. The states that contributed matching funds were: Arizona, Arkansas, Colorado, Illinois, Kansas, Kentucky, Missouri, New Mexico, Utah, Virginia and West Virginia. A Steering Committee, consisting of a representative from each of the 11 states and FHWA, was organized to provide technical direction to the study. The Missouri Highway and Transportation Department volunteered to serve as the administrative agent for the study.

Subsequently, Oklahoma also became a participant in the study bringing the Steering Committee up to 12 states representatives, plus FHWA.

A contract was executed by the Missouri Highway and Transportation Department with Wilbur Smith Associates on June 15, 1992, to conduct the study under the technical direction of the Steering Committee. Since that time, the Consultant has produced a number of Task Reports and meetings of the Steering Committee have been held to review the reports and to determine subsequent causes of action. The Steering Committee approved this Final Report at its meeting on May 24, 1994.

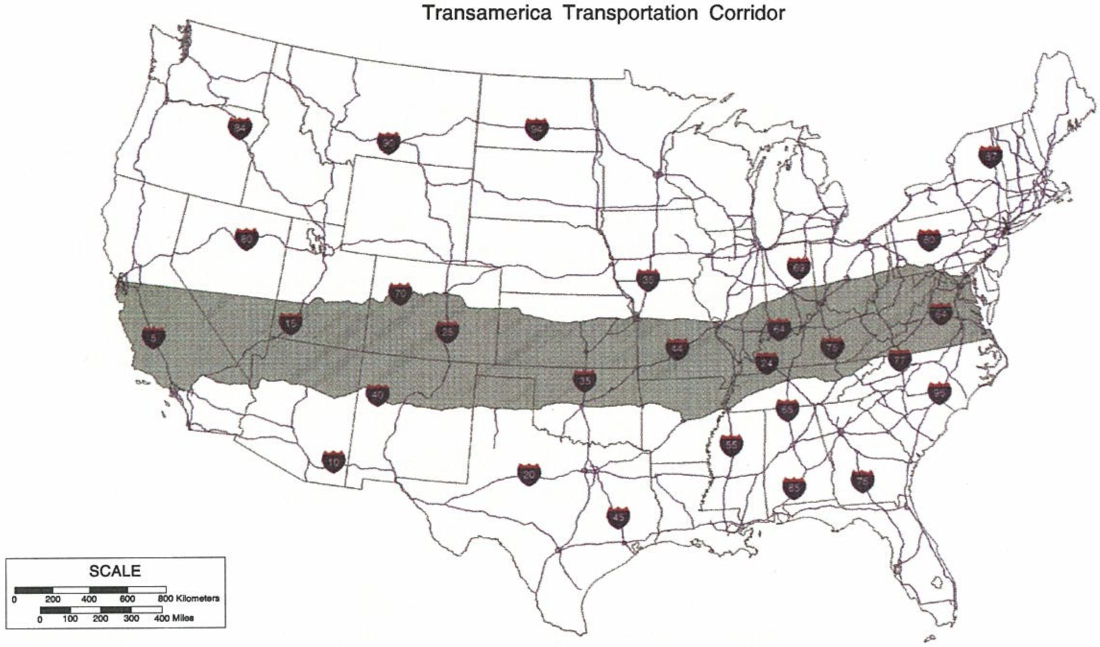
THE CORRIDOR

For purposes of this study, the Transamerica Transportation Corridor (TTC) was defined as a transcontinental route extending from the East to the West Coast. As shown in Exhibit 1-1, the corridor is generally located between two major east/west routes of the Dwight D. Eisenhower System of Interstate and Defense Highways, i.e., I-70 and I-40. It has an eastern terminus generally in the Commonwealth of

Virginia area and a western terminus likely in, or near, California. The corridor includes, but is not limited to, an area in Kentucky which is centered on the cities of Bowling Green, Columbia, Somerset, London, Hazard, Jenkins and Pikesville as called for in the 1991 Appropriations Act.

Exhibit 1-1

U.S. INTERSTATES & CORRIDOR LIMITS
Transamerica Transportation Corridor



The dimensions of the corridor are roughly 4,800 km (3,000 miles) long and between 400 and 560 km (250 and 350 miles) wide. Within this corridor area, there is a great diversity of conditions. While there are some major communities in the corridor, it is not as heavily populated as some other parts of the nation. Topography varies considerably through the corridor and the mountain ranges in the eastern and western portions will present formidable challenges for a transportation facility, especially because of their north-south orientation. Wetlands, such as those associated with the Mississippi River, also will require special consideration. Land ownership patterns vary also and the large parcels in the western states will have certain advantages. On the other hand, lands under the jurisdiction of Indian Tribal Governments and national parks and forests will constrain the choices for where a transportation facility might be sited. These and other characteristics of the corridor were addressed in the corridor feasibility study as reported herein.

STUDY CONTEXT

In addressing the feasibility of a new transcontinental surface transportation facility, the Steering Committee chose to maintain a broad vision of the opportunities and constraints for the TTC. For example, the public agencies (state and national) charged with the responsibility of providing, administering and maintaining the nation's transportation systems and infrastructure have a dilemma: increasingly available funds must be used just to maintain and operate highway and other transportation systems already in place, with limited funds available for new investment. At the same time, the agencies need to have the ability to plan for the 21st century, to be able to respond to and utilize the new and emerging transportation systems and technologies that can increase efficiency and expand the nation's productivity.

This study was an excellent opportunity to address this dilemma, by contemplating the future and helping the nation and the participating states make strategic plans for that future. In short, this study provided an opportunity to accomplish something more noteworthy than just being a conventional highway feasibility study.

FUTURISTIC VISION

Because of the unique opportunities provided by this study, it contained elements of a traditional corridor study, but was not constrained by conventional methods. In the words of George Bernard Shaw, *"We are made wise, not by the recollections of our past, but by the responsibility for our future."* In response to this, the study explored the future, and a full range of alternative futures. It explored new and emerging technologies, analyzed "strategic" transportation concepts that might complement our highway, rail, waterway and aviation systems, and considered whether such concepts might be warranted in the defined corridor.

STUDY PURPOSES

Within this context, the study was "strategic" in nature, with visionary and research elements. It was not concerned with specific alignments and avoided becoming mired in minor details. Rather, it focused on strategic issues such as:

- Does this specific corridor have attributes that make it a good candidate route? What opportunities exist to make it a good candidate corridor?

- How much impact will such concepts have on travel time savings, vehicle operating costs and safety? On energy consumption? On the environment?

- Might this be a new type of highway? a very high speed highway? a heavy duty road? an automated or semi-automated highway? or a new rail system? or a joint utility/transportation corridor? Could it be a combination of facilities and services?

- Are there new or emerging modal, multimodal, technological or joint use opportunities and concepts that might make sense?

- What can such transportation concepts do for the nation's economy? What might they mean for the corridor?

- What legal, institutional, legislative, funding and public policy changes will be needed for a 21st Century transportation project?

These strategic issues are addressed in subsequent chapters of this report. Chapter 15 presents the study's overall conclusions. As noted there, the study has helped determine which of the transportation concepts make sense, which are applicable to the designated corridor region, and which options are most practical and reasonable.

In summary, this study determined whether or not another east-west, coast-to-coast Interstate-type highway is needed and appears feasible; it also analyzed more advanced transportation systems and concepts.

STUDY APPROACH

Given the immense scale of this corridor and its futuristic vision (30 to 50 years in the future), this study was exploratory in nature — it investigated the need for, and feasibility of, new as well as traditional approaches to transportation on an interstate and even transcontinental basis. In this sense, the Study provided a challenging opportunity to explore new techniques, technologies and concepts, and intergovernmental arrangements.

Within this comprehensive context, the study also was a feasibility study. Indicators of feasibility included:

- Engineering feasibility (constructability and cost)
- Economic feasibility (efficiency, productivity, development)
- Financial feasibility (costs, revenues, funding)
- Implications (environmental, energy, safety, demographic)
- Need (passenger and freight utilization)
- Institutional feasibility (legal, legislative, public policy)

WORK PROGRAM

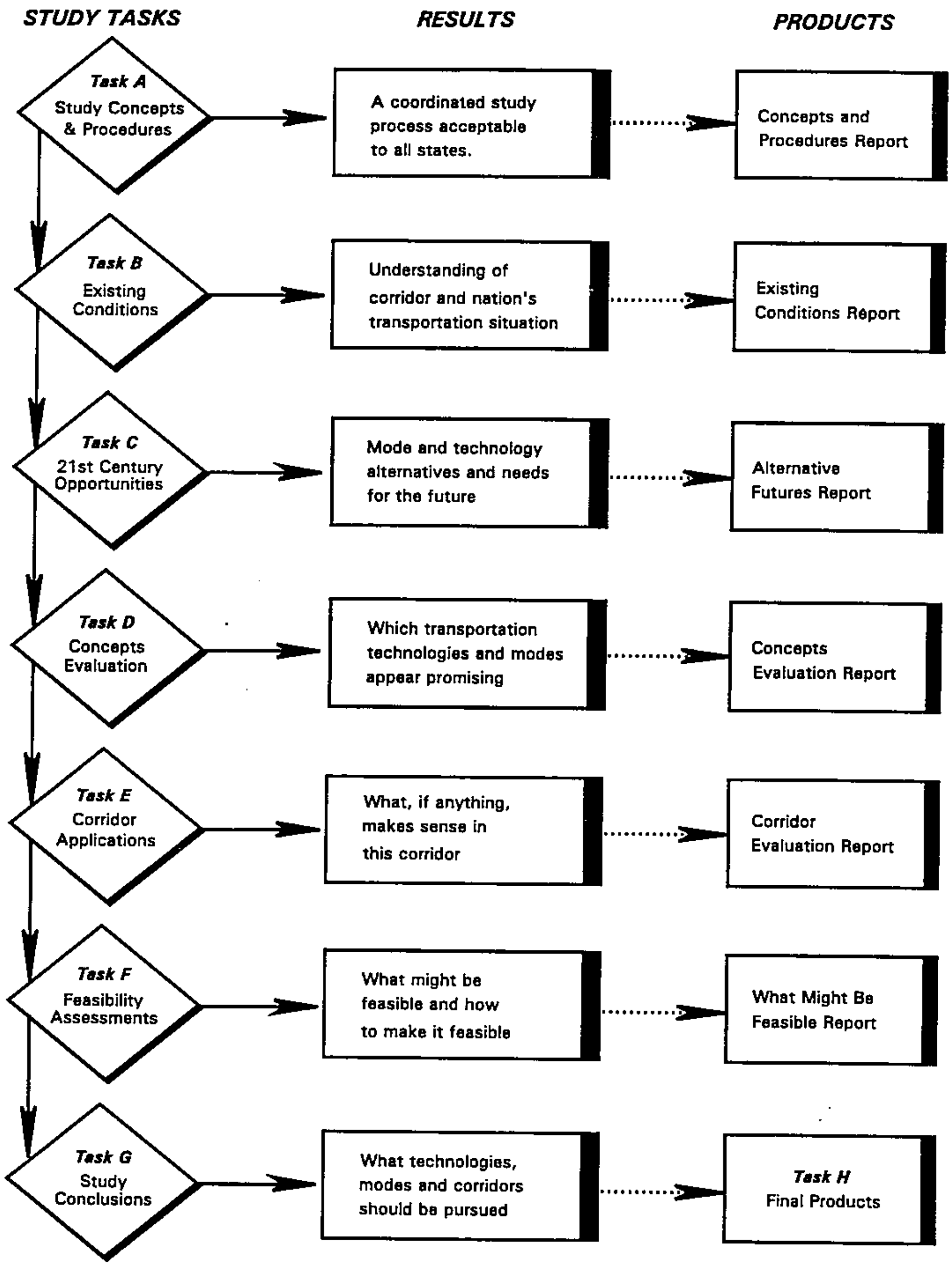
The study was divided into an eight work task approach which is summarized as follows:

Task A: Study Concepts and Procedures Task B: Existing Conditions	BACKGROUND ↓
Task C: 21st Century Opportunities Task D: Evaluation of Alternative Concepts Task E: Possible Corridor Applications Task F: Feasibility Assessments	ANALYSES ↓
Task G: Study Conclusions Task H: Study Products	RESULTS

Exhibit 1-2 demonstrates how the tasks were linked to yield a comprehensive analysis.

- <u>Task A: Study Concepts and Procedures</u> - This initial task identified the important study issues and focused the study upon specific agreed upon objectives which answered the question:

Exhibit 1-2
EIGHT TASK STUDY APPROACH



> *"How can this study be most useful to the individual states and to the nation?"*

- <u>Task B: Existing Conditions</u> - This task collected and presented transportation and corridor data and insights that served as a foundation for the entire study. It answered the question:

  > *"What combination of issues, circumstances and expectations cause us to think that some type of fast, high capacity transportation system coast-to-coast in this corridor may be desired?"*

- <u>Task C: 21st Century Opportunities</u> - This task presented a key study challenge since it dealt with transportation needs and systems 30-50 years into the future on a national scale. The task explored the question:

  > *"What types of emerging technologies might be available, and will the nation need and be ready to develop some type of new coast-to-coast transportation facility?"*

- <u>Task D: Evaluation of Alternative Concepts</u> - In this task the alternative modes, technologies and joint use options were evaluated to seek a consensus within the Steering Committee as to which of them might be appropriate. The task addressed the question:

  > *"Which mode, technology and joint use concepts seem to make the most sense, and warrant further consideration?"*

- <u>Task E: Possible Corridor Applications</u> - This task explored the designated corridor to determine its needs, the roles it might play within the context of this strategic concept, and how the emerging technology, modal and joint use concepts might apply to the corridor. The task answered the question:

> *"What makes the most sense in this designated corridor region, and what are the alignment issues, constraints and opportunities?"*

- Task F: Feasibility Assessments - This task explored the relative feasibility of both the transportation and multi-purpose concepts and their applicability to the corridor in terms of engineering constructability, cost, efficiency, productivity, economic development, need and such implications as environmental, safety, energy and others. The task answered the question:

  > *"What is feasible and what are the trade-offs? What needs to be done to make alternative concepts feasible?"*

- Task G: Study Conclusions - In this task the study's conclusions were developed. It addressed the question:

  > *"Does the nation need, and might it be ready for a new order of transportation technology and service?"*

- Task H: Study Products - This task comprised study reports and presentations. This included a series of newsletters and the study's Final Report.

STUDY TEAM APPROACH

The Study Team for the Transamerica Transportation Corridor was composed of both public sector and private sector participants.

Public Sector

The public sector was represented by 12 states, the U.S. Department of Transportation, and the Volpe National Transportation Systems Center. The Study's Steering Committee included the following representatives:

Mr. Harvey Atchison - Colorado
Mr. Elmore Dean - New Mexico

Mr. Roger Driskill - Oklahoma
Mr. Tom Harrell - Arkansas
Mr. Dale Janik - Illinois
Mr. Kyle Kittrell - Missouri
Mr. Jay Klagge - Arizona
Mr. Dick Lockwood - Virginia
Ms. Debra Miller - Kansas
Mr. David Smith - Kentucky
Mr. Clint Topham - Utah
Mr. Paul Wilkinson - West Virginia
Mr. Thomas Weeks - Federal Highway Administration
Mr. Michael Jacobs - Volpe National Transportation Systems Center

The Missouri Highway and Transportation Department was the administrative agency for the study.

Seven other states potentially could be affected by this Transamerica Transportation Corridor. These are California, Indiana, Maryland, Ohio, Nevada, Tennessee and Texas. These states were kept advised regarding the study and contributed data and other information.

Consultant Team

The Consultant Team included representatives of the public and private sectors. This team was comprised of:

- **Wilbur Smith Associates (WSA)**, the prime contractor for the study. WSA is an international consulting, engineering, economics and planning firm which specializes in the transportation sector. The WSA Project Manager was Mr. James L. Covil, P.E., Senior Vice President, Transportation Policy and Planning.

- **Howard Needles Tammen and Bergendoff (HNTB)**, the principal subcontractor. HNTB is a nationally recognized engineering, architecture and planning firm. Mr. Joseph W. Guyton, P.E. was the Deputy Project Director for the study.

- **Supporting Team Members** - Three firms, one university and a university professor provided support services.

  — Price Waterhouse
  — University of Kentucky Transportation Center

— Haugen Associates
— Transportation Associates
— Dr. David Forkenbrock

Expert Panels

Given the futuristic vision of this study, it was necessary to maintain a very broad view of 21st Century transportation concepts and opportunities. To achieve an improved understanding of possible future trends, two panels of nationally recognized experts reviewed the Study's major concepts and assumptions regarding the future and provided their views about matters that should be considered.

An "Emerging Futures" panel provided insights regarding macro-scale trends of a demographic, economic and social nature. Panel participants were:

- Dr. Patricia F. Waller, Director, Transportation Research Institute, The University of Michigan
- Mr. Alan E. Pisarski, Consultant

The "Emerging Technologies" panel provided insights concerning future events that might affect the need for and features of future transportation technologies. Panel participants were:

- Dr. C. Michael Walton, Chairman, College of Engineering, The University of Texas at Austin
- Mr. William M. Spreitzer, Technical Director, IVHS Program Office, General Motors Corporation
- Dr. Richard Uher, Director, High-Speed Ground Transportation Center, Carnegie-Mellon University

Chapter 2
EXISTING CONDITIONS

The identification of existing conditions within the study area was an essential study task required before representative TTC alignments could be located and before feasibility assessments of proposed technologies could be made. Development of the existing conditions database, including issues and circumstances related to the planning of a coast to coast TTC, was facilitated by the assistance rendered by the 12 State Departments of Transportation who provided technical and policy direction for this study. These public sector agencies provided the data described in Exhibit 2-1.

Exhibit 2-1
DATA COLLECTION FROM PARTICIPATING STATES

- 1990 Classified Traffic Counts
- Congestion Points on Interstates
- Accident Rates
- Major Origin/Destination Studies
- Truck Cargo Data
- Planned and Proposed Projects (Parallel to and crossing the Corridor)
- Major Destinations
- Highway Maps
- Railroads - Freight/Passenger
- Rail Traffic Flows
- Rail Line Characteristics
- State Geological Survey Publications
- Sensitive Ecosystems
- Suggestions about Route Alternatives
- Local Interest Groups of which the Consultant Team should be aware
- State Transportation Plan
- Short-Term Construction Program
- Long-Range Highway Plan
- State Aviation Plan
- State Rail Plan
- Other Plans: Bicycle, Trails, etc.
- Long-Range Transportation/ Land Use Plans - Urbanized Areas
- Air Quality Non-Attainment Areas
- State/National Registers of Historical Places
- Average Costs of Interstates/ High Speed Rail

These and other data provided the database to identify the following:

- Physiographic, demographic, economic and corridor specific issues data summarized in this chapter.

- The existing transportation services and system information that contributed to the baseline Travel Demand Analysis described in Chapter 3.

- The environmental considerations, jurisdictional issues, cost factors and proposed transportation facility information needed to develop representative Corridor Applications in Chapter 6.

SUMMARY

This study area is about 2.59 million sq km (1 million sq miles) of land, or about 31 percent of the land area of the contiguous 48 states. The TTC study area crosses 21 states including the northern portion of the Texas Panhandle and far southwestern corner of Pennsylvania.

Because of the small land area inside the study area from Pennsylvania and Texas, only 19 of the 21 states are included in most tabulations of data. The 19 states are referred to herein as the TTC Corridor States. They have a population of about 97.5 million persons, some 39 percent of the 1990 U.S. population. However, within the limits of the I-40/I-70 boundaries, there is an estimated population of about 65 million, which is referred to herein as the Study Area Population.

In general terms, the study area can be described with a few, somewhat summary statements:

- Topography ranges from sea level through high plains and rolling hills to mountainous with passes as high as 3.7 km (12,000 ft). and peaks of over 4.3 km (14,000 ft.).

- Hydrology includes numerous streams, lakes, and rivers with the Mississippi, Tennessee, Colorado, Ohio, Missouri, Arkansas, and Rio Grande Rivers cutting across either all or portions of the study area.

- Geology ranges from poorly consolidated sediments, alluvial sediments and carbonate sediments to layers of sandstone, limestone, and shale to metamorphic rocks intruded by igneous rock.

- Natural environment also includes forests, wildlife preserves, wetlands and other sensitive ecosystem.
- Environmental problems range from air quality and coastal pollution to top soil loss.
- The man-made environment (buildings and concrete) covers less than 2 percent of the corridor land area. At the East and West termini, however, urbanization and traffic congestion are prominent.
- Economic conditions reflect much of the nation in a variety of urban work forces as well as the rich agricultural base of the Great Central Valley of California and the mid western "bread basket".
- Transportation in and across the study area includes extensive street and highway networks, key trunk lines of the system of rail lines crossing the country, numerous truck and regional airlines, important sea ports on both coasts, and connections with major inland waterways, including the Mississippi River.
- Political jurisdictions impose numerous town, city, regional, agency, county, state, and federal rules, regulations and policies, including the special considerations of lands of Indian Nations.

PHYSIOGRAPHIC AND GEOLOGIC CHARACTERISTICS

This section provides an overview of the detailed databases that were collected to undertake the analyses in this study. Included are a regional overview of topographic and environmental conditions followed by a review of hydrology.

The study area was divided into six general physiographic regions that contain distinct or subtle provinces within themselves. Physical, topographic, geologic and environmental conditions can abruptly or gently blend together. These conditions were analyzed in a later task to determine facility location, constructability and cost.

Exhibit 2-2 illustrates the general regions from east to west that were analyzed. They are the Atlantic Coastal Area; the Appalachian Highlands; the Interior Plains; the Rocky Mountains; the Intermontane Plateau System; and the Pacific Mountain System and Coastal Area. The following is a brief general description of the geology, topography, landscape, and environmental characteristics in each area.

Atlantic Coastal Area

The eastern terminus of the study corridor is the Atlantic coast of Virginia and North Carolina. This lies in the Coastal Plain Area. Environmentally, this coastal region includes wetland areas and pollution occurs along some of the Virginia coast. This is generally an area of low relief. Exhibit 2-2 also illustrates the topography of the area.

Air quality problems exist in the urbanized areas of the east coast. Acid rain occurs throughout the coastal plain and westward over the Appalachian Highlands and throughout most of the Interior Plains.

Appalachian Highlands

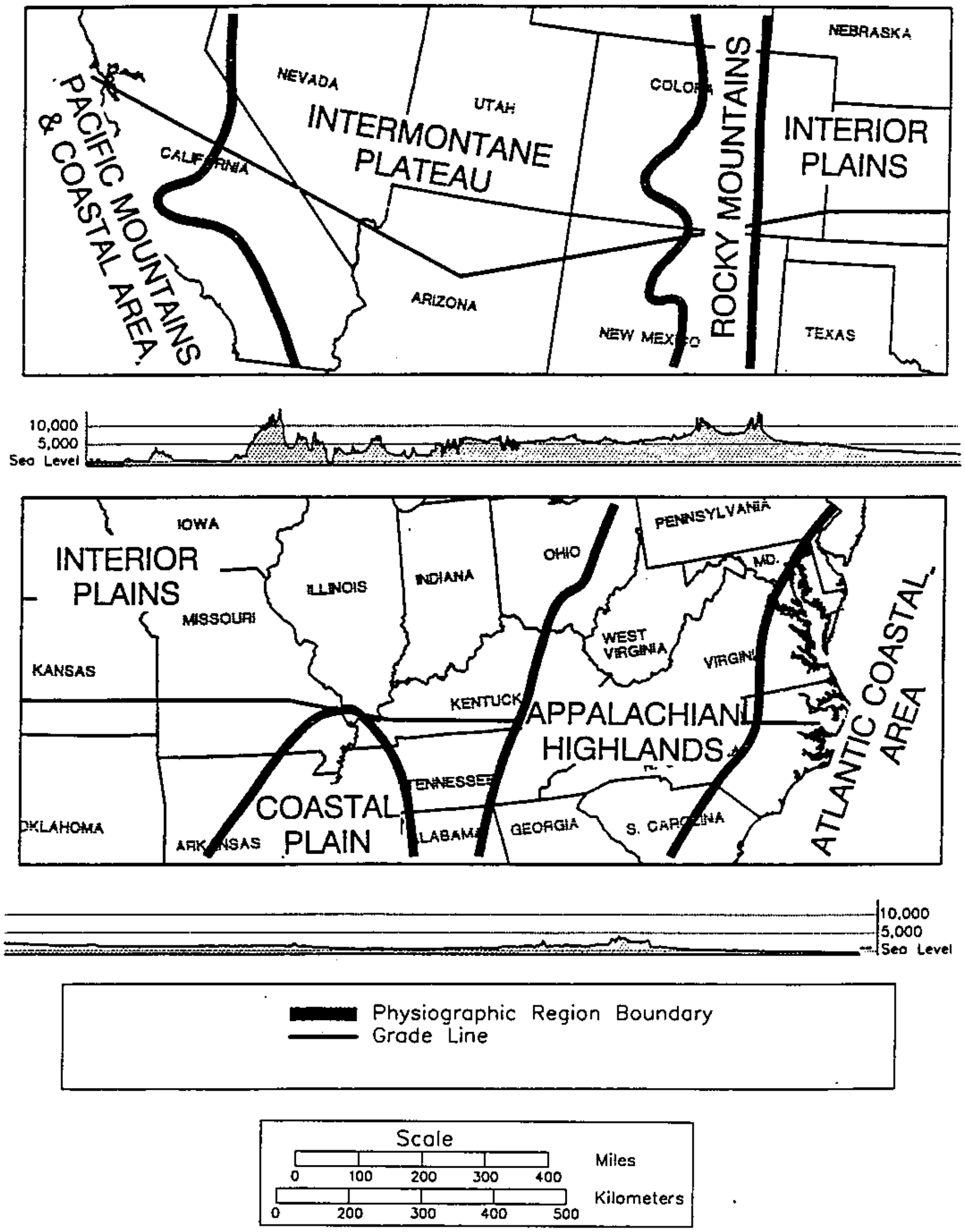
The Appalachian Highlands includes from east to west four rather distinct districts, the Piedmont, Blue Ridge, Ridge and Valley, and Appalachian Plateau provinces.

The Piedmont is characterized by land surface of rolling hills. The Blue Ridge is depicted as more rugged than the Piedmont with elevations over 1,825 meters (6,000 ft) above sea level. The Ridge and Valley Province is characterized by linear ridges. These are some of the most noted valleys in American history, such as Cumberland and Shenandoah. Roadways constructed in this region have generally followed the northeast-southwest trending features of the ridges.

The Appalachian Plateau is characterized also by parallel ridges and valleys. Topography is one of steep hills. Highways typically are constructed on tops of ridges or through the valleys. A portion of the White Top Mountain above 1,370 meters (4,500 ft) elevation is a non-attainment area for ozone.

Exhibit 2-2

GENERAL PHYSIOGRAPHIC REGIONS



Interior Plains

The interior plains include four similar districts, the Interior Low Plateaus, the Central Lowlands, the Interior Highlands, and the Great Plains. This is an area surrounded by higher land except for the southern gulf coast sediments. Elevations range from 100 meters (around 300 ft) to almost 900 meters (around 2,500 ft) above sea level.

The Interior Low Plateau is adjacent and similar to the Appalachian Plateau but with less altitude and relief. The Central Lowlands cover the area from Mid-Ohio to Mid-Kansas. This area is characterized by a topography of gently rolling plains. Important wetlands also occur in the area.

The Interior Highlands, an area generally known as the Ozarks, includes the Ozark Plateau and rugged areas such as the Ouchita Mountains in Arkansas. This is the most rugged and heavily vegetated area of the Interior Plains.

The Great Plains are essentially flat but rise gently to the west to an altitude of over 1.6 km (one mile) above sea level. There is little difference in their almost arbitrary eastern boundary with the lowlands. However, there is a distinct, abrupt border with the Rocky Mountains to the west. The Great Plains can be very flat, but they also may contain areas of greater relief known as badlands or breaks. The area receives less rainfall, thus less vegetative growth. Acid rain occurs over most of the area. Air quality conditions vary greatly.

Rocky Mountains

The Rocky Mountains form a rugged barrier to east-west transportation. They are composed of many smaller ranges roughly parallel to each other trending north and south. The Rockies are generally higher than other western mountains. Peak elevations of over 4,000 m (14,000 ft) are not uncommon, and relief of 1,500 m (5,000 ft) is typical. The highest pass is over 3,700 m (12,000 ft). Exhibit 2-3 identifies the highest Rocky Mountain passes.

Drainage is characterized by swift, rock strewn streams with rapids and waterfalls. Modern highways or rail lines would require tunneling, deep cuts, or bridges to maintain desirable grades in this region.

Intermontane Plateau

This area consists of two districts, the Colorado Plateau and the Basin and Range Province.

Exhibit 2-3
ROCKY MOUNTAIN PASSES

PASS	ELEVATION	ROUTE
Vail	3,251 m (10,666 ft)	I-70
Independence	3,687 m (12,095 ft)	Colorado 82
Monarch	3,448 m (11,312 ft)	U.S. 50
Wolf Creek	3,307 m (10,850 ft)	U.S. 160

The Colorado Plateau is generally 1.6 km (one mile) or higher in elevation above sea level. It is also characterized by plateaus. Topography is one of broad flat surfaces, bounded by cliffs, cuesta scarps and cut by deep canyons - The Grand Canyon being the best known. Natural vegetation is also rather limited in this area except at higher elevations.

The Basin and Range Province is typified by isolated mountain ranges trending north-south that rise nearly 900 to 1,500 meters (3,000 to 5,000 ft) above Intermontane desert basins. Great alluvial fans fall from the steep mountain slopes and fill the valleys adjacent to them with fine sediments. Cities such as Phoenix and Las Vegas have been constructed in these desert valleys. With minimal precipitation, but infrequent deluge events, normally dry drainageways become rapid rivers. Areas of serious top soil loss and salinization exists. Adequate bridging and scour proof foundations would be required.

Pacific Mountains and Coastal Area

This area consists of the Sierra Nevada Mountains and The Mountains and Valleys of the Pacific Coast. Exhibit 2-4 identifies the highest existing passes.

Exhibit 2-4
WEST COAST MOUNTAIN RANGES

ELEVATION	ROUTE
1,139 m (3,737 ft)	I-8
1,400 m (4,593 ft)	California 14
1,300 m (4,265 ft)	I-15
782 m (2,566 ft)	I-10

The Sierra Nevadas consist of a large continuous mountain block 64 km to 98 km (40 to 60 miles) wide extending 644 km (400 miles) north and south. The system is generalized as a faulted, uplifted crustal block creating precipitous slopes, especially to the west.

The Pacific Border consists of a series of mountain ranges and valleys along the western coast. The region contains the Great Valley of California - the area between the Sierra Nevadas and the California Coastal Ranges. Elevations vary between 610 meters and 1,219 meters (2,000 and 4,000 ft) with mountain peaks to 1,829 meters (6,000 ft). The area is seismically active and interlaced by active and non active faults. The San Andreas is probably the best known fault system and extends from San Francisco south through the Imperial Valley.

Severe coastal pollution exists in the Los Angeles area and points south. There are severe air quality problems where major coastal cities do not meet federal ozone standards.

HYDROLOGY

Identification of the representative alignments in Chapter 6 required consideration of river crossings. Many water bodies can usually be avoided when refining a corridor location by adjusting the roadway alignment. Rivers crossing the entire corridor and/or perpendicular to traffic ways usually cannot be avoided. With any river or water body crossing, major concerns are environmental impacts and cost implications. Significant portions of rivers and the adjacent banks may be considered sensitive eco-systems.

All coast to coast alignment have a minimum of 24 river crossings. The first major river crossing when moving from east to west will be either the Ohio River or the Tennessee River. If an alignment were to be located north of the southern tip of Illinois, the Ohio River and possibly the Wabash River would have to be crossed. An alignment which does not pass through Illinois must cross the Tennessee River. The Mississippi River and the Colorado River are the other two major rivers which are crossed by all representative corridors.

DEMOGRAPHIC CONDITIONS

Demographic conditions data was collected and analyzed in order to determine the potential usefulness of the various TTC technologies within different corridors. This section summarizes data that particularly contributed to identifying corridor locations and determining usefulness of particular technologies.

Location of Major Population Centers

Approximately 26 percent of the U.S. population, 65 million individuals, resides in the TTC study area. Nearly half of this population is located in the major urban areas located on the study area boundaries: I-40 and I-70. I-70 passes through Columbus, Indianapolis, St. Louis, Kansas City, and Denver. I-40 passes through numerous urban areas including Albuquerque, Oklahoma City, Memphis, Nashville, Knoxville, Asheville, Winston-Salem, Greensboro, and Raleigh. The larger population centers are located on the east and west coasts. Exhibit 2-5 illustrates the urban areas over 200,000 population.

The predominance of major population centers increases the potential for transportation demand for a TTC facility. However their existence also presents certain constraints. Many of these cities, as discussed elsewhere in this report, have failed to attain clean air standards established by the federal government. Construction of a TTC facility could pose serious constraints if such a facility contributed to future air quality problems.

Present and Future Population Trends

Population Density - Low population density provides certain opportunities for construction of new facilities in undeveloped areas. The population density of the study area is lower than for the United States as a whole. In 1990, the population density in the study area was 29 persons per sq km (74 persons per sq mile). This compares with the average population of 47 persons per sq km (122 persons per sq mile) for the contiguous 48 states. Population density is particularly low in the center of the corridor.

Population Trends - If present population trends continue, it can be expected that the corridor will continue to grow and that it will be well positioned to both intercept and assist the migration flow in the nation from the central northeast to the western states. Exhibit 2-6 describes how the greatest increase in population between 1980 and 1990 occurred primarily in the western states. The population of

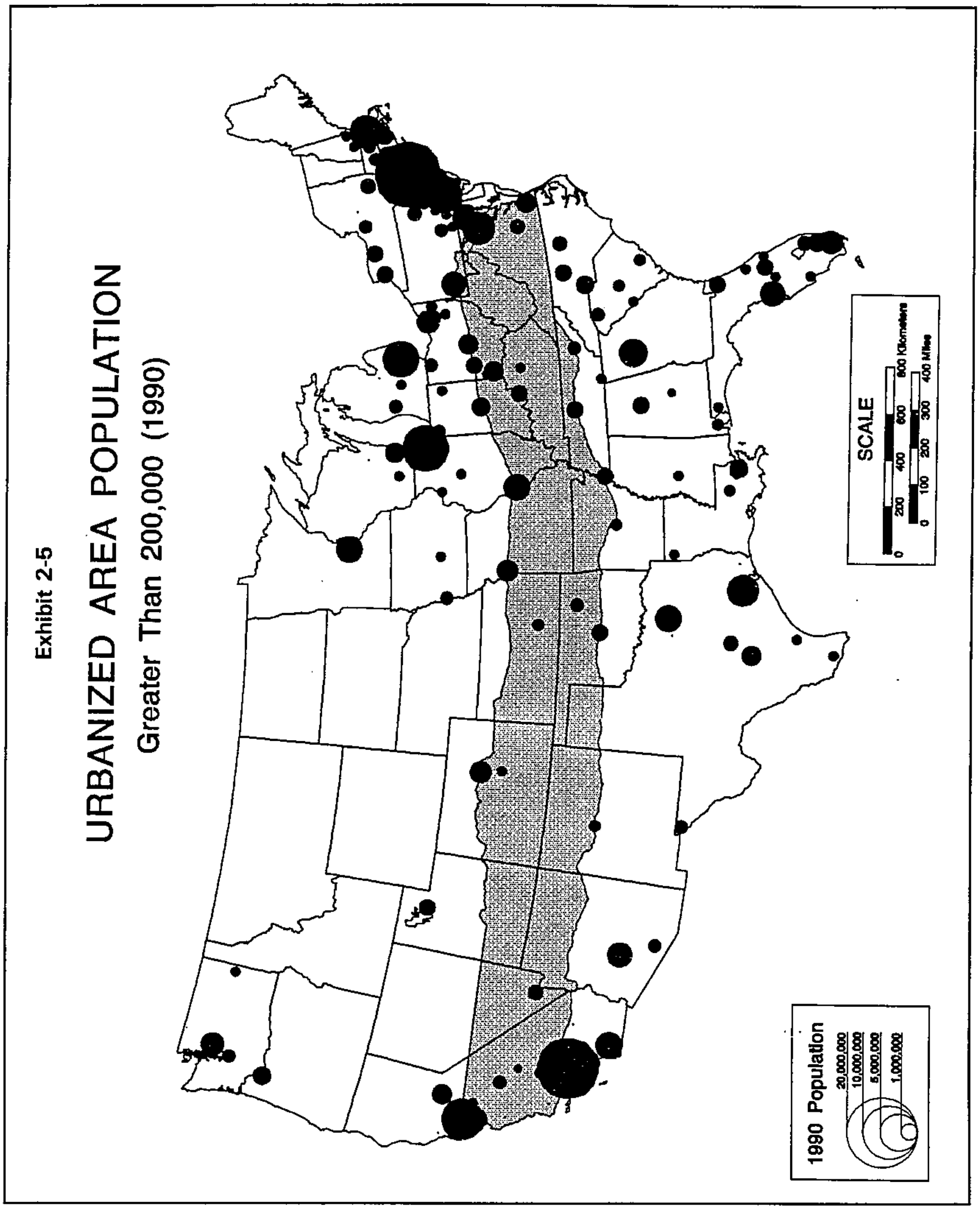


Exhibit 2-5
URBANIZED AREA POPULATION
Greater Than 200,000 (1990)

the corridor states is estimated to have increased by approximately 10 percent from 1980 to 1990.

Exhibit 2-6
POPULATION CHANGE
1980-1990
(thousands)

	1980	1990	% Change
Nevada	800	1,193	49%
Arizona	2,718	3,619	33%
California	23,668	29,279	24%
Utah	1,461	1,711	17%
Virginia	5,347	6,128	15%
New Mexico	1,303	1,490	14%
Colorado	2,890	3,272	13%
North Carolina	5,882	6,553	11%
Tennessee	4,591	4,822	5%
Kansas	2,364	2,468	4%
Missouri	4,917	5,079	3%
Oklahoma	3,025	3,124	3%
Arkansas	2,286	2,337	2%
Indiana	5,490	5,499	0%
Kentucky	3,661	3,665	0%
Ohio	10,798	10,778	-0%
Illinois	11,427	11,325	-1%
West Virginia	1,950	1,783	-9%
TOTAL	94,578	104,125	10%

SOURCE: P.C. Globe, Tempe, AZ

Rural to Urban - A large portion of the TTC Study Area remains rural even as the U.S. population has moved to urban areas. Two hundred years ago, 95 percent of the U.S. population lived in rural areas. Today, almost 75 percent of U.S. citizens live in cities. As the population has become more urbanized, the number of licensed drivers has increased. The trend is expected to continue. Today there are a total of 168 million licensed drivers in the U.S., a 16 percent increase in the last eight years.

ECONOMIC CONDITIONS

For the purposes of this feasibility study, some general data regarding economic conditions were compiled.

Perhaps the best indicator of economics for the corridor states is data relative to gross state products by state. One tabulation of this information for 1986 is provided in Exhibit 2-7. This indicates the gross state product (GSP) for each of the nineteen states with a large proportion of land area in the TTC study corridor. In addition, the exhibit indicates the percent of the gross state product which can be allocated to each industry group.

Overall the TTC corridor states derive more than half of their gross state product from three industry groups. These are manufacturing, services, and financial/insurance. Over half of the corridor states derive more than 15 percent of the GSP from the services industries. The GSP for all states (1986) is about $4.2 trillion. The TTC corridor states total about $1.8 trillion in GSP, which includes significant portions of Illinois, Indiana, and Ohio that are outside the study area. However, their proximity to the study area will significantly affect transportation demand and service in the TTC Study Area.

On a per capita basis, the TTC corridor states show a 1986 GSP per capita slightly higher than the sum of the GSP's for all states.

CORRIDOR SPECIFIC ISSUES

This section addresses state specific and jurisdictional issues.

Jurisdictional Characteristics

The study corridor includes portions of twenty-one states, approximately one thousand counties and thirty-five metropolitan areas with a population of 200,000 or greater (1990 census). Federally controlled jurisdictional areas within the corridor include military installations and federally owned lands controlled by the Bureau of Land Management. There also are numerous lands under the jurisdiction of Indian Tribal governments.

State Specific Concerns and Participation

Suggestions by the individual states concerning possible representative corridors and proposed transportation facilities that could complement a TTC facility were compiled to determine state specific concerns and interest. These routes were used in developing representative corridor locations for further study.

Exhibit 2-7
GROSS PRODUCT BY STATE

GROSS STATE PRODUCT (1986) BY STATE, IN MILLIONS OF DOLLARS

INDUSTRY	ARIZONA	ARKANSAS	CALIFORNIA	COLORADO	ILLINOIS	INDIANA	KANSAS	KENTUCKY	MARYLAND	MISSOURI	NEVADA
Agriculture	$310	$129	$3,319	$245	$558	$205	$138	$205	$308	$254	$58
Construction	$5,330	$1,552	$23,855	$3,510	$8,630	$3,891	$1,721	$2,621	$4,012	$3,458	$1,505
Farms	$812	$1,758	$7,963	$1,272	$3,385	$2,061	$2,823	$1,705	$623	$1,943	$110
Federal Gov't	$1,342	$454	$10,742	$1,760	$3,633	$1,338	$523	$1,297	$5,400	$2,181	$359
Federal Military	$839	$401	$9,406	$1,313	$1,477	$450	$880	$1,118	$1,432	$695	$309
Fin.,Insur.,etc.	$8,909	$4,479	$93,790	$9,688	$36,728	$12,296	$6,572	$7,909	$12,827	$13,042	$2,746
Manufacturing	$7,172	$7,782	$97,680	$7,631	$42,277	$25,305	$7,922	$12,764	$9,106	$18,912	$933
Mining	$683	$508	$5,927	$1,704	$1,599	$556	$877	$3,007	$114	$293	$548
Retail Trade	$6,131	$3,298	$55,216	$6,285	$19,690	$8,538	$3,823	$5,127	$8,769	$8,707	$907
Services	$9,045	$3,829	$103,397	$10,218	$36,656	$10,956	$5,635	$6,356	$15,335	$13,484	$6,901
State/Local Gov't	$5,232	$2,431	$41,881	$5,202	$14,622	$6,154	$3,522	$3,743	$6,519	$5,537	$1,426
Transportation	$4,646	$3,295	$41,928	$6,564	$22,637	$8,187	$5,090	$4,641	$6,590	$9,155	$1,834
Wholesale Trade	$2,802	$1,718	$38,711	$3,784	$17,771	$4,984	$2,947	$2,643	$5,469	$5,873	$790
Total GSP	$53,253	$31,634	$533,815	$59,176	$209,663	$84,921	$42,473	$53,136	$76,504	$83,534	$18,426
GSP Per Capita	$16,372	$13,430	$19,816	$18,264	$18,238	$15,441	$17,322	$14,314	$17,156	$16,559	$19,626

PERCENT GROSS STATE PRODUCT (1986) BY STATE

INDUSTRY	ARIZONA	ARKANSAS	CALIFORNIA	COLORADO	ILLINOIS	INDIANA	KANSAS	KENTUCKY	MARYLAND	MISSOURI	NEVADA
Agriculture	.58%	.41%	.62%	.41%	.27%	.24%	.32%	.39%	.40%	.30%	.31%
Construction	10.01%	4.91%	4.47%	5.93%	4.12%	4.58%	4.05%	4.93%	5.24%	4.14%	8.17%
Farms	1.52%	5.56%	1.49%	2.15%	1.61%	2.43%	6.65%	3.21%	.81%	2.33%	.60%
Federal Gov't	2.52%	1.44%	2.01%	2.97%	1.73%	1.58%	1.23%	2.44%	7.06%	2.61%	1.95%
Federal Military	1.58%	1.27%	1.76%	2.22%	.70%	.53%	2.07%	2.10%	1.87%	.83%	1.68%
Fin.,Insur.,etc.	16.73%	14.16%	17.57%	16.37%	17.52%	14.48%	15.47%	14.88%	16.77%	15.61%	14.90%
Manufacturing	13.47%	24.60%	18.30%	12.90%	20.16%	29.80%	18.65%	24.02%	11.90%	22.64%	5.06%
Mining	1.28%	1.61%	1.11%	2.88%	.76%	.65%	2.06%	5.66%	.15%	.35%	2.97%
Retail Trade	11.51%	10.43%	10.34%	10.62%	9.39%	10.05%	9.00%	9.65%	11.46%	10.42%	4.92%
Services	16.98%	12.10%	19.37%	17.27%	17.48%	12.90%	13.27%	11.96%	20.04%	16.14%	37.45%
State/Local Gov't	9.82%	7.68%	7.85%	8.79%	6.97%	7.25%	8.29%	7.04%	8.52%	6.63%	7.74%
Transportation	8.72%	10.42%	7.85%	11.09%	10.80%	9.64%	11.98%	8.73%	8.61%	10.96%	9.95%
Wholesale Trade	5.26%	5.43%	7.25%	6.39%	8.48%	5.87%	6.94%	4.97%	7.15%	7.03%	4.29%

SOURCE: U.S. Census and information from P.C. Globe, Tempe, Arizona

Exhibit 2-7 (continued)
GROSS PRODUCT BY STATE

INDUSTRY	NEW MEXICO	N CAROLINA	OHIO	OKLAHOMA	TENNESSEE	UTAH	VIRGINIA	W VIRGINIA	TOTAL
Agriculture	$64	$357	$439	$135	$199	$51	$339	$39	$7,352
Construction	$1,576	$4,015	$5,563	$2,132	$3,188	$1,220	$6,014	$1,153	$84,946
Farms	$449	$2,065	$1,909	$1,687	$1,184	$349	$966	$186	$33,250
Federal Gov't	$940	$1,655	$3,021	$1,835	$2,935	$1,244	$6,293	$421	$47,373
Federal Military	$587	$2,805	$725	$1,017	$452	$284	$6,203	$69	$30,462
Fin.,Insur.,etc.	$3,389	$12,781	$27,058	$6,745	$10,326	$3,574	$15,352	$3,509	$291,720
Manufacturing	$1,881	$31,671	$51,421	$7,110	$18,097	$3,989	$18,605	$3,485	$373,743
Mining	$3,181	$284	$1,441	$5,183	$351	$625	$1,117	$3,177	$31,175
Retail Trade	$2,214	$10,241	$17,258	$4,917	$8,190	$2,402	$9,801	$2,253	$183,767
Services	$3,502	$11,853	$26,725	$6,509	$11,135	$3,500	$16,389	$3,008	$304,433
State/Local Gov't	$2,434	$8,078	$12,789	$4,255	$5,393	$2,162	$7,805	$2,276	$141,461
Transportation	$2,428	$8,713	$16,308	$5,240	$5,614	$3,035	$9,577	$3,287	$168,769
Wholesale Trade	$958	$6,444	$11,445	$3,049	$5,274	$1,576	$5,693	$1,232	$123,163
Total GSP	$23,603	$100,962	$176,102	$49,814	$72,338	$24,011	$104,154	$24,095	$1,821,614
GSP Per Capita	$16,189	$15,983	$16,344	$15,250	$15,140	$14,487	$17,992	$12,646	

INDUSTRY	NEW MEXICO	N CAROLINA	OHIO	OKLAHOMA	TENNESSEE	UTAH	VIRGINIA	W VIRGINIA	TOTAL
Agriculture	.27%	.35%	.25%	.27%	.28%	.21%	.33%	.16%	.40%
Construction	6.68%	3.98%	3.16%	4.28%	4.41%	5.08%	5.77%	4.79%	4.66%
Farms	1.90%	2.05%	1.08%	3.39%	1.64%	1.45%	.93%	.77%	1.83%
Federal Gov't	3.98%	1.64%	1.72%	3.68%	4.06%	5.18%	6.04%	1.75%	2.60%
Federal Military	2.49%	2.78%	.41%	2.04%	.62%	1.18%	5.96%	.29%	1.67%
Fin.,Insur.,etc.	14.36%	12.66%	15.36%	13.54%	14.27%	14.88%	14.74%	14.56%	16.01%
Manufacturing	7.97%	31.37%	29.20%	14.27%	25.02%	16.61%	17.86%	14.46%	20.52%
Mining	13.48%	.28%	.82%	10.40%	.49%	2.60%	1.07%	13.19%	1.71%
Retail Trade	9.38%	10.14%	9.80%	9.87%	11.32%	10.00%	9.41%	9.35%	10.09%
Services	14.84%	11.74%	15.18%	13.07%	15.39%	14.58%	15.74%	12.48%	16.71%
State/Local Gov't	10.31%	8.00%	7.26%	8.54%	7.46%	9.00%	7.49%	9.45%	7.77%
Transportation	10.29%	8.63%	9.26%	10.52%	7.76%	12.64%	9.20%	13.64%	9.26%
Wholesale Trade	4.06%	6.38%	6.50%	6.12%	7.29%	6.56%	5.47%	5.11%	6.76%

There are a number of states within the study area where interest groups have been formed to promote the development of interstate highways in their respective states as part of the Transamerica Corridor Plan. These state efforts are summarized below:

- In Missouri and Kansas, an organization known as Interstate 66 Project, Inc. has been active in promoting a highway which would cross the Mississippi River at Cape Girardeau. The TTC Study has its roots partially in the efforts to link Cape Girardeau with Paducah, Kentucky: a 68-km (42-mile) stretch.

- In Southern Illinois there are a number of local issues. These not only include the advantages and limitations associated with crossing the Mississippi River and the Ohio River, and possibly the Wabash River, but also a significant concern related to protection of Shawnee National Forest in the southern portion of Illinois.

- In Kentucky there are two proposals that have been set forth. They include a northern route from Ashland to Lexington then onward to the western border. A southern route incorporates the corridor referenced in the 1991 U.S. Department of Transportation Appropriation Act as including but not limited to a 80-km (50-mile) wide corridor centered on the cities of Bowling Green, Columbia, Somerset, London, Hazard, Jenkins, and Pikeville.

- In West Virginia there are at least three proposals presented by elected officials. One includes a six-lane interstate to operate over 105 km/h (65 mph). The corridors include one through Charleston, a secondary route through Parkersburg parallel to I-50, and another route through Beckley in southern West Virginia.

- In Arkansas and Oklahoma, U.S. 412 was recently designated a High Priority Corridor in ISTEA: across north Arkansas from Tennessee into Oklahoma to provide continuity of travel through this east-west corridor.

- A Southern Utah Corridor Task Force has been formed to examine existing and alternate routes for a coal haul route from Lake Powell to I-15 near St. George, Utah. The existing roads include areas of steep grades near schools considered to be hazardous for sustained heavy truck usage. Rapid growth from a healthy economy highlights deficiencies in the existing highways to support a major coal haul and service to other large commercial/manufacturing/warehousing expansion. The hope and expectation is to identify a bypass route to most communities that can function as an arterial highway with controlled access features.

Chapter 3
BASELINE TRAVEL DEMANDS

This Chapter describes existing transportation facilities within the study corridor. Facilities are described for both passenger and freight transportation.

PASSENGER TRANSPORTATION

Passenger transportation facilities and travel demand will be summarized under the principal topics:

- Passenger Transportation Systems and Services,
- Intercity Passenger Travel Characteristics, and
- Existing Passenger Travel Demand.

PASSENGER TRANSPORTATION SYSTEMS AND SERVICES

Three modes of transportation provide intercity passenger travel services through the study corridor, namely road, air and rail. Due to the east-west orientation of the corridor, emphasis will be given to facilities available for east-west travel.

Corridor Highway System

The U.S. Interstate system is illustrated in Exhibit 3-1. Interstates I-40 and I-70 form the southern and northern boundaries, respectively of the study corridor.

The western extremity of I-40 is located at Barstow in California, where it intersects with I-15. Barstow is approximately 220 km (138 miles) east of Los Angeles. I-40 runs east from California, through Arizona, New Mexico, Texas, Oklahoma, Arkansas, Tennessee and North Carolina. I-40 terminates at the coastal city of Wilmington, North Carolina; a distance of approximately 4,117 km (2,573 miles) from Barstow.

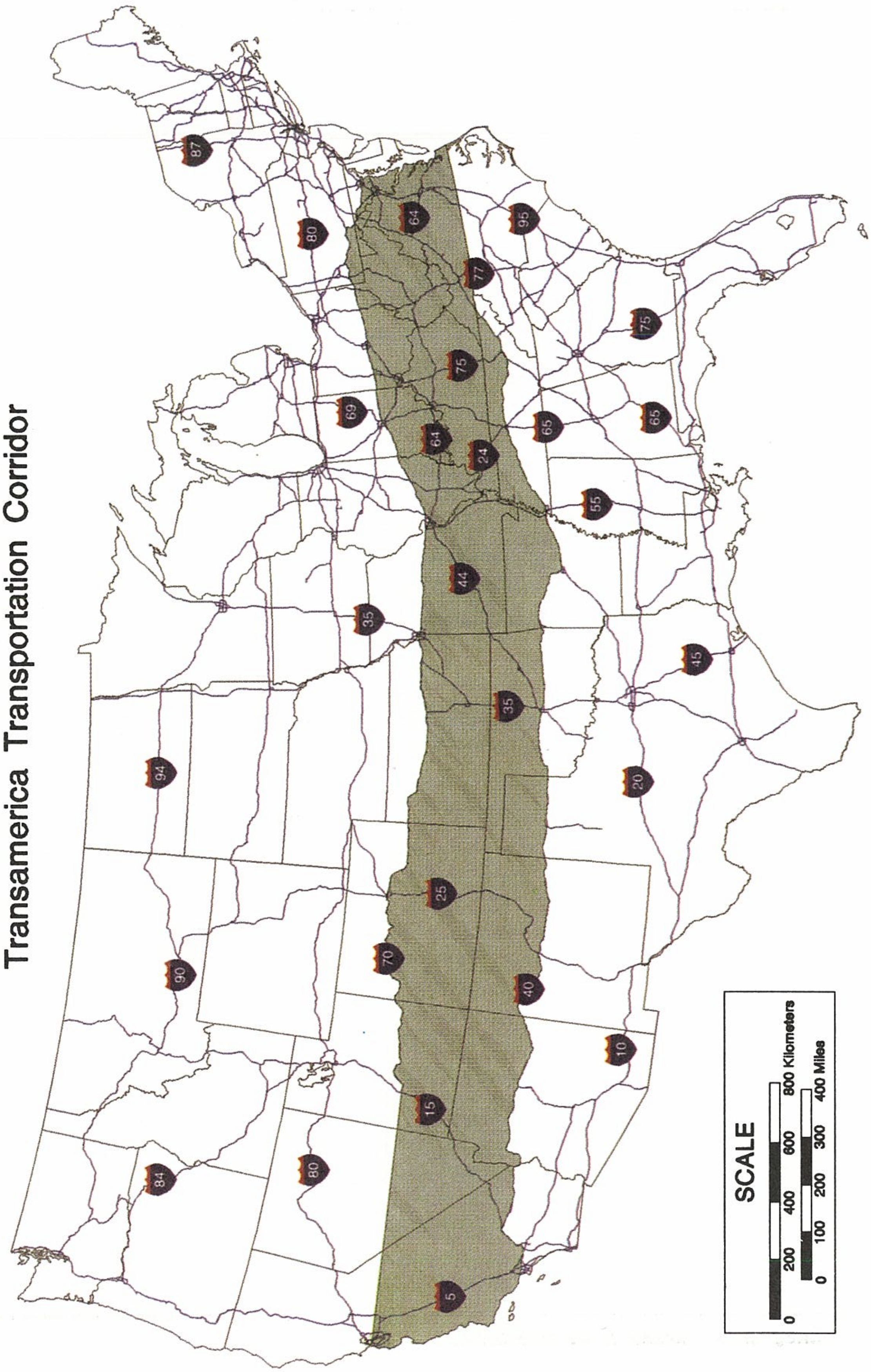
I-70 terminates in the west at the interchange with I-15, just west of the Fishlake National Forest area in Utah. I-70 runs east from Utah, through Colorado, Kansas, Missouri, Illinois, Indiana, Ohio, Pennsylvania and Maryland to Baltimore. The length of I-70 is approximately 3,488 km (2,180 miles).

Apart from I-40 and I-70, only I-64 traverses a substantial portion of the study corridor in an east-west direction. I-64 runs east from St. Louis, through southern

Exhibit 3-1

U.S. INTERSTATES & CORRIDOR LIMITS

Transamerica Transportation Corridor



Illinois and Indiana, into Kentucky, West Virginia and Virginia, terminating at Norfolk on the Atlantic coast.

Three Interstates cut the corridor in a northeast and southwest orientation. In the west, I-15 runs south through Utah before heading west through Nevada and California to San Diego. I-44 runs from St. Louis in Missouri to Wichita Falls in Texas, via Oklahoma City. In the east, I-81 intersects the northern study corridor boundary in Maryland, and continues south and west through Virginia to Knoxville, Tennessee.

Airport Facilities

Total enplanements at airports within the study corridor and throughout the U.S. are shown in Exhibit 3-2. The corridor includes seven airports at which annual enplanements exceeded five million in 1990, namely Los Angeles, San Francisco, Denver, St. Louis, Las Vegas, Washington National and Baltimore-Washington. Information for airport facilities was obtained from the airports database developed by the Service Assessment Division of the Volpe National Transportation Systems Center.

Rail System

Passenger services operated by Amtrak are illustrated in Exhibit 3-3. This exhibit highlights east-west routes through the study corridor. Exhibit 3-4 defines existing Amtrak services through the corridor in greater detail by illustrating the major stops along each route.

Exhibit 3-5 lists the train name, service frequency, distance and travel time for rail passenger travel between selected city pairs through the study corridor. Service frequency between city pairs ranges from three trains per week, on the Cardinal between Cincinnati and Indianapolis and three times per day between St. Louis and Kansas City. Based on scheduled departure and arrival times, the effective speed of travel between these cities by Amtrak ranges from 93 km/h (58 mph) between Chicago and Kansas City to 67 km/h (42 mph) between Denver and Las Vegas.

INTERCITY PASSENGER TRAVEL CHARACTERISTICS

The mode of transportation used for intercity passenger travel is influenced by a number of factors including trip purpose, speed, cost, convenience, reliability, trip length, persons in the group and accessibility. A discussion of competing modes is presented below, which reflects conditions in the United States as a whole.

Exhibit 3-2

U.S. AIRPORTS - ANNUAL ENPLANEMENTS (1990)

Scheduled Air Carrier Service Airports

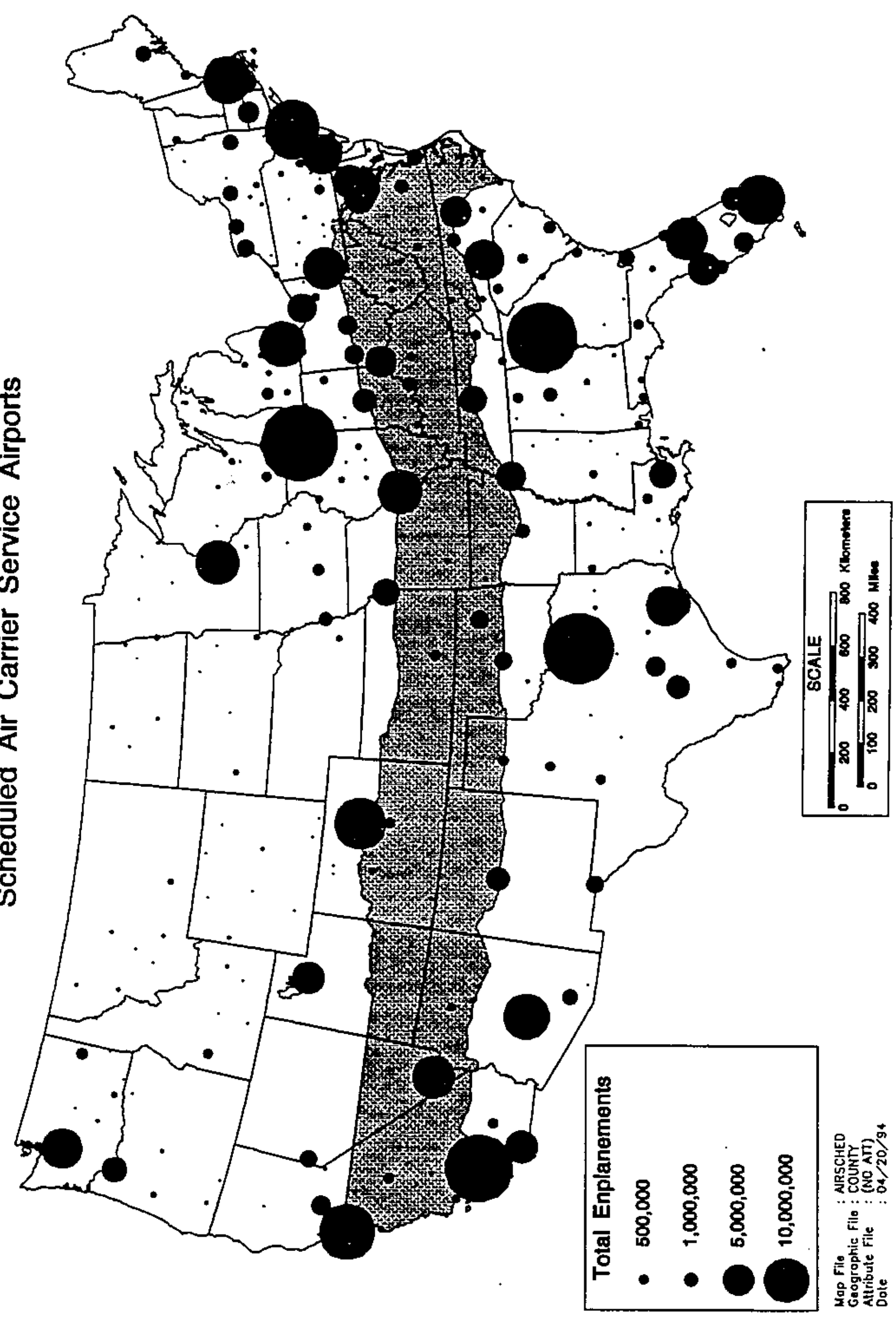


Exhibit 3-3

EAST-WEST AMTRAK ROUTES THROUGH THE CORRIDOR

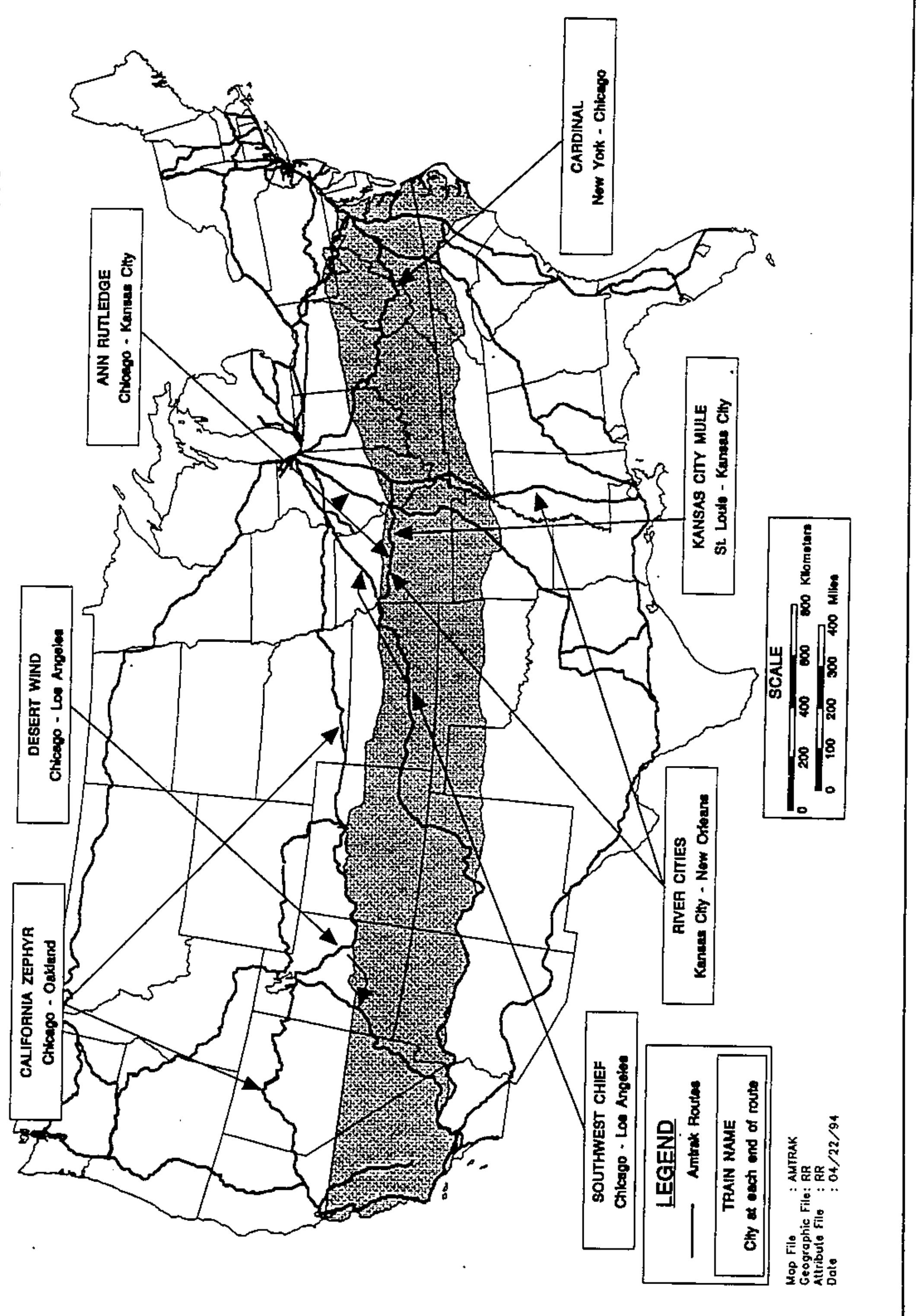
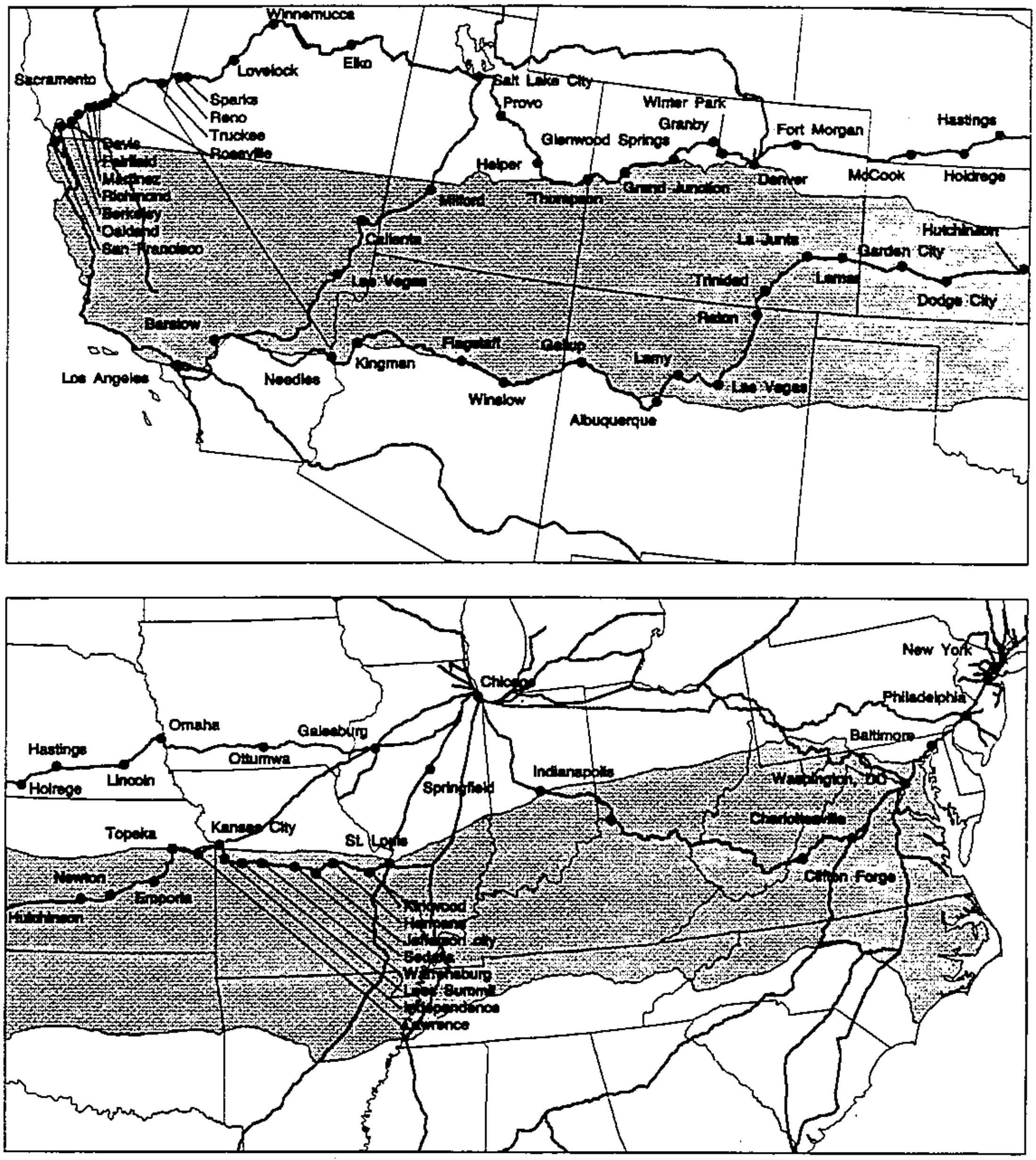


Exhibit 3-4

CORRIDOR PASSENGER RAIL SYSTEM



Map File : CORRID2
Geographic File : RR
Attribute File : RR
Date : 04/22/94

SCALE
0 200 400 600 800 Kilometers
0 100 200 300 400 Miles

Exhibit 3-5
SELECTED CITY PAIRS SERVED BY AMTRAK

CITY PAIRS		TRAIN NAME	FREQUENCY	DISTANCE (kilometers)	[miles]	TIME[1] (hrs:min)
Chicago, IL	St. Louis, MO	Ann Rutledge[2]	3 per day	451	[282]	5:45
	Kansas City, MO	Southwest Chief	Daily	720	[450]	7:45
	Denver, CO	Desert Wind[3]	Daily	1,659	[1,037]	18:05
	Albuquerque, NM	Southwest Chief	Daily	2,166	[1,354]	24:50
	Las Vegas, NV	Desert Wind	Daily	3,291	[2,057]	42:15
	Los Angeles, CA	Southwest Chief	Daily	3,595	[2,247]	41:10
	Oakland, CA	California Zephyr	Daily	3,866	[2,416]	51:25
St. Louis, MO	Kansas City, MO	Ann Rutledge[4]	3 per day	450	[281]	5:25
	Albuquerque, NM	Ann Rutledge[5]	Daily	1,896	[1,185]	24:35
	Los Angeles, CA	Ann Rutledge[5]	Daily	3,325	[2,078]	40:55
Denver, CO	Las Vegas, NV	Desert Wind	Daily	1,632	[1,020]	24:10
	Los Angeles, CA	Desert Wind	Daily	2,176	[1,360]	31:20
	Oakland, CA	California Zephyr	Daily	2,206	[1,379]	32:20
Kansas City, MO	Albuquerque, NM	Southwest Chief	Daily	1,446	[904]	16:45
	Los Angeles, CA	Southwest Chief	Daily	2,875	[1,797]	33:05
Washington, DC	Cincinnati, OH	Cardinal	3 per week	963	[602]	13:55
	Indianapolis, IN	Cardinal	3 per week	1,174	[734]	16:50
Cincinnati, OH	Indianapolis, IN	Cardinal	3 per week	211	[132]	2:40
Las Vegas, NV	Los Angeles, CA	Desert Wind	Daily	544	[340]	7:10
Reno, NV	Sacramento, CA	California Zephyr	Daily	243	[152]	4:59
	San Francisco, CA	California Zephyr	Daily	379	[237]	7:29

NOTES:
(1) Based on schedule for westbound travel.
(2) Chicago to St. Louis – 3 trains per day: Ann Rutledge, State House and Texas Eagle.
(3) From Chicago To Denver (and Salt Lake City) Desert Wind and California Zephyr are the same train.
(4) St. Louis to Kansas City – 3 trains per day: Anne Rutledge, Kansas City Mule and River Cities.
(5) Change to Southwest Chief at Kansas City, MO.

SOURCE: *Amtrak National Timetable*, Spring/Summer 1992.

Intercity Travel By Mode

Intercity travel between urban areas is dominated by automobile travel. In terms of passenger-km of travel, the automobile accounted for 83.5 percent of intercity passenger-km in 1980 and 81.0 percent in 1990. The percentage decrease in market share is accounted for primarily by an increase in air travel, from 14.0 percent of intercity passenger-km in 1980 to 17.2 percent in 1990. The rail mode (Amtrak) accounts for only about 0.3 percent of all intercity travel.

Intercity passenger-km of travel between 1980 and 1990 are listed in Exhibit 3-6 and illustrated in Exhibit 3-7. Total intercity travel increased by about 35 percent during the last decade.

The increasing use of air travel for intercity trips during the 1980s is even more marked in terms of passengers carried by "for hire" modes (air, rail and bus). Exhibit 3-8 lists the total number of passengers by mode and year. Exhibit 3-9 illustrates the change in market share of each mode during the decade.

Distance and Mode Choice

To examine the effect of distance on mode choice for intercity travel, the Nationwide Personal Transportation Study (NPTS) data for 1990 were analyzed. All trips greater than 120 km (75 miles) in length were examined to identify the affect of distance on mode choice. Exhibit 3-10 illustrates the dominance of automobile travel for distances up to approximately 1,600 km (1,000 miles), after which point the majority of person-trips are made by air.

Trip Length and Trip Purpose

Trip length distributions also differ by trip purpose. For intercity automobile trips, short distances (less than 320 km [200 miles]) predominate for both business and non-business trips. However, only ten percent of intercity business trips by auto exceed 320 km (200 miles) and none were recorded in the NPTS over 1,920 km (1,200 miles). In contrast 25 percent of non-business trips by auto exceeded 320 km (200 miles) and the range of trip lengths extended to 4,160 km (2,600 miles). Auto trip length distributions by purpose are shown in Exhibit 3-11.

Exhibit 3-6

INTERCITY PASSENGER - KILOMETERS BY MODE

PASSENGER - KILOMETERS (BILLIONS)										
YEAR	AUTO (1)		AIR		BUS		RAIL (2)		TOTAL	
	Pass	%	Pass.	%	Pass.	%	Pass.	%	Pass.	%
1980	2,080.6	83.8	350.6	14.1	43.8	1.8	7.2	0.3	2,482.2	100.0
1981	2,110.9	84.2	345.6	13.8	43.4	1.7	7.0	0.3	2,506.9	100.0
1982	2,151.8	83.9	362.7	14.1	43.0	1.7	6.7	0.3	2,564.3	100.0
1983	2,182.6	83.2	391.8	14.9	41.0	1.6	6.7	0.3	2,622.1	100.0
1984	2,221.0	82.6	421.9	15.7	39.4	1.5	7.4	0.3	2,689.6	100.0
1985	2,269.3	81.6	465.3	16.7	38.1	1.4	7.7	0.3	2,780.3	100.0
1986	2,323.4	80.6	512.5	17.8	37.9	1.3	8.0	0.3	2,881.8	100.0
1987	2,420.2	80.4	546.1	18.1	36.8	1.2	8.6	0.3	3,011.7	100.0
1988	2,519.0	80.8	554.1	17.8	37.0	1.2	9.1	0.3	3,119.2	100.0
1989	2,603.4	81.2	555.7	17.3	38.4	1.2	9.4	0.3	3,206.9	100.0
1990	2,667.2	81.3	567.7	17.3	36.8	1.1	9.8	0.3	3,281.4	100.0

NOTES:
(1) Includes small trucks used for travel purposes.
(2) Excludes short-haul commuter trips and urban rail transit.
Source: Interstate Commerce Commission and Transportation Association of America.

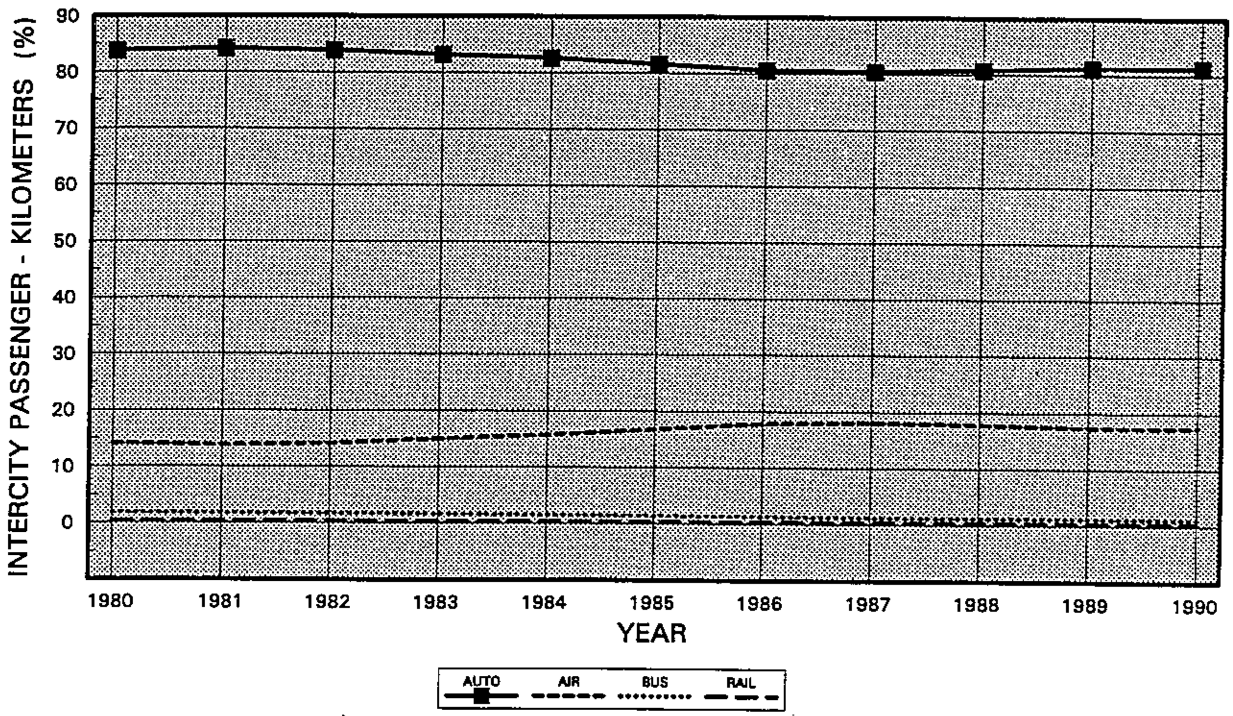
INTERCITY PASSENGER - MILES BY MODE

PASSENGER - MILES (BILLIONS)										
YEAR	AUTO (1)		AIR		BUS		RAIL (2)		TOTAL	
	Pass	%	Pass.	%	Pass.	%	Pass.	%	Pass.	%
1980	1,300.4	83.8	219.1	14.1	27.4	1.8	4.5	0.3	1,551.4	100.0
1981	1,319.3	84.2	216.0	13.8	27.1	1.7	4.4	0.3	1,566.8	100.0
1982	1,344.9	83.9	226.7	14.1	26.9	1.7	4.2	0.3	1,602.7	100.0
1983	1,364.1	83.2	244.9	14.9	25.6	1.6	4.2	0.3	1,638.8	100.0
1984	1,388.1	82.6	263.7	15.7	24.6	1.5	4.6	0.3	1,681.0	100.0
1985	1,418.3	81.6	290.8	16.7	23.8	1.4	4.8	0.3	1,737.7	100.0
1986	1,452.1	80.6	320.3	17.8	23.7	1.3	5.0	0.3	1,801.1	100.0
1987	1,512.6	80.4	341.3	18.1	23.0	1.2	5.4	0.3	1,882.3	100.0
1988	1,574.4	80.8	346.3	17.8	23.1	1.2	5.7	0.3	1,949.5	100.0
1989	1,627.1	81.2	347.3	17.3	24.0	1.2	5.9	0.3	2,004.3	100.0
1990	1,667.0	81.3	354.8	17.3	23.0	1.1	6.1	0.3	2,050.9	100.0

NOTES:
(1) Includes small trucks used for travel purposes.
(2) Excludes short-haul commuter trips and urban rail transit.
Source: Interstate Commerce Commission and Transportation Association of America.

Exhibit 3-7

MODE SHARE BY PASSENGER - KILOMETERS



For air travel, both business and non-business trip length distributions cover the full range of distances, from 160 km (100 miles) up to approximately 4,800 km (3,000 miles) for domestic travel. The distribution for business trips is weighted towards shorter trips. In contrast, the median non-business air trip is approximately 1,760 km (1,100 miles), reflecting the tendency for the automobile to be the mode of choice for shorter distance non-business intercity travel. Air trip length distributions are shown in Exhibit 3-12.

EXISTING PASSENGER TRAVEL DEMAND

Existing passenger travel demands in the study corridor are discussed below for the modes of auto, air and rail.

Intercity Auto Travel Demand Model

Data on passenger movements by air are available from FAA's ten percent ticket sample. Amtrak maintains passenger traffic data by route. Station-to-station trip data can be obtained for some routes. No similar nationwide database exists for intercity passenger movements by private automobile.

Exhibit 3-8
INTERCITY PASSENGERS BY FOR-HIRE MODES

YEAR	AIR Pass.	AIR %	BUS Pass.	BUS %	RAIL[1] Pass.	RAIL[1] %	TOTAL Pass.	TOTAL %
1980	275.2	41.3	370.0	55.6	20.8	3.1	666.0	100.0
1981	267.3	40.3	375.0	56.6	20.6	3.1	662.9	100.0
1982	277.0	41.6	370.0	55.5	19.4	2.9	666.4	100.0
1983	299.7	43.8	365.0	53.4	18.9	2.8	683.6	100.0
1984	325.2	46.7	352.0	50.5	19.9	2.9	697.1	100.0
1985	362.6	49.6	348.0	47.6	20.1	2.8	730.7	100.0
1986	398.4	52.8	336.0	44.5	20.2	2.7	754.6	100.0
1987	420.8	54.3	333.0	43.0	20.7	2.7	774.5	100.0
1988	423.9	54.4	334.0	42.9	21.5	2.8	779.4	100.0
1989	421.3	53.6	343.0	43.7	21.4	2.7	785.7	100.0
1990	428.8	55.5	322.0	41.7	22.2	2.9	773.0	100.0

PASSENGERS (MILLIONS)

NOTE:
(1) Excludes short-haul commuter trips and urban rail transit.

Exhibit 3-9
MODE SHARE BY INTERCITY PASSENGERS

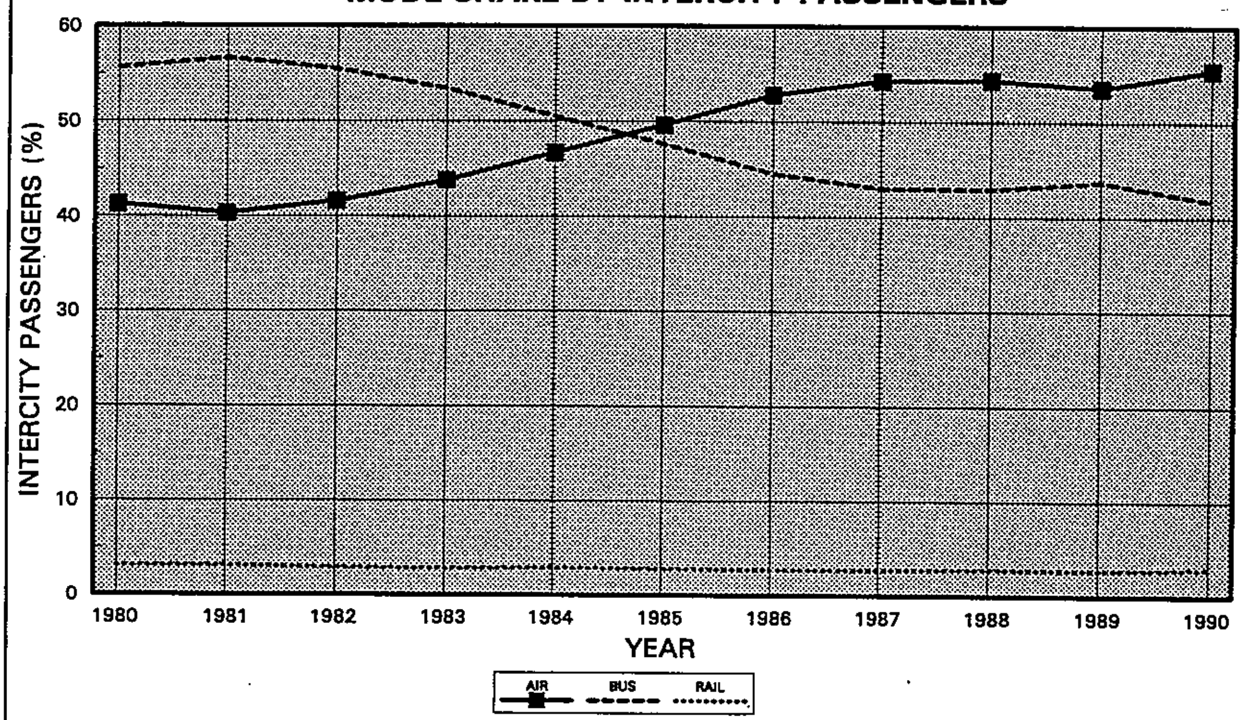
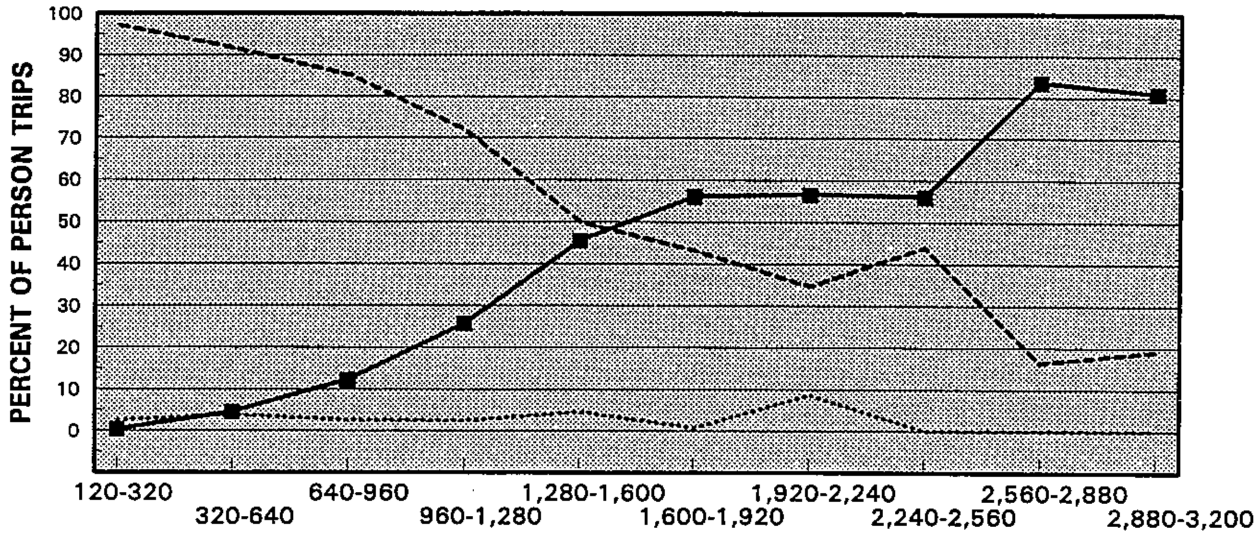


Exhibit 3-10
TRAVEL MODE BY DISTANCE

Trips in Excess of 120 Kilometers



Trips in Excess of 75 Miles

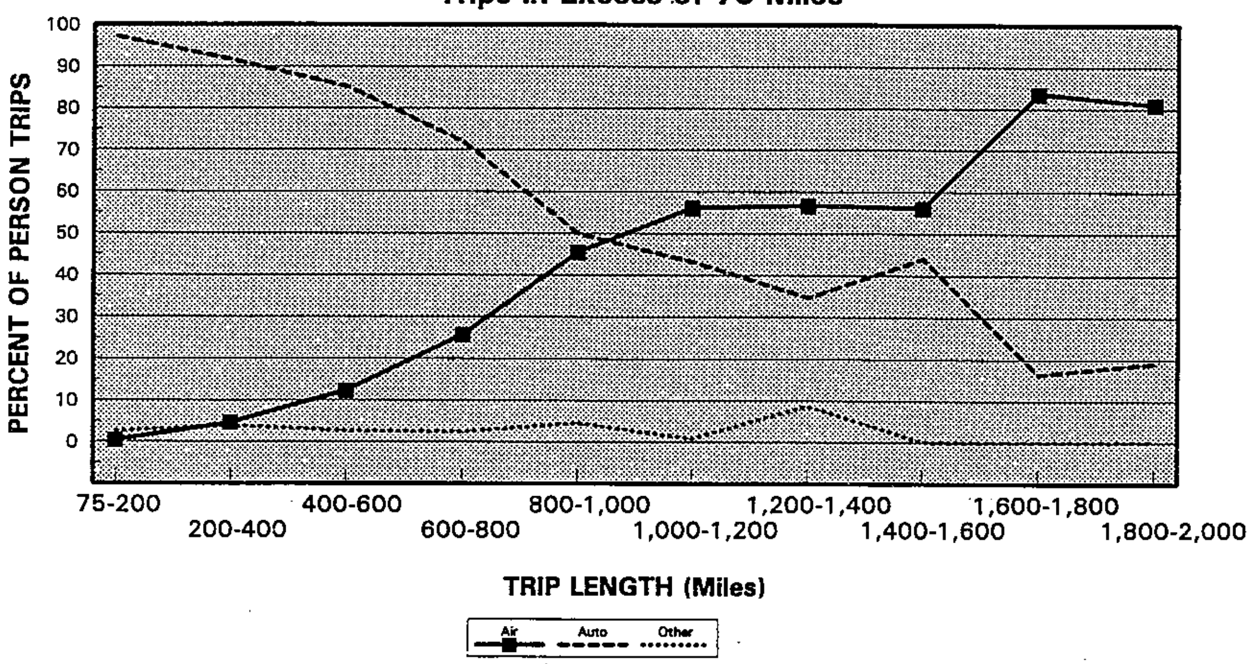
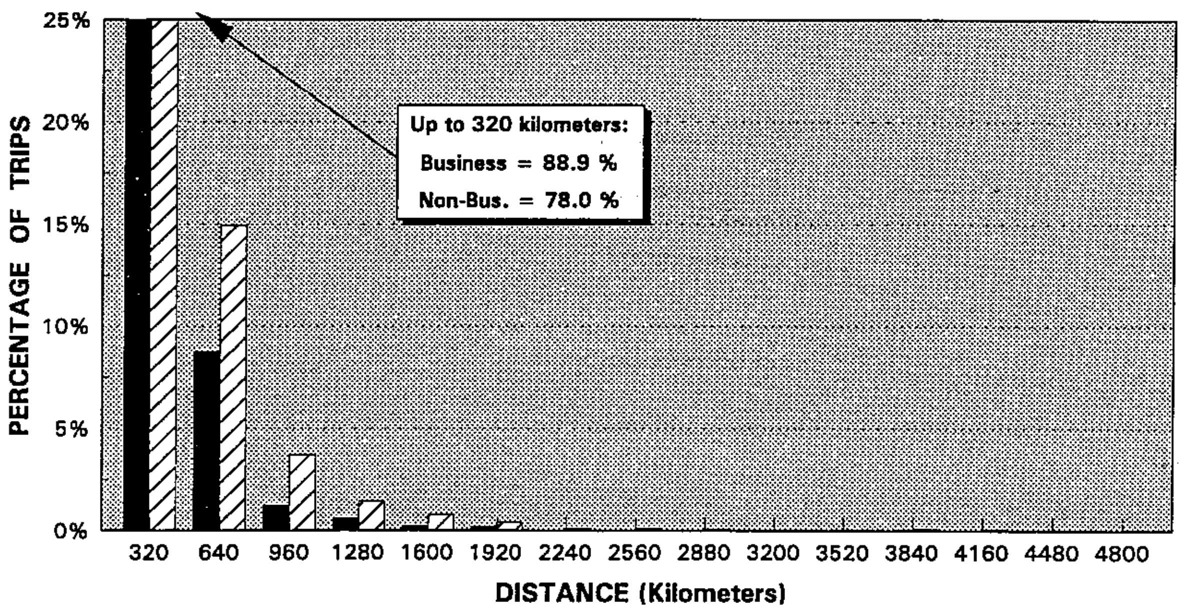


Exhibit 3-11

AUTO TRIP LENGTH DISTRIBUTION BY PURPOSE



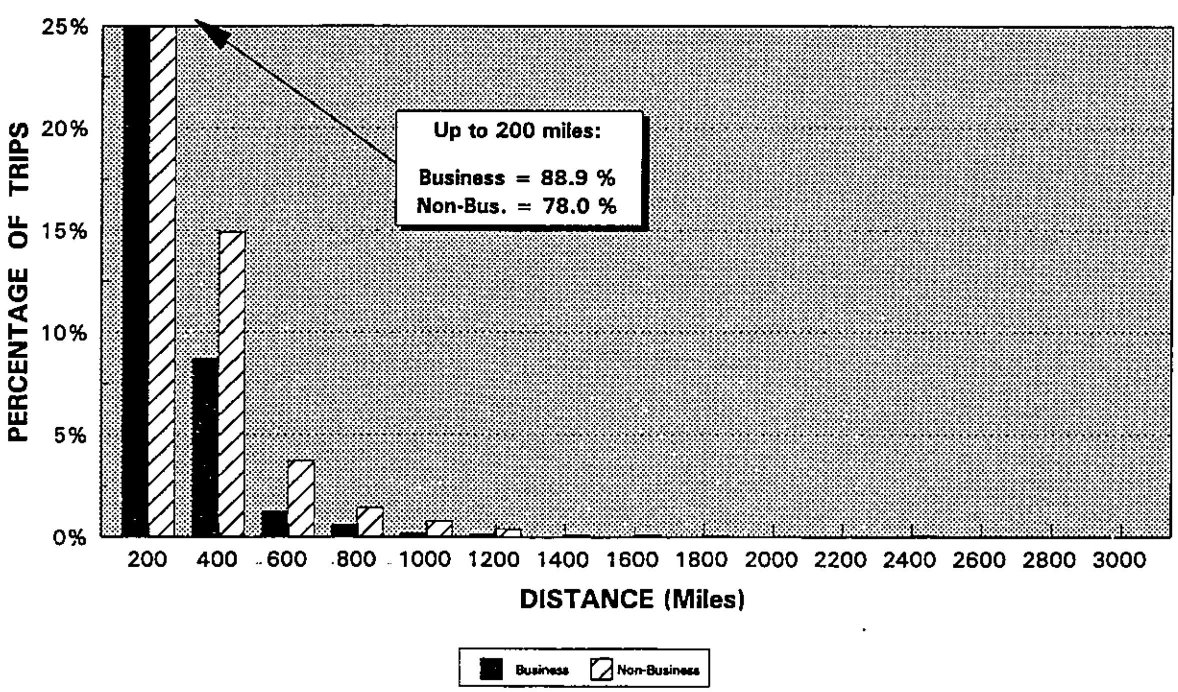
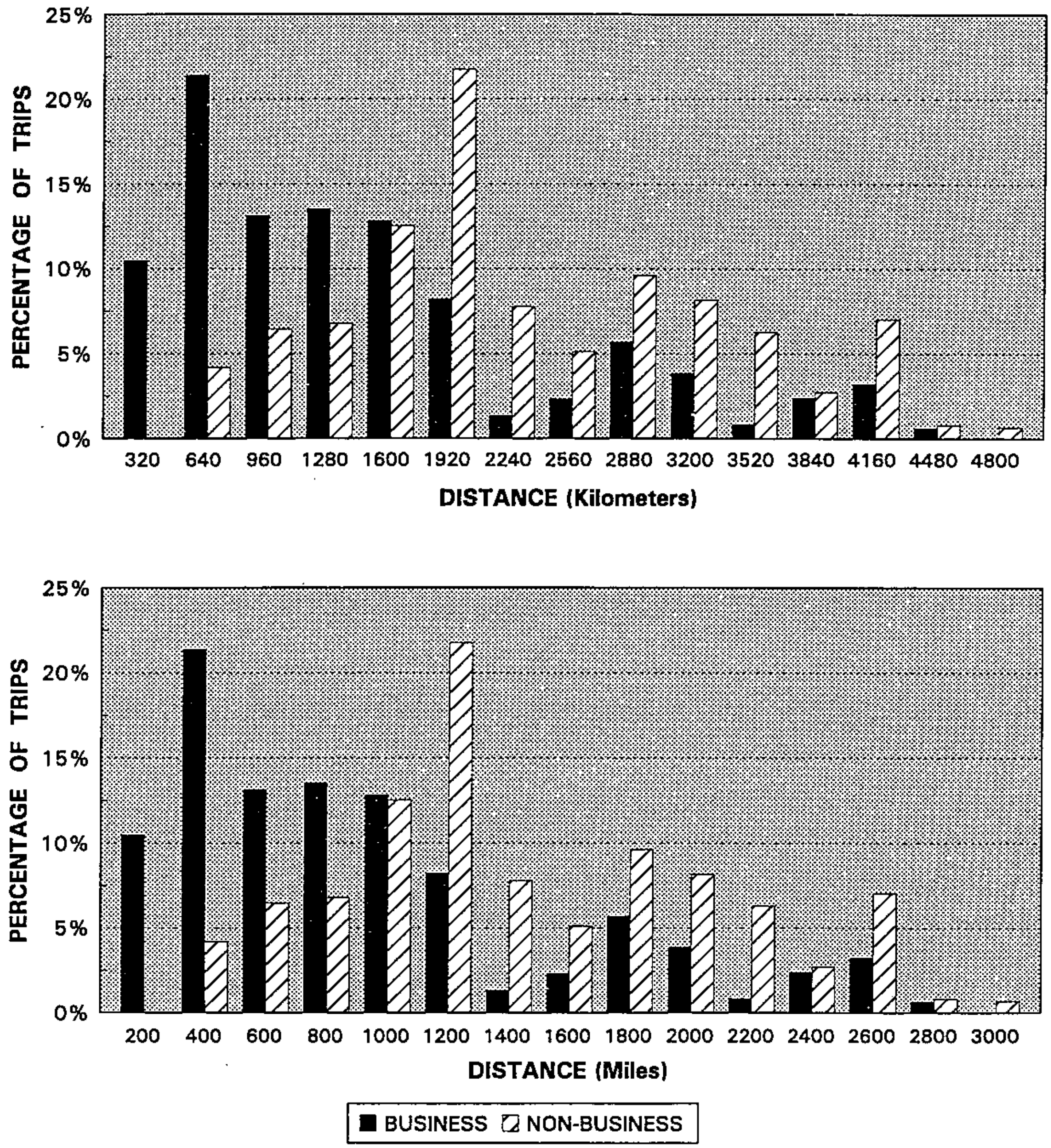


Exhibit 3-12

AIR TRIP LENGTH DISTRIBUTION BY PURPOSE



To estimate intercity auto trips, a model was developed based on one formulated by The Volpe National Transportation Systems Center. The Volpe model is a direct demand model designed to estimate auto trips between city pairs separated by distances in the range of 136 to 720 km (85 to 450 miles).

The model estimates one-way auto person trips between two cities as a function of:

- total income (population multiplied by per capita income) in origin city;
- total income in destination city;
- distance between the cities (in km); and,
- whether or not competing, frequently operated rail service exists between the cities.

The Volpe model was adapted for this study to estimate person auto trips throughout the corridor, as follows:

- A highway network was developed for the 48 contiguous states, based on the existing interstate system;
- Analysis zones were defined in accordance with the 181 Bureau of Economic Analysis (BEA) zones in the 48 states; and,
- Trips over 720 km (450 miles) in length were estimated to be consistent with trip length distributions obtained from the 1990 National Personal Travel Survey (NPTS).

BEA zones are illustrated in Exhibit 3-13 and are listed in Exhibit 3-14.

The Study model was calibrated using information from FHWA's Highway Performance Monitoring System (HPMS) database for the year 1990. The model was calibrated to nine screenlines across the study corridor from I-70 in the north to I-40 in the south. The total base year vehicle-km of travel on roads included in the network was consistent with published figures for vehicle-km of travel on the

Exhibit 3-13

BUREAU OF ECONOMIC ANALYSIS ZONES

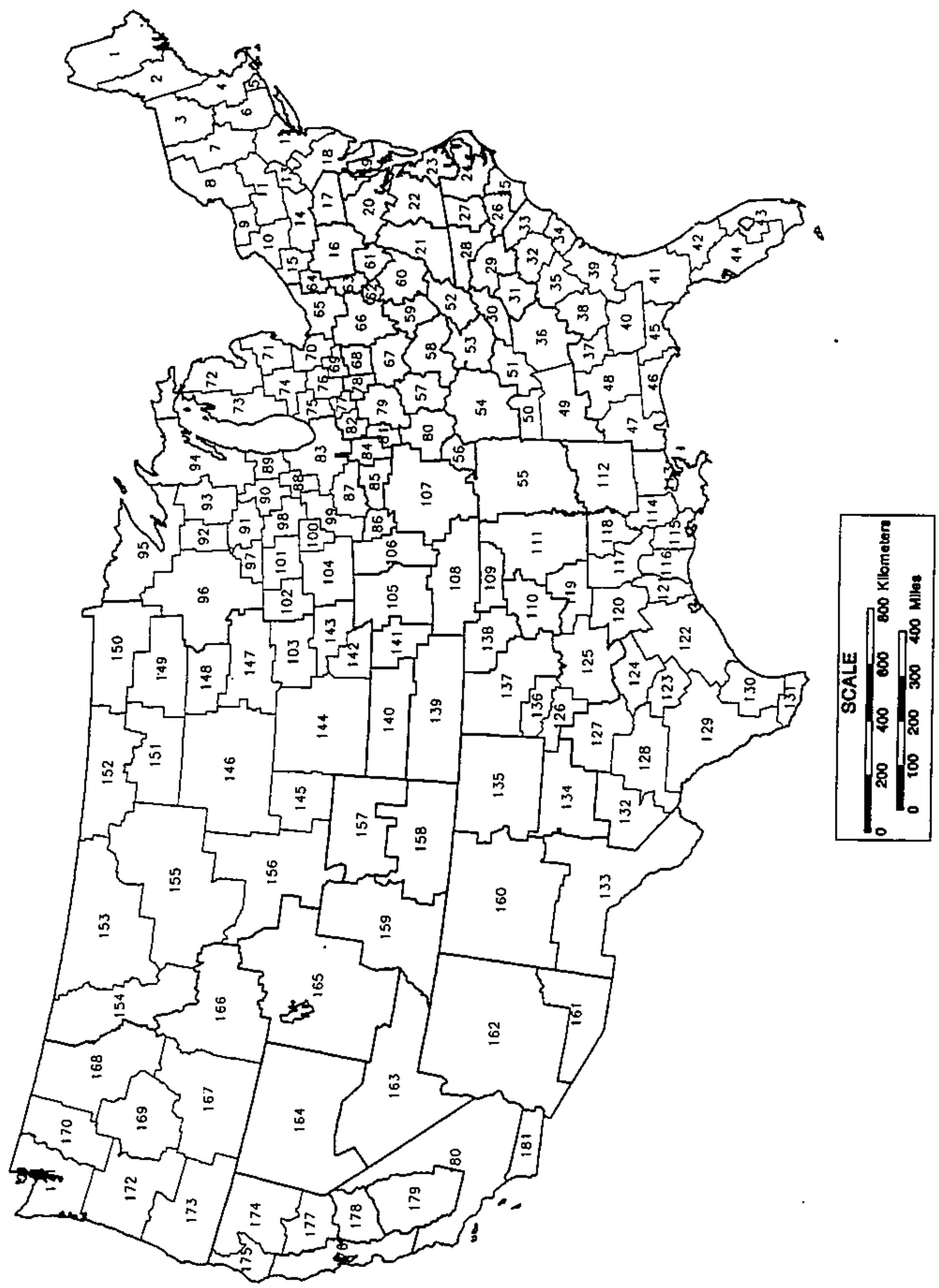


Exhibit 3-14
BEA ZONE LISTING

1	BANGOR ME	46	PENSACOLA FL	91	LA CROSSE WI	136	LAWTON OK
2	PORTLAND ME	47	MOBILE AL	92	EAU CLAIRE WI	137	OKLAHOMA CITY OK
3	BURLINGTON VT	48	MONTGOMERY AL	93	WAUSAU WI	138	TULSA OK
4	BOSTON MA	49	BIRMINGHAM AL	94	GREEN BAY WI	139	WICHITA KS
5	PROVIDENCE RI	50	HUNTSVILLE AL	95	DULUTH MN	140	SALINA KS
6	HARTFORD CT	51	CHATTANOOGA TN	96	MPLS-ST. PAUL MN	141	TOPEKA KS
7	ALBANY NY	52	JOHNSON CITY TN	97	ROCHESTER MN	142	LINCOLN NE
8	SYRACUSE NY	53	KNOXVILLE TN	98	DUBUQUE IA	143	OMAHA NE
9	ROCHESTER NY	54	NASHVILLE TN	99	DAVENPORT IA	144	GRAND ISLAND NE
10	BUFFALO NY	55	MEMPHIS TN	100	CEDAR RAPIDS IA	145	SCOTTSBLUFF NE
11	BINGHAMTON NY	56	PADUCAH KY	101	WATERLOO IA	146	RAPID CITY SD
12	NEW YORK NY	57	LOUISVILLE KY	102	FORT DODGE IA	147	SIOUX FALLS SD
13	SCRANTON PA	58	LEXINGTON KY	103	SIOUX CITY IA	148	ABERDEEN SD
14	WILLIAMSPORT PA	59	HUNTINGTON WV	104	DES MOINES IA	149	FARGO ND
15	ERIE PA	60	CHARLESTON WV	105	KANSAS CITY MO	150	GRAND FORKS ND
16	PITTSBURGH PA	61	MORGANTOWN WV	106	COLUMBIA MO	151	BISMARCK ND
17	HARRISBURG PA	62	PARKERSBURG WV	107	ST LOUIS MO	152	MINOT ND
18	PHILADELPHIA PA	63	WHEELING WV	108	SPRINGFIELD MO	153	GREAT FALLS MT
19	BALTIMORE MD	64	YOUNGSTOWN OH	109	FAYETTEVILLE AR	154	MISSOULA MT
20	WASHINGTON DC	65	CLEVELAND OH	110	FORT SMITH AR	155	BILLINGS MT
21	ROANOKE VA	66	COLUMBUS OH	111	LITTLE ROCK AR	156	CHEYENNE WY
22	RICHMOND VA	67	CINCINNATI OH	112	JACKSON MS	157	DENVER CO
23	NORFOLK VA	68	DAYTON OH	113	NEW ORLEANS LA	158	COLORADO SPRINGS CO
24	ROCKY MOUNT NC	69	LIMA OH	114	BATON ROUGE LA	159	GRAND JUNCTION CO
25	WILMINGTON NC	70	TOLEDO OH	115	LAFAYETTE LA	160	ALBUQUERQUE NM
26	FAYETTEVILLE NC	71	DETROIT MI	116	LAKE CHARLES LA	161	TUCSON AZ
27	RALEIGH NC	72	SAGINAW MI	117	SHREVEPORT LA	162	PHOENIX AZ
28	GREENSBORO NC	73	GRAND RAPIDS MI	118	MONROE LA	163	LAS VEGAS NV
29	CHARLOTTE NC	74	LANSING MI	119	TEXARKANA TX	164	RENO NV
30	ASHEVILLE NC	75	SOUTH BEND IN	120	TYLER TX	165	SALT LAKE CITY UT
31	GREENVILLE SC	76	FORT WAYNE IN	121	BEAUMONT TX	166	POCATELLO ID
32	COLUMBIA SC	77	KOKOMO IN	122	HOUSTON TX	167	BOISE CITY ID
33	FLORENCE SC	78	ANDERSON IN	123	AUSTIN TX	168	SPOKANE WA
34	CHARLESTON SC	79	INDIANAPOLIS IN	124	WACO TX	169	RICHLAND WA
35	AUGUSTA GA	80	EVANSVILLE IN	125	DALLAS TX	170	YAKIMA WA
36	ATLANTA GA	81	TERRE HAUTE IN	126	WICHITA FALLS TX	171	SEATTLE WA
37	COLUMBUS GA	82	LAFAYETTE IN	127	ABILENE TX	172	PORTLAND OR
38	MACON GA	83	CHICAGO IL	128	SAN ANGELO TX	173	EUGENE OR
39	SAVANNAH GA	84	CHAMPAIGN IL	129	SAN ANTONIO TX	174	REDDING CA
40	ALBANY GA	85	SPRINGFIELD IL	130	CORPUS CHRISTI TX	175	EUREKA CA
41	JACKSONVILLE FL	86	QUINCY IL	131	BROWNSVILLE TX	176	SAN FRANCISCO CA
42	ORLANDO FL	87	PEORIA IL	132	ODESSA TX	177	SACRAMENTO CA
43	MIAMI FL	88	ROCKFORD IL	133	EL PASO TX	178	STOCKTON CA
44	TAMPA FL	89	MILWAUKEE WI	134	LUBBOCK TX	179	FRESNO CA
45	TALLAHASSEE FL	90	MADISON WI	135	AMARILLO TX	180	LOS ANGELES CA
						181	SAN DIEGO CA

rural-interstate system in 1990. Calibration results are illustrated in Exhibit 3-15.

Air Travel

Air passenger movements were obtained for all city pairs within the United States for 1990. This information was based on FAA's ten percent ticket sample. Movements between regions in the corridor are illustrated in Exhibit 3-16.

Non-discounted air fares per 160 km (100 miles) of travel are shown in Exhibit 3-17 for 300 city pairs throughout the country. Fares per 160 km (100 miles) vary considerably for distances up to 800 km (500 miles). For longer distances, fares per 160 km (100 miles) reflect a linear relationship which may be approximated as:

$$F = \$51 - \$0.0109 \times D$$

where F = one-way coach fare per 100 miles of travel, for trips exceeding 500 miles in length (one-way)
D = road distance between origin and destination cities in miles.

Alternatively, fares may be approximated by:

$$F = 32 - 0.0043 \times K$$

where F = one-way coach fare per 100 km of travel, for trips exceeding 800 km in length (one-way)
K = road distance in kilometers

Discounted air fares, such as non-refundable 7-day advance bookings, with a Saturday night stay required, average 48 percent of the non-discounted fares.

Based on scheduled arrival and departure times and the road distance between cities, the effective speed of air travel, exclusive of airport access time, ranges from 240 to 640 km/h (150 to 400 mph) for short trips (up to 800 km [500 miles]). Beyond 800 km (500 miles) speeds tend to increase on average up to approximately 800 km/h (500 mph). Speeds between 300 city pairs are shown in Exhibit 3-18, including both direct flights and those requiring connections. The distance speed relationships may be approximated as:

Exhibit 3-15
SCREENLINE CALIBRATION RESULTS
1990 DAILY PASSENGER CAR FLOWS CROSSING CORRIDOR SCREENLINES

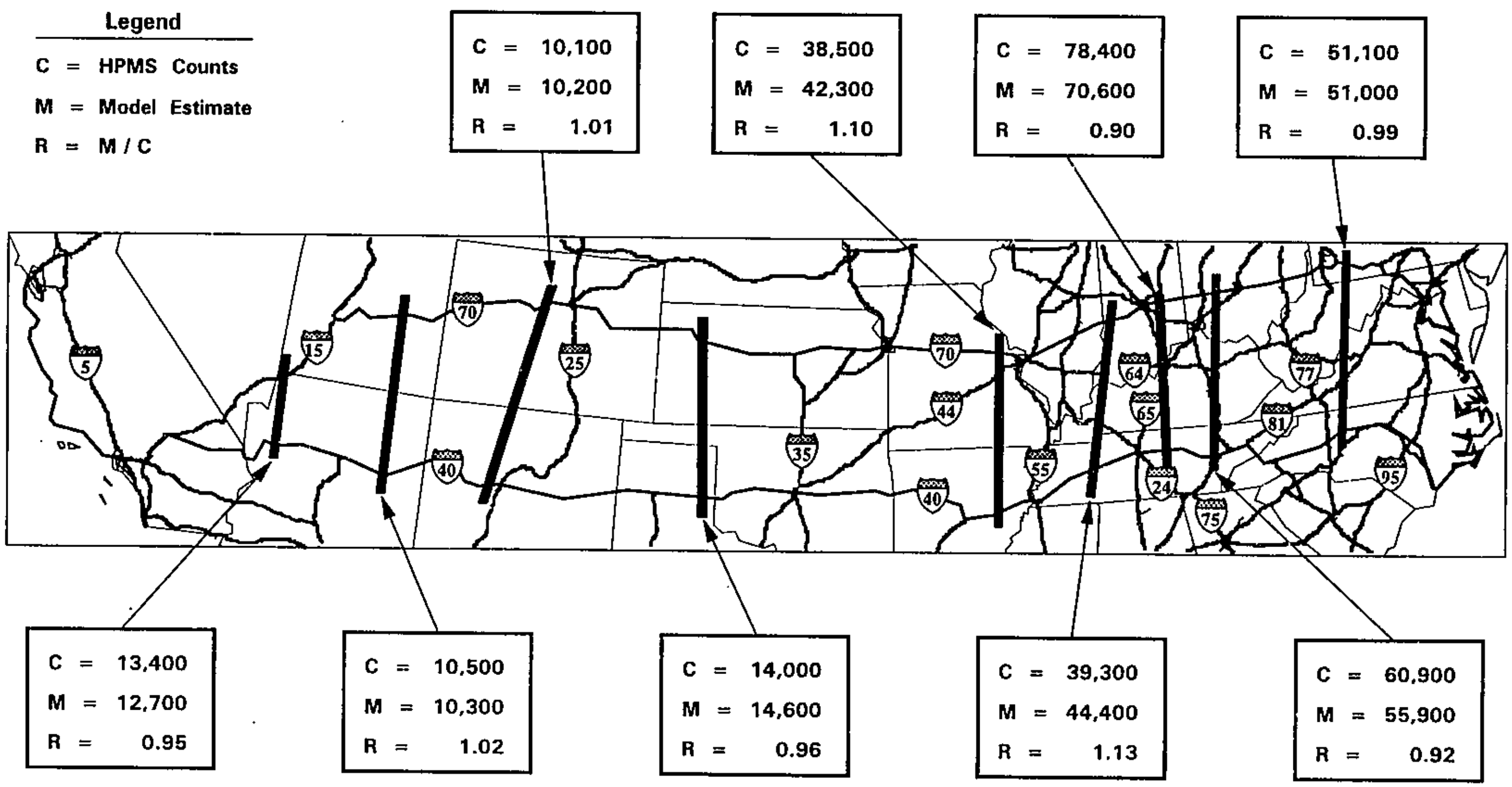


Exhibit 3-16
1990 AIR PASSENGER MOVEMENTS
One-Way Trips (Thousands)

FROM ZONE 1/2 TO:		
ZONE	TRIPS	%
1/2	11,950	50
3	4,953	21
4	1,929	8
5	1,201	5
6	943	4
7	1,275	5
8	1,613	7
TOTAL	23,864	100

FROM ZONE 3 TO:		
ZONE	TRIPS	%
1/2	4,956	49
3	1,718	17
4	1,205	12
5	586	6
6	564	6
7	575	6
8	441	4
TOTAL	10,045	100

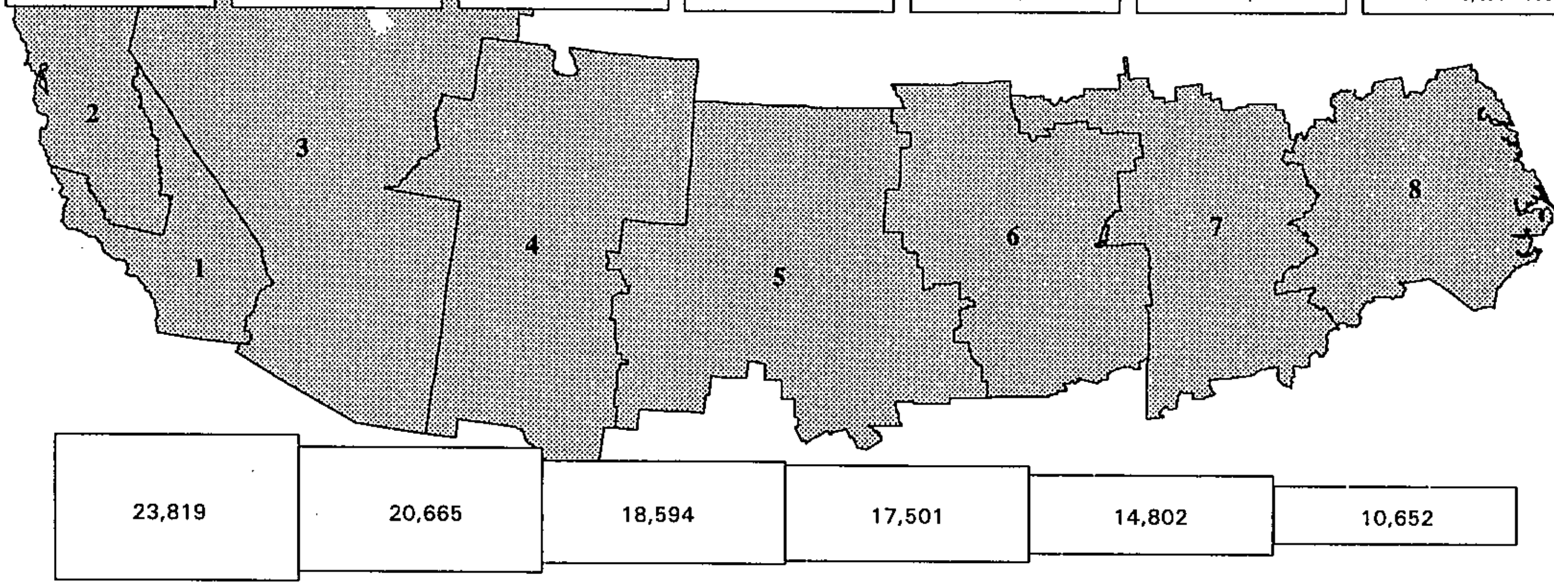
FROM ZONE 4 TO:		
ZONE	TRIPS	%
1/2	1,949	34
3	1,223	21
4	437	8
5	904	16
6	326	6
7	429	7
8	470	8
TOTAL	5,738	100

FROM ZONE 5 TO:		
ZONE	TRIPS	%
1/2	1,194	20
3	584	10
4	882	15
5	1,082	18
6	828	14
7	676	12
8	633	11
TOTAL	5,879	100

FROM ZONE 6 TO:		
ZONE	TRIPS	%
1/2	932	22
3	556	13
4	322	8
5	817	19
6	317	8
7	688	16
8	605	14
TOTAL	4,237	100

FROM ZONE 7 TO:		
ZONE	TRIPS	%
1/2	1,270	21
3	575	9
4	431	7
5	671	11
6	688	11
7	887	15
8	1,559	26
TOTAL	6,081	100

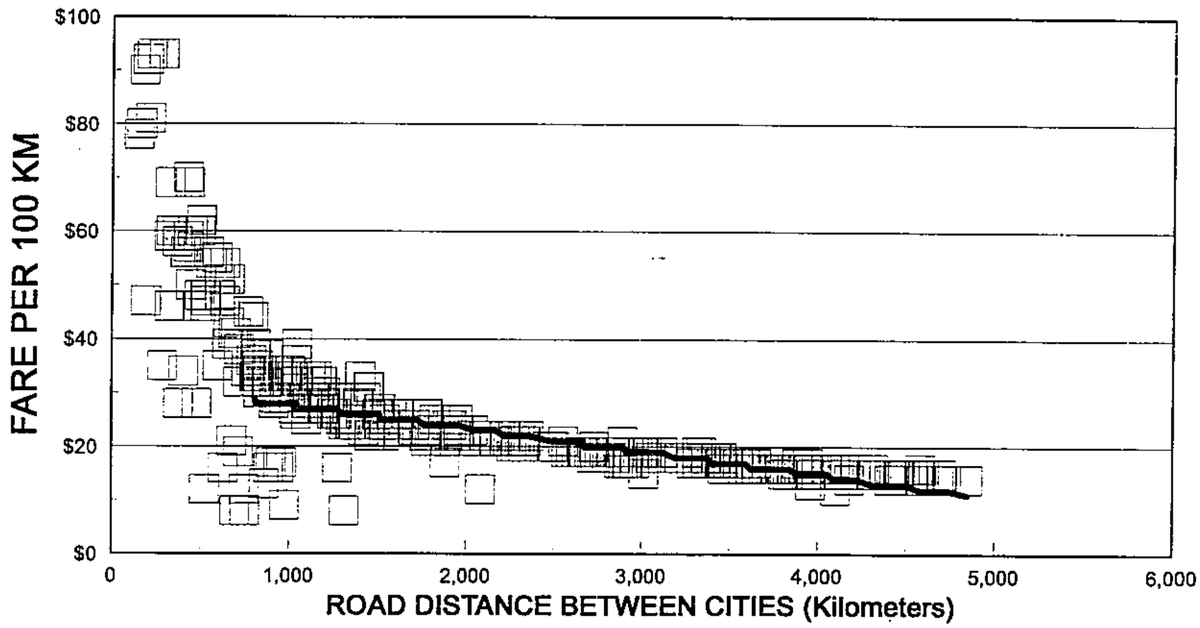
FROM ZONE 8 TO:		
ZONE	TRIPS	%
1/2	1,603	25
3	444	7
4	471	8
5	635	10
6	608	10
7	1,570	25
8	959	15
TOTAL	6,290	100



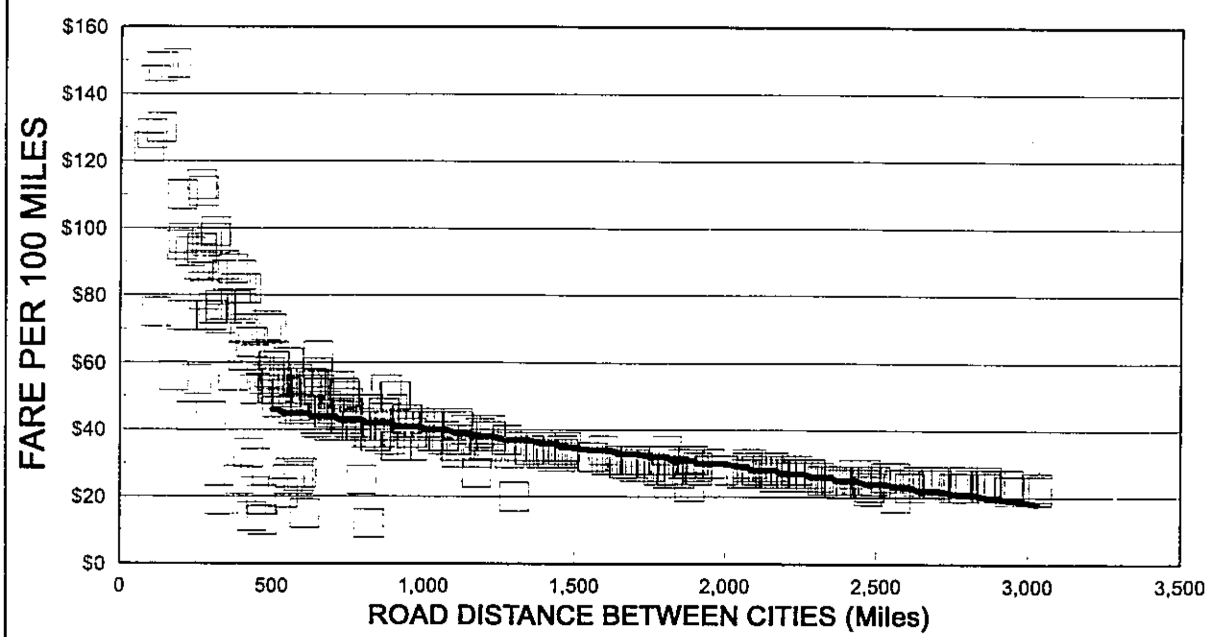
NOTE: Band widths include trips starting or ending in respective zones plus through trips. Band widths exclude intra-zonal trips.
SOURCE: Back Information Services, compiled by Wilbur Smith Associates.

Exhibit 3-17
AVERAGE ONE-WAY COACH FARE

PER 100 KILOMETERS VERSUS DISTANCE



PER 100 MILES VERSUS DISTANCE



$$S(<500) = 105 + 0.5757 \times D$$
$$S(>500) = 347 + 0.0397 \times D$$

where

- $S(<500)$ = average effective speed by air for trips less than 500 miles
- $S(>500)$ = average effective speed by air for trips greater than 500 miles
- D = road distance in miles.

Alternatively,

$$S(<800) = 168 + 0.5757 \times K$$
$$S(>800) = 555 + 0.0397 \times K$$

where

- $S(<800)$ = average effective speed in km/h by air for trips less than 80 km
- $S(>800)$ = average effective speed in km/h by air for trips greater than 80 km
- K = road distance in kilometers.

Rail Travel

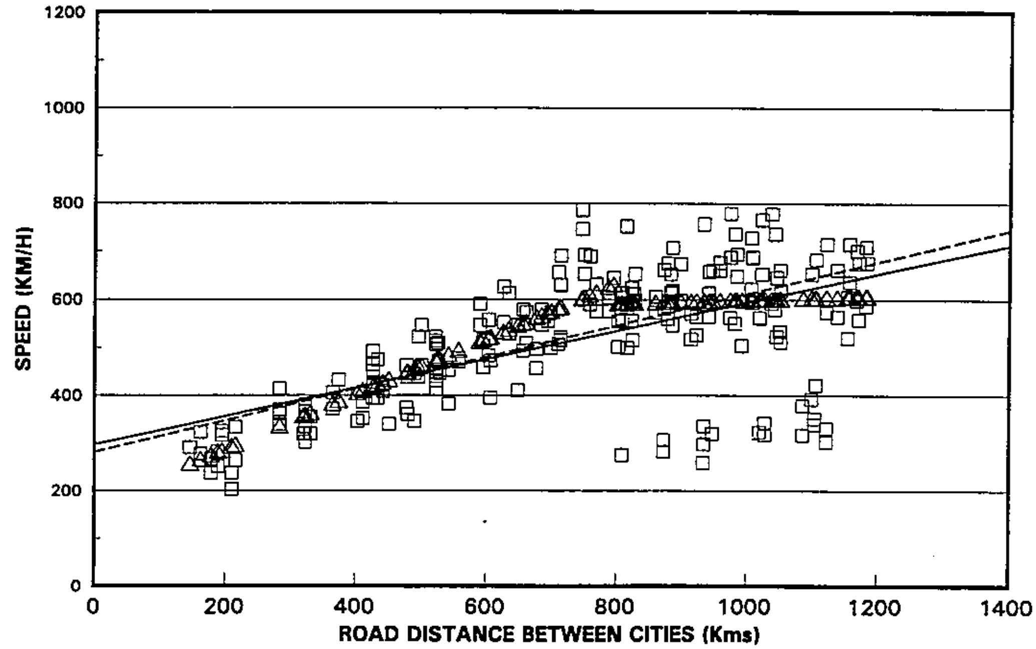
In comparison to the modes of auto and air, intercity rail passenger movements through the study corridor are relatively low. In reviewing available rail passenger origin/destination data, city pairs were identified with more than 10,000 passengers per year (one-way), corresponding to 27 person trips a day. Only two city pairs within the corridor fell in this category, namely Kansas City/St. Louis and Los Angeles/Las Vegas.

The estimated percentage of trips by rail is illustrated in Exhibit 3-19 for city pairs with more than 10,000 one-way rail passengers per year. City pairs with a modal split of ten percent or more for rail are all located in the northeast corridor. The density of population in the northeast far exceeds that of the study corridor, making these particular city pairs (such as New York to Washington) unrepresentative of existing or projected corridor conditions. Excluding city pairs with more than a ten percent rail modal split the weighted average of existing rail usage for city pairs with significant rail patronage is calculated as:

Exhibit 3-18

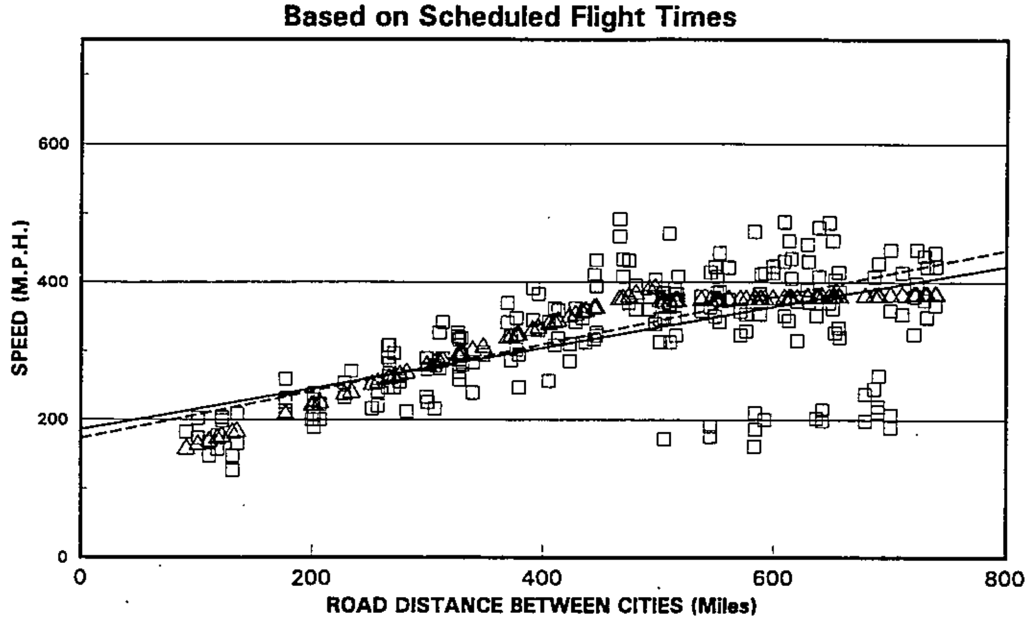
EFFECTIVE SPEED OF AIR PASSENGER TRAVEL

Based On Scheduled Flight Times



EFFECTIVE SPEED OF AIR PASSENGER TRAVEL

Based on Scheduled Flight Times



3.0 percent - for trips between 160 and 320 km (100 and 200 miles)
2.7 percent - for trips between 320 and 480 km (200 and 300 miles)
1.7 percent - for trips between 480 and 640 km (300 and 400 miles)
1.3 percent - for trips between 640 and 800 km (400 and 500 miles)
1.7 percent - for trips between 800 and 960 km (500 and 600 miles)

Rail fares per 160 km (100 miles) of travel are shown in Exhibit C-20. The average fares may be represented as a function of distance as:

$$F = \$24 - \$0.02 \times D$$

where F = one-way rail fare per 100 miles of travel, and
D = distance between origin and destination cities, in miles.

Alternatively, average fares may be represented as:

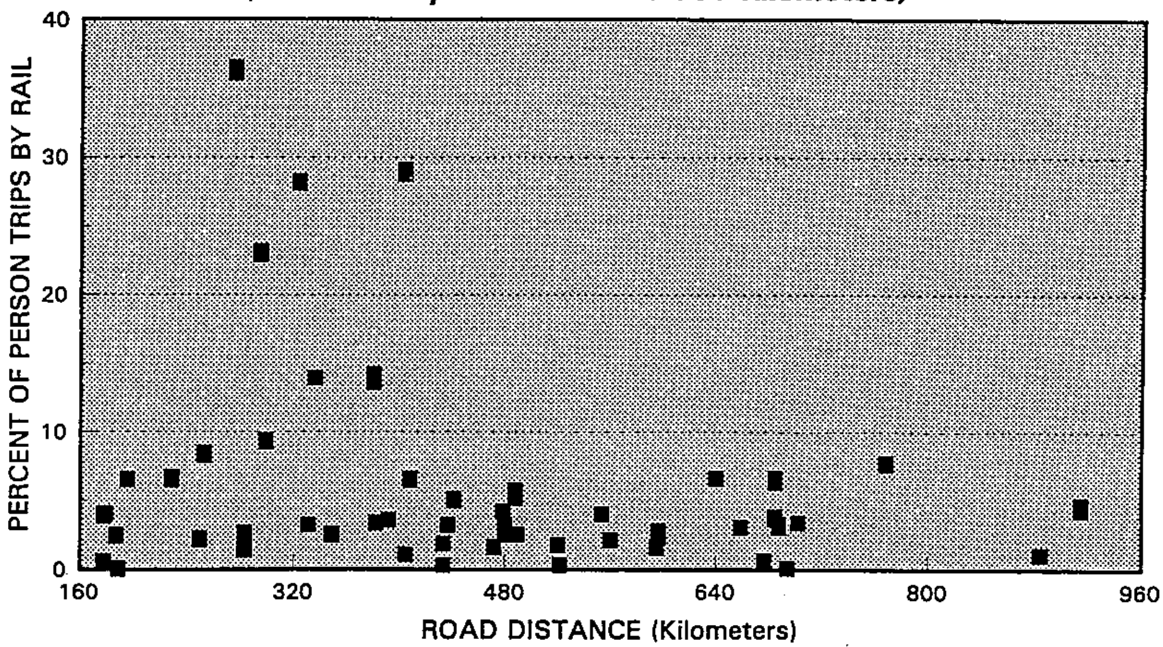
$$F = \$15 - \$0.0078 \times K$$

where F = one-way rail fare per 100 km of travel, and
K = distance between origin and destination cities, in kilometers.

A review of scheduled arrival and departure times indicates a range of effective travel speeds from 21 to 133 km/h (13 to 83 mph). No relationship was found between effective speed and distance. Over the range of distances up to 960 km (600 miles) the average effective speed of rail travel was approximately 80 km/h (50 mph).

Exhibit 3-19
INTER-CITY RAIL MODAL SPLIT

(Excludes trips shorter than 160 Kilometers)



(Excludes trips shorter than 100 miles)

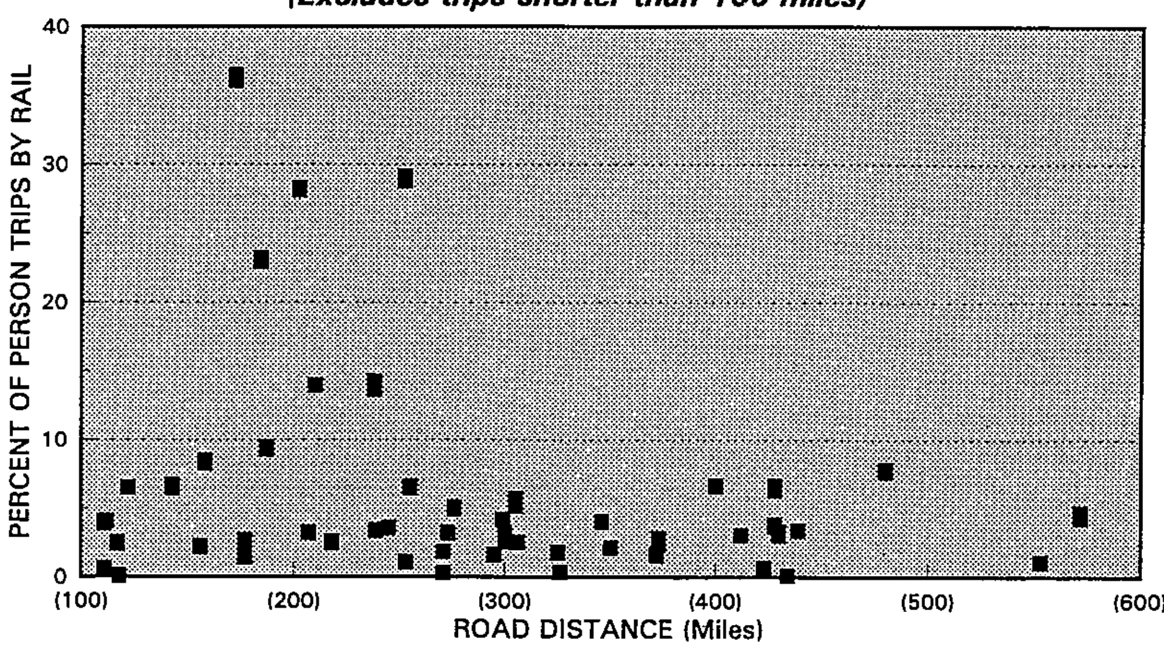
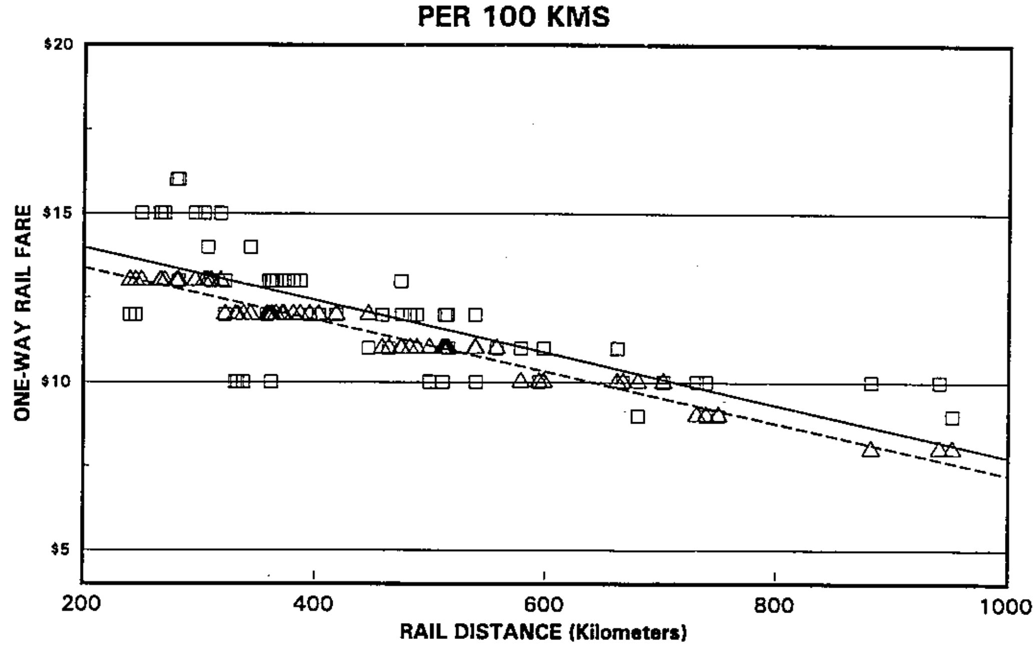
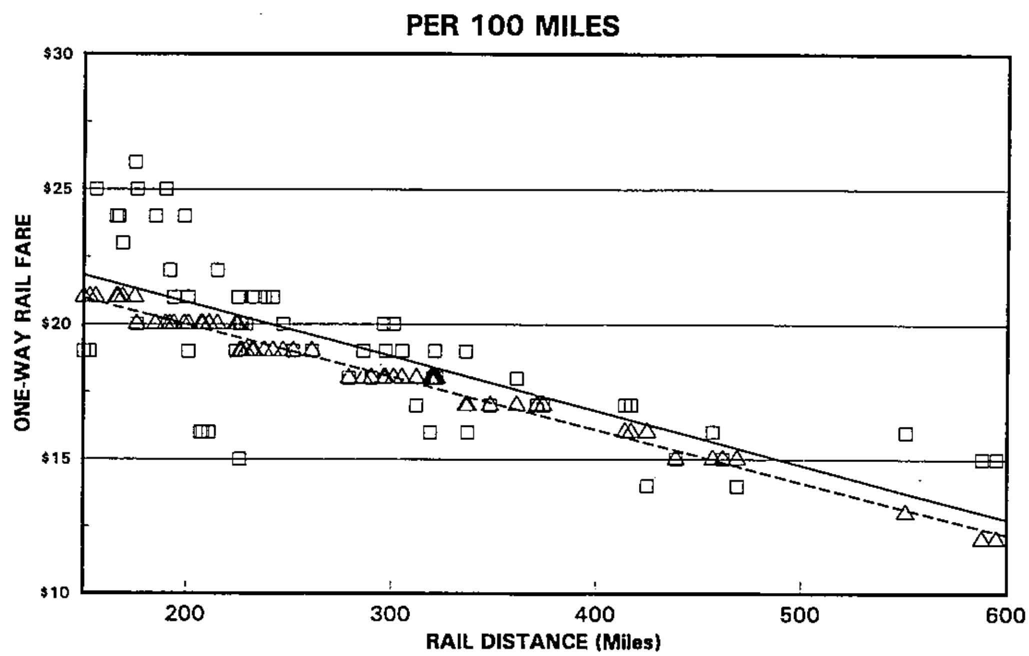


Exhibit 3-20

AVERAGE RAIL FARE





FREIGHT TRANSPORTATION

If a new transcontinental corridor were to reduce the total cost of shipping/receiving cargo in the U.S., the chief beneficiary would be the U.S. (and the corridor's) economy. Total cost, in this sense, includes the cost of carrying and handling the cargo, the time involved, and delivery reliability (the total cost of the total physical distribution process).

Certain technology types (conventional Interstate Highway, conventional or even high-speed rail, or even an advanced new highway system) could carry both passengers and freight. Alternatively, the corridor could include a separate, advanced, cargo-oriented facility. In either case, the freight industry, and therefore the economy, would benefit.

RATIONALE FOR FREIGHT CONSIDERATION

It is important that freight needs and opportunities be recognized in the evaluation of the transcontinental corridor simply because freight transportation plays such an important role in serving the U.S. (and the corridor's) economy.

The Nation's Freight Bill

In 1990, the U.S. freight bill was $349.7 billion, and constituted 6.4 percent of the U.S. GNP, as shown in Exhibit 3-21.

Exhibit 3-21
U.S. TRANSPORTATION OUTLAYS
($ Billion)

	1960	1970	1980	1990
Freight Transport	$47.8	$84.0	$213.4	$349.7
Passenger Transport	60.5	114.3	338.1	621.6
GNP	515.3	1,015.5	2,732.0	5,465.1
Freight % of GNP	9.3%	8.3%	7.8%	6.4%

These statistics suggest that a transcontinental corridor that creates efficiencies in the movement of goods might be as important to the economy as similar efficiencies in the transport of people. The statistics also suggest that freight efficiencies are occurring, at a considerable rate, given freight transportation's declining share of the nation's GNP.

Over three fourths of the U.S. freight bill is spent on trucking, as shown on Exhibit 3-22.

Exhibit 3-22
U.S. FREIGHT BY MODE
($ Billion)

	1960	1970	1980	1990
Trucking	$32.2	$63.4	$155.1	$272.4
Bus	.04	.12	.24	.17
Rail	9.0	11.9	27.9	30.4
Water	3.5	5.3	15.5	20.7
Oil Pipeline	.9	1.4	7.5	8.4
Air	.3	1.2	4.0	13.7
Other Costs	1.8	.7	3.2	3.9
TOTAL	$47.8	$84.0	$213.4	$349.7

Clearly, if a new transcontinental corridor could save as little as 1 or 2 percent of trucking costs, the savings could be several billion dollars annually.

U.S. National Cargo Trends

In terms of capturing a significant share of the freight market, the transcontinental corridor would have to help the trucking and/or rail modes to be completely effective, although it could connect with the seaports and riverports, and could conceivably include a liquid or dry bulk or even a new type of pipeline. Exhibit 3-23 presents the domestic traffic shares for each of these modes.

Other Freight Industry Characteristics Nationally

To put the proper perspective on freight transportation and its potential, a number of other national freight industry statistics are presented.

To be effective, a transcontinental corridor will have to be more direct, and/or faster, and/or cheaper. The cost to the consignee typically dominates most freight decisions. Exhibit 3-24 summarizes average carrier revenues per ton-km with which the transcontinental corridor would compete.

Exhibit 3-23
DOMESTIC INTERCITY TON-KILOMETERS BY MODE
(Billion Annual Ton-Km)[Billion Annual Ton-Miles]

	1960		1970		1980		1990	
Trucking	416	[285]	601	[412]	810	[555]	1,072	[1,072]
Rail	845	[579]	1,125	[771]	1,360	[932]	1,563	[1,071]
Water	694	[476]	991	[679]	1,514	[1,038]	1,360	[932]
Oil Pipeline	334	[229]	629	[431]	858	[588]	988	[677]
Air	1	[1]	4	[3]	7	[5]	15	[10]
TOTAL	2,290	[1,570]	3,350	[2,296]	4,549	[3,118]	4,998	[3,325]

Exhibit 3-24
AVERAGE CARRIER REVENUE PER TON-KM
(1989)

	DOLLARS PER:	
	Ton-KM	Ton-Mile
Rail (Class I)	$ 1.83	$ 2.67
Truck (Class I)	16.02	23.37
Domestic Air	33.29	48.57
Oil Pipeline	0.91	1.33
Barge	0.52	0.76

If the transcontinental corridor is a conventional highway, it will function as a freight corridor just as the existing Interstate Highways function. If, however, a more advanced system is to be developed, that system will likely have to be faster, and more efficient (larger, heavier vehicles?). Due to its nature, it likely will serve long-distance movements of 500 or more miles per trip. Exhibit 3-25 summarizes average length of haul for existing interstate freight movements.

Freight Industry Interest in the Transcontinental Highway

To be used, and to be effective, the transcontinental corridor must offer characteristics that are not currently in existence. These characteristics must be sufficiently significant to influence the mode choice and route and even the ship/no ship decision process. This, in effect, is how the

Exhibit 3-25
DOMESTIC INTERSTATE LENGTH OF HAUL
(1989)

	AVERAGE HAUL LENGTH	
	Km	Miles
LTL Trucks	898	558
Truckload Trucks	386	240
Railroads	927	576
Air Carrier	2,000	1,243
Rivers/Canals	737	458
Great Lakes	853	530

corridor will be assessed from the freight transportation perspective.

Each transcontinental option will be assessed in accordance with four criteria which dominate the freight decision process: 1) cost, 2) transit time, 3) reliability, and 4) directness.

1. **Cost** - For some shipments, the rate paid is the dominant criterion. For these shipments, the shipper/receiver is not willing to pay much, or at all, to receive faster service. In this sense, the corridor must be cost competitive (for most shipments) with the existing modes and corridors.

2. **Transit Time** - For some shipments, total transit time is important, and sometimes critical. This criterion varies a great deal from cargo type to cargo type. Likely the new system will have to be faster than the existing systems.

3. **Reliability** - For some shipments, knowing when it will be picked up and/or delivered is more important than how fast the shipment moves.

4. **Directness** - Some movements, especially by truck, are priced based on distance. For these, the corridor must create the most direct route, if it is to be competitive.

These are examples of the criteria that will be used to evaluate the corridor concepts, and the corridor routes, from the freight transportation perspective.

RAIL FREIGHT SYSTEMS

All of the country's major railroads operate within the corridor, although no one carrier operates the entire length of the corridor. In fact, there are not any transcontinental railroads in the U.S.

Corridor Rail System

The rail network in the corridor, delineated on Exhibit 3-26, is, for all practical purposes, divided into two distinct systems at the Mississippi River, the traditional railroad dividing line between east and west. Modern railroad mergers have crossed this barrier in places, but corridor cities such as St. Louis and Memphis are still functioning as "gateways."

<u>Eastern Railroads</u> - The corridor east of the Mississippi is served by all three major eastern railroads -- Conrail, CSX Transportation, and Norfolk Southern. Conrail is more or less confined within the northern portion of the corridor, while the other two are spread across all of it. These railroads, however, tend to have more of a north-south orientation than the western carriers. Although all of the carriers connect with the gateways in the corridor, there does not appear to be that much traffic flowing east-west at these points.

<u>Western Railroads</u> - As in the case of the east, all of the major western railroads are represented in the corridor, but not all of them, for example, serve all of the western portion of the corridor. The railroads pretty much run through the middle of the corridor through Missouri and Kansas to Colorado where they split and run along the north-south corridor boundaries. The Santa Fe, Union Pacific and Southern Pacific do the best job serving the western portion of the corridor from east to west.

<u>Railroad Mileage</u> - In total, 62,202 route-km (41,145 route-miles) of rail line exist in the corridor.

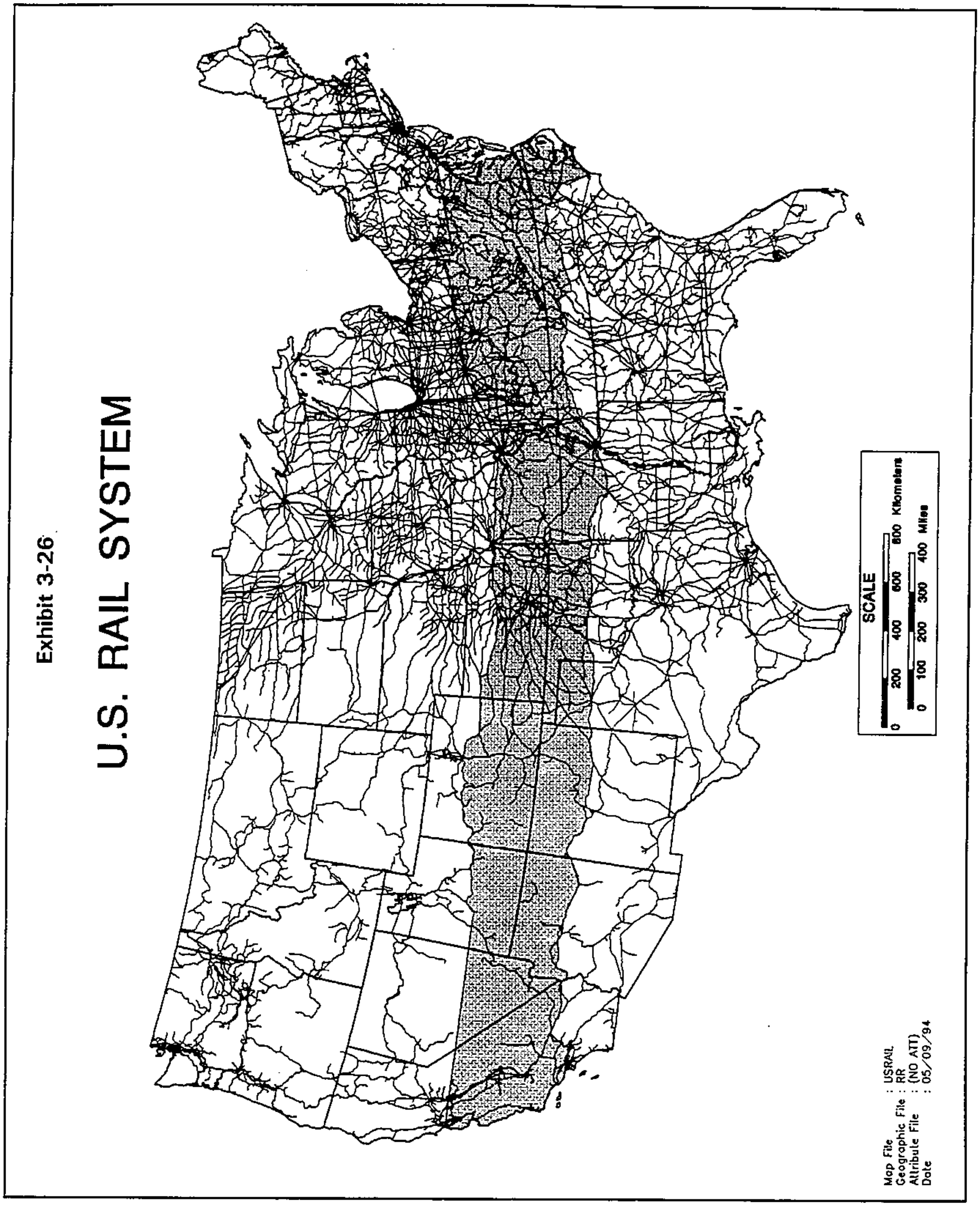


Exhibit 3-26
U.S. RAIL SYSTEM
SCALE
0 200 400 600 800 Kilometers
0 100 200 300 400 Miles
Map File : USRAIL
Geographic File : RR
Attribute File : (NO ATT)
Date : 05/09/94

Recent Railroad Actions

Railroad merger and bankruptcy actions have changed some of the traditional railroad traffic patterns. These actions have extended the service territories of most of the remaining major railroads.

Western Railroads - As discussed earlier, there are four major rail carriers left in the western (west of the Mississippi) portion of the U.S. (and the corridor). The composition of existing carriers, except for the Santa Fe, are the result of mergers, trackage rights obtained from merger settlements, and trackage or trackage rights obtained through bankruptcies.

The merger of the Missouri Pacific, Union Pacific and Western Pacific into the Union Pacific provides single-line service from the Mississippi River gateways of St. Louis and Memphis to San Francisco and Los Angeles. Chicago is reached from St. Louis although the Union Pacific routes its tonnage to Chicago via the Chicago and North Western from Fremont and Omaha, Nebraska. The Santa Fe has always had single-line service from Chicago to Los Angeles comprised of the shortest and fastest route via Kansas City and Amarillo. It also has a route to St. Louis, now, which was absent until this year.

The Burlington Northern, comprised of five former major railroads provides single-line service from Chicago to the Pacific Northwest, and from Chicago and the Pacific Northwest to the Gulf Coast in Florida and Texas. The route into Florida crosses the traditional Mississippi River east-west gateways providing direct connections with southern railroads in Birmingham, Alabama and Pensacola, Florida.

Southern Pacific Lines, comprised of the Southern Pacific Transportation Company, the Denver and Rio Grande Western Railroad and the St. Louis Southwestern Railway, also now provides direct Chicago-California service. The SP picked up the former Rock Island Tucumcari, New Mexico to Kansas City line upon that carrier's bankruptcy. The Rio Grande obtained trackage rights from Pueblo, Colorado to Kansas City in the Union Pacific merger, and the recently acquired St. Louis to Chicago line (from another bankruptcy -- Chicago, Missouri and Western) completed the route.

<u>Eastern Railroads</u> - The three major eastern railroads are all the result of mergers and bankruptcies. Conrail was formed from the remnants of the northeast bankruptcies, i.e., Penn Central, et.al. CSX Transportation combined railroads of the southeast with the northeast (Seaboard and Chessie Systems -- themselves comprised of merged carriers). The Norfolk Southern Railway is a merger of the former Southern Railway and Norfolk and Western Railroad. It too serves both the northeast and southeast crossing the traditional Potomac River gateway.

Principal Main Lines

The rail system in the U.S. is comprised of rail lines of different functions just as is the roadway system. The branch lines, often referenced as light density lines because of their low traffic levels, provide local service and feed traffic to the busier lines. Following are the secondary main and the principal main lines which are more oriented to moving traffic, but still perform the gathering function.

Between 1975 and 1981, planners for the Military Traffic Management Command delineated a core system of railroad main lines considered important to the national defense -- the Strategic Rail Corridor Network (STRACNET). The system, shown on Exhibit 3-27, connects military installations, defense industries, major population centers, and seaports and airports of embarkation. Of prime importance are track condition and clearances, particularly the ability to handle oversize loads. The system is constantly monitored by the Department of Defense and the Federal Railroad Administration's Office of Safety. The STRACNET system is one version of a core rail system which could be considered comparable to the Interstate Highway System.

Intermodal

A growing percentage of rail business is comprised of intermodal traffic -- trailer on flatcar (TOFC) or container on flatcar (COFC). This form or transport has currently come to the forefront with the operation of double-stack equipment.

<u>1990 Intermodal Traffic</u> - Based on the project traffic database, 83.4 million metric tons (91.9 million tons) of rail traffic nationwide in 1990 was attributed to intermodal movements. This volume represented six percent of total rail tonnage for the year. This proportion compares with just over five percent of the rail tonnage for the Bureau

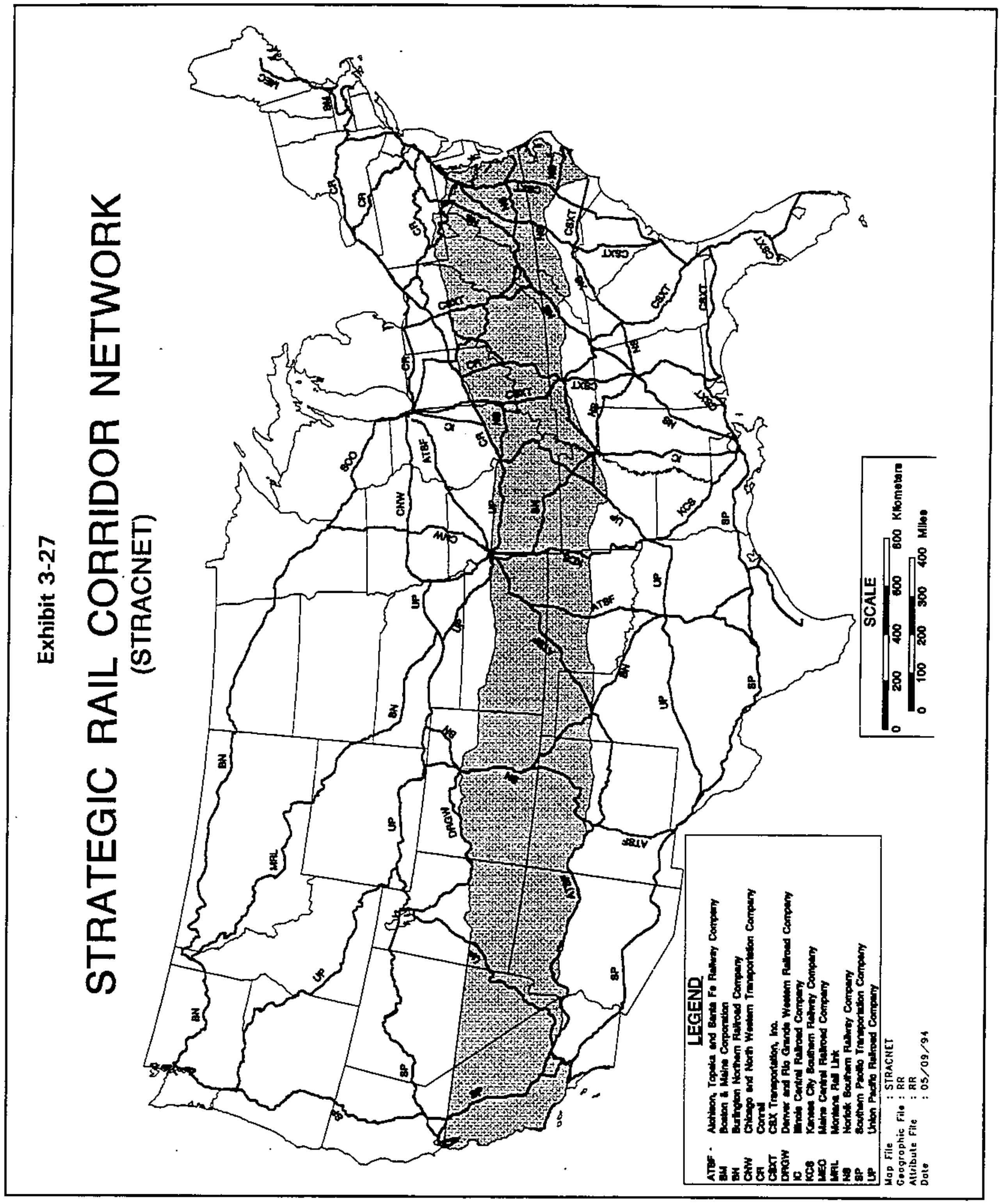


Exhibit 3-27
STRATEGIC RAIL CORRIDOR NETWORK
(STRACNET)
LEGEND
ATBF - Atchison, Topeka and Santa Fe Railway Company
BM Boston & Maine Corporation
BN Burlington Northern Railroad Company
CNW Chicago and North Western Transportation Company
CR Conrail
CSXT CSX Transportation, Inc.
DRGW Denver and Rio Grande Western Railroad Company
IC Illinois Central Railroad Company
KCS Kansas City Southern Railway Company
MEC Maine Central Railroad Company
MRL Montana Rail Link
NS Norfolk Southern Railway Company
SP Southern Pacific Transportation Company
UP Union Pacific Railroad Company
Map File : STRACNET
Geographic File : RR
Attribute File : RR
Date : 05/09/94
SCALE
0 200 400 600 800 Kilometers
0 100 200 300 400 Miles

of Economic Analysis Economic Areas (BEAs) located in the corridor.

An examination of corridor intermodal tonnage by BEA reveals that five BEA's are by far the largest generators of intermodal traffic -- San Francisco, Los Angeles, Denver, St. Louis and Kansas City. Baltimore is the largest on the east coast, but only accounts for about seven percent of that of the Los Angeles BEA.

Priority Rail Movements - Most intermodal movements are treated as priority traffic by the railroads. Probably the quickest schedule for Chicago-Los Angeles movement (the principal intermodal lane in the country) was that of Santa Fe's former Super C intermodal train. The late '60's-early '70's premium service was scheduled for 40 hours each way between the two cities. Test runs for the train established the Chicago-Los Angeles record at 34 hours, 35 minutes.

A recent study conducted for the Federal Railroad and Maritime Administrations[1] revealed the fastest long-distance intermodal schedules in the west now call for average speeds of 64 km/h (40 mph), equivalent to a 56-hour schedule, along the same Chicago-Los Angeles route.

Double-Stack Movement - The latest development in railroad intermodal traffic is the use of equipment permitting one container to be stacked on top of another permitting the transport of two containers in the place of one on conventional equipment. These movements were initiated by the steamship lines for the transportation of marine containers in various landbridge services. The corridor ports of Long Beach and Los Angeles, as shown later, are the largest originators of this service, as well as conventional intermodal traffic, in the county.

MOTOR CARRIERS

Motor carriers (or trucking companies) are a major provider of freight transportation in the United States. They operate over the public highway system, as opposed to railroads which own and maintain the infrastructure over which

[1] *Double Stack Container Systems: Implications for U.S. Railroads and Ports*, prepared for the Federal Railroad Administration and the Maritime Administration of the U.S. Department of Transportation by Manalytics, Inc., June, 1990.

they operate. Trucking services are provided by a variety of carrier types.

Carrier Types

Motor carriage is provided by public or common carriers[2] as well as private carriers, and within these broad categories, there are many different types of companies and services. The Motor Carrier Act of 1980 which deregulated entry into the business also essentially removed any legal distinction between the types of carriage, but customer need for a variety of services has retained the classifications functionally.

Common Carriage - Common carriage is usually divided into less-than- truckload (LTL) and truckload (TL) operations. The former collects small quantities of freight and combines it into truckload lots for over-the-road movement. Thus, LTL operations require a system of terminals and pickup and delivery services as well as line-haul transport. Truckload carriers, on the other hand, can move directly from the shipper's dock to the consignee's dock without involving a terminal.

Contract Carriage - Businesses with sizeable volumes of TL shipments, would be subject to lower freight rates from a contract carrier than a common carrier used principally by shippers with less frequent demand.

Private Carriage - Private carriage, or carriage by the businesses shipping or receiving the freight, has been employed by some companies for a variety of reasons -- financial, control of shipments, etc. This means of carriage was enhanced by the Motor Carrier Act of 1980 which permitted private carriers to engage in for-hire operations. This eliminated a lot of empty backhauls.

Exempt Carriage - This segment of the trucking industry, engaged in the transport of exempt commodities such as agricultural products, has always been unregulated.

Specialty Carriers - There are a number of carriers who specialize in different types of motor transport. These carriers are typically engaged in transport of liquid bulk

2 A common carrier holds itself out to the general public to transport property and passengers for compensation.

(tankers) or dry bulk commodities, refrigerated products, or products requiring flatbed trailers.

Truck Sizes

As mentioned under specialty carriers, there are a variety of truck (trailer) types designed to fit particular commodities transported over the nation's highways. These are a variety of sizes as well. Although trucks perform a number of functions ranging from local delivery to coast-to-coast transport, this report focuses on over-the-road commodity movement.

Trailer Size and Number - The size of truck trailers has continued to grow over time. The standard 12.1-m (40-foot) trailer became 13.7 m (45 feet) long, then 14.6 m (48 feet), and now 16.1 m (53 feet). The heights and widths have also grown over time as the desire to increase capacity has continued.

Increasing the number of trailers which can be pulled by a tractor is another means of increasing truck capacity. These longer combination vehicles (LCVs) are very controversial given public concerns about safety and competitors concerned with increased productivity in the trucking industry. Concerned are twin 13.7 to 14.6-m (45 to 48-foot) trailers commonly called turnpike doubles, triple 7.9 to 8.8-m (26 to 29-foot) trailers (triple combinations) and Rocky Mountain doubles (one 13.7 to 14.6-m [45 to 48-foot] trailer operated with a 7.9 to 8.8-m [26 to 29-foot] trailer). Some form of LCV is permissible in eight of the corridor states: Ohio, Indiana, Kansas, Oklahoma, Colorado, Arizona, Utah and Nevada.

Weights - Along with increased size, higher allowable weights in excess of the typical single-trailer 36,320 kg (80,000 lbs) would increase truck productivity. At present, weights vary by state and by vehicle combinations with some as high as 54,500 to 59,000 kg (120,000 to 130,000 lbs).

Transit Times

Over-the-road trucks are operated by single drivers or two-person driver teams. The latter with a relay driver permits the fastest motor carrier service as a single driver needs to stop for rest. Federal regulations permit a driver to operate a vehicle for a maximum of ten hours with an eight-hour rest period. Typically, 869 km (540 miles) are covered during the ten hours of vehicle operation.[3] The ten hours on and eight hours off traveling 869 km (540 miles) is equivalent to an overall operating speed of 48 km/h (30 mph). The two-man driver team would average 87 km/h (54 mph) for the same period.

PORTS AND WATERWAYS

Water transportation for the corridor is comprised of deepwater ports at both ends of the corridor on the Atlantic and Pacific Oceans as well as inland waterways and ports as shown on Exhibit 3-28. These port and waterway facilities not only contribute to the transportation infrastructure of the corridor, but also play a large role in corridor transportation as traffic generators.

Deepwater Ports

The corridor serves some of the major ports on both coasts. On the Pacific coast, the San Francisco-Oakland, Los Angeles-Long Beach complexes anchor the northern and southern boundaries of the corridor, respectively. Tonnages passing through these ports are some of the largest in the country.

On the east or Atlantic coast, the corridor serves the principal ports of Baltimore, Hampton Roads and Wilmington, NC. The first two lie at the northern limits of the corridor, while Wilmington anchors the southern extreme. The first two ports (the Hampton Roads complex includes the ports of Norfolk, Portsmouth and Newport News) are by far the largest.

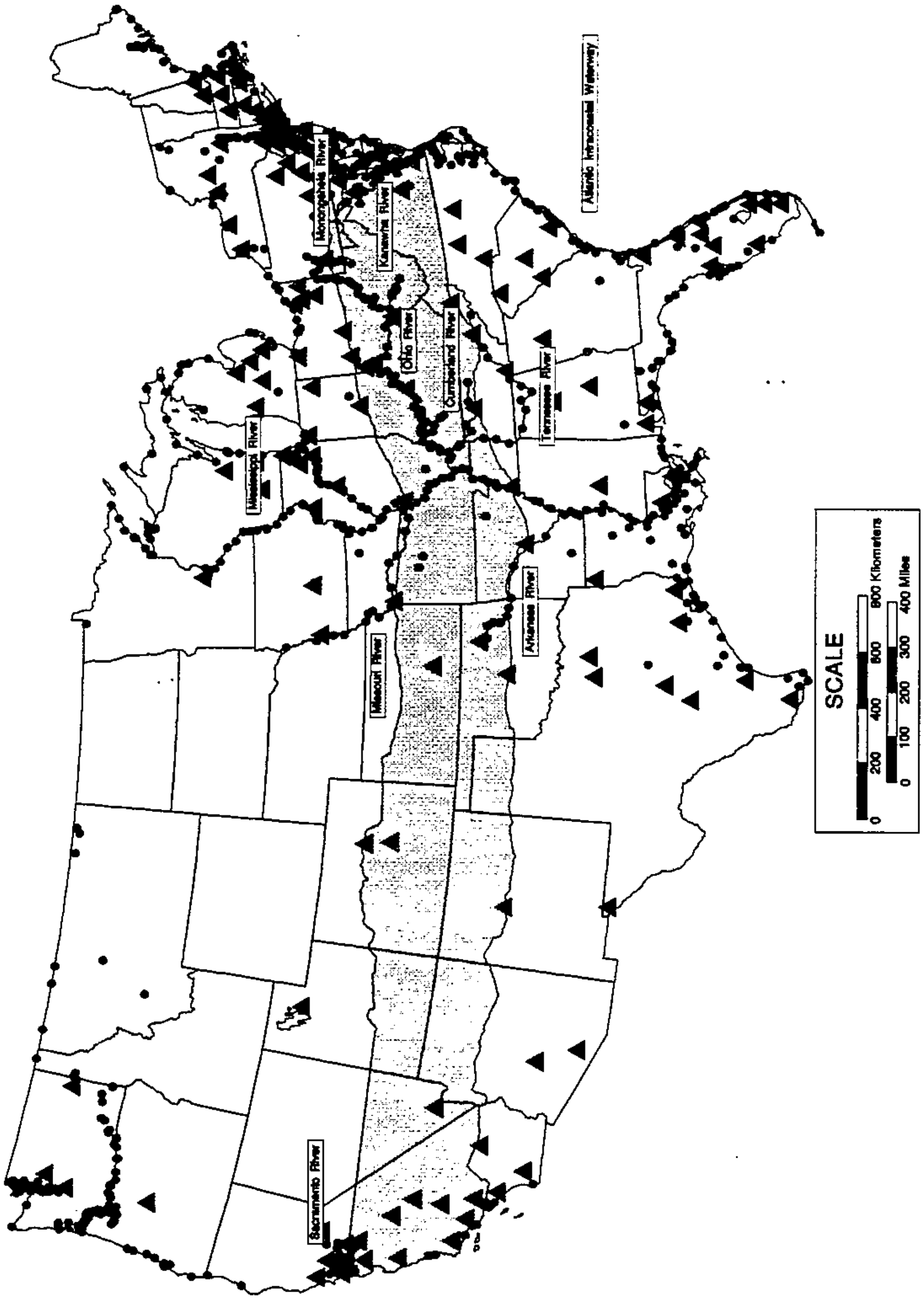
<u>Cargo Types</u> - Cargo moving through deepwater ports is of three basic types: containerized, breakbulk, and bulk. Containerized cargo is that which is carried aboard ship in metal containers measuring 6.1, 12.2 or 13.7 m (20, 40, or 45 feet) in length. Breakbulk refers to cargo which is carried aboard ship in "loose" form, as for instance newsprint, or wire rod, or telephone poles. Bulk cargo is typically carried by specialized vessels able to hold massive amounts of granular or liquid commodity.

Containerization of both ocean and domestic freight continues to grow and is becoming the shipping technology of choice. Although it still represents only a small portion of the total tonnage of some ports, it includes the high-value

[3] Manalytics, Inc., p. 49.

Exhibit 3-28

PORTS AND WATERWAYS



manufactured and agricultural production components of waterborne trade.

Foreign Commerce - In terms of imports and exports, the total volume moving through U.S. ports in 1991 was 850.7 million metric tons (937.9 million tons). Of this total, the major corridor ports[4] handled 134 million metric tons (147 million tons) as shown in Exhibit 3-29, with the largest volume in the country passing through Hampton Roads. Exhibit 3-29 also depicts the value of the imports/exports handled. In this case the ports of Long Beach and Los Angeles rank first and third in the country although their volumes are considerably less than higher tonnage ports. This is indicative of the high proportion of containers handled.

Exhibit 3-29
CORRIDOR PORTS
WATERBORNE FOREIGN COMMERCE
(1991)

PORT	TONNAGE			VALUE	
	Metric Tons (000)	Tons (000)	National Rank	Dollars ($ million)	National Rank
Hampton Roads	65,264	71,956	1	$19,174	7
Baltimore	21,689	23,913	12	16,604	9
Long Beach	23,693	26,122	8	48,863	3
Los Angeles	22,885	25,231	9	57,375	1
TOTALS	133,531	147,222		$142,016	

SOURCE: U.S. Bureau of the Census, compiled by the American Association of Port Authorities

Based on data current through July, 1992,[5] Los Angeles is the largest container port in the country, followed by Long Beach as number two. Oakland would rank number four and San Francisco number 15. These four California ports combined handled over one third (37 percent) of the 1992 international container traffic as of that date. The corridor's

4 Hampton Roads, Baltimore, Long Beach, Los Angeles.

5 Port Import Export Reporting Service (PIERS).

east coast ports were led by Norfolk and Baltimore ranked number 11 and 12, respectively, followed by Portsmouth, Virginia (number 14) and Wilmington, NC (number 21). In all, the east coast ports, including Richmond, Newport News and Wilmington, Delaware, accounted for almost 10 percent of the U.S. total. Thus, almost one half of the nations containerized import-export traffic moves through corridor ports.

Inland Waterways

A number of inland waterways also exist in the corridor. As seen on Exhibit 3-28, only the Sacramento River provides inland transportation in the western portion of the corridor. Traveling east, the main waterway is the Mississippi with a variety of other waterways feeding into it, the largest being the Ohio running from Pittsburgh to Cairo. The Atlantic Intercoastal Waterway runs up and down the Atlantic coast line.

Types of Commodities - Due to the slow speed of inland waterway travel, the waterways are used principally for the movement of heavy, bulk commodities which are not time sensitive such as coal, petroleum, chemicals, construction materials and grain.

Transport by Waterway System - Data from the Army Corps of Engineers for 1989 indicate that 365.6 billion ton-km (250.6 billion ton-miles) of transportation were generated on the inland waterway system. Transportation on corridor waterways totaled 259.1 billion ton-km (177.6 billion ton-miles) (Exhibit 3-30), or 71 percent of the national total. Exhibit 3-30 also reveals use of the inland waterway system is dominated by the Mississippi River.

AIR CARGO

The movement of freight by air is different from the other modes in two respects -- tonnage and speed. While the other modes move 18.1 metric tons (20+ tons) per trailer, 90.7 metric tons (100 tons) per rail freight car, 1,361 metric tons (1,500 tons) per barge, air cargo shipments tend to be much smaller. There is an 2.4x2.4x6.1-m (8x8x20-foot) air-surface intermodal container (lighter than the marine container of the same size), but most air freight containers tend to be much smaller than that. The small freight capacity, relative to the other modes, and the speed of transport, place typical air cargo in the premium transport category.

Exhibit 3-30
CORRIDOR WATERWAY FREIGHT TRANSPORTATION
(1989)

WATERWAY	TON-KM (millions)	TON-MILES (millions)	NATIONAL RANK
Mississippi (Ohio River-Baton Rouge)	164,732	112,908	1
Ohio	75,279	51,596	2
Tennessee	9,501	6,512	8
Arkansas System (McClellan-Kerr)	2,610	1,789	9
Monogahela	2,224	1,524	10
Kanawha	1,853	1,270	12
Cumberland	1,773	1,215	13
Missouri	1,163	797	14
Atlantic intracoastal Waterway	673	461	19
TOTAL	259,808	178,072	

SOURCE: Army Corps of Engineers.

National Portion

As stated above, the value of air transportation is not a function of tonnage. The air industry transported only 0.03 percent (approximately 1.8 million metric tons [2 million tons]) of the total freight in the United States in 1990 based on the project data source. Instead, the nature of the air transportation promotes the carriage of low-bulk, high-priced goods.

The air freight traffic in the TTC displays the same characteristics as national traffic, with 0.03 percent of total freight tonnage in the corridor transported by air. The statistics do show, however, that approximately one third (34.7 percent) of all air freight originations and terminations in the U.S. occur in the corridor (Exhibit 3-31). Los Angeles and San Francisco are the two largest areas, with St. Louis, Washington, D.C., and Denver following close behind. The Los Angeles area is responsible for approximately 10 percent of the total inbound and outbound air freight movements in the United States.

Corridor Tonnages

The breakdown of air cargo traffic within the TTC indicates that the majority of traffic begins and ends at a small number of locations. Approximately one third (30.8%) of all inbound and outbound traffic in the corridor is attributable to the Los Angeles area (Exhibit 3-32). San Francisco, St. Louis, Washington, D.C., and Denver round out the top

Exhibit 3-31
CORRIDOR AIR CARGO AS A PERCENT OF TOTAL AIR FREIGHT

BEA	PERCENTAGE OF NATIONAL TONNAGE	
	Inbound	Outbound
Los Angeles	10.4	10.9
San Francisco	3.6	8.7
St. Louis	3.1	2.0
Washington, DC	2.4	1.9
Denver	1.6	2.6
Phoenix	1.4	1.5
Kansas City	1.6	.3
Baltimore	1.2	.7
Louisville	1.3	.4
Charlotte	.5	1.1
CORRIDOR TOTALS	33.7	35.6

SOURCE: Reebie Associates, compiled by Wilbur Smith Associates

five. Together, the top five airports carry over two thirds (67.9%) of the freight tonnage in the study corridor.

Exhibit 3-32
CORRIDOR AIR CARGO CHARACTERISTICS

BEA	INBOUND			OUTBOUND		
	Metric Tons	Tons	Percent of Total	Metric Tons	Tons	Percent of Total
Los Angeles	169,316	186,677	30.9	177,259	195,434	30.6
San Francisco	57,738	63,658	10.5	140,999	155,456	24.3
St. Louis	49,900	55,017	9.1	32,944	36,322	5.7
Washington, DC	38,674	42,640	7.1	30,852	34,015	5.3
Denver	26,577	29,302	4.9	41,714	45,991	7.2
Phoenix	23,146	25,519	4.2	23,662	26,088	4.1
Kansas City	25,586	28,209	4.7	5,543	6,111	1.0
Charlotte	8,440	9,305	1.5	18,606	20,514	3.2

SOURCE: Reebie Associates, compiled by Wilbur Smith Associates.

FREIGHT TRANSPORT DEMAND

As already mentioned, freight transport demand is high in the corridor. The following discussions reveal to just what extent from a variety of viewpoints.

National Transport Demand

Based on data[6] used in the preparation of this study effort, 1990 freight tonnage totaled almost 5.0 billion metric tons [5.5 billion tons] (5.437) nationwide. As evident from Exhibit 3-33, motor carriers transported the largest tonnage of any mode, almost one half of the total, with air transport accounting for very little as mentioned earlier. Rail tonnage followed truck tonnage accounting for just under one third of the total with water movement equating to just over 20 percent.

Exhibit 3-33
NATIONAL FREIGHT TRANSPORT
(1990)

MODE	TONNAGE (millions)		PERCENT OF TOTAL
	Metric Tons	Tons	
Rail	1,474	1,625	30
Truck	2,438	2,688	49
Air	2	2	--
Water	1,017	1,121	21
TOTAL	4,931	5,436	100

SOURCE: Reebie Associates.

In terms of commodities transported, coal comprised the largest tonnage moved in 1990, followed by clay, concrete, glass or stone products (predominately portland cement, concrete products and wet ready mix concrete along with processed non-metallic minerals). Other major commodities were food or kindred products, lumber or wood products, and petroleum or coal products.

A comparison of modal commodity movements revealed some major preferences for transport of certain commodities

6 Transearch by Reebie Associates. Excludes pipeline transport.

by selected modes. For example, rail is the preferred mode for the movement of farm products (60 percent), metallic ores (61 percent) and coal (67 percent). Crude petroleum or natural gas moves almost exclusively by water (98 percent), after excluding pipeline transport.

Corridor Freight Transportation

Transport within the corridor is very similar to that nationwide.

Total Transport by Mode - As shown in Exhibit 3-34, trucks handle about 47 percent of the inbound and outbound corridor freight traffic. Railroads terminate about 35 percent of the traffic while originating 34 percent. As in the case of the national statistics, air is insignificant in terms of tonnage, while water transport accounts for approximately one fifth of inbound and outbound traffic.

Exhibit 3-34
CORRIDOR INBOUND AND OUTBOUND
FREIGHT TRAFFIC BY MODE

	TRAFFIC					
	INBOUND			OUTBOUND		
MODE	Metric Tonnage (millions)	Tonnage (millions)	Percent of Total	Metric Tonnage (millions)	Tonnage (millions)	Percent of Total
Rail	588	648	35	581	641	34
Truck	804	887	47	805	888	47
Air	--	--	--	1	1	--
Water	300	331	18	324	357	19
TOTALS	1,692	1,865	100	1,711	1,887	100

SOURCE: Reebie Associates, compiled by Wilbur Smith Associates.

Transport by Region - Another view of transportation in the corridor by mode was obtained by breaking the corridor into three regions -- east, midwest and west -- using the Mississippi River and the Nebraska-Colorado border, respectively, as the dividing lines. As evident from Exhibit 3-35, inbound and outbound volumes in the east are approximately double those in the west with the midwest in between the two. The modal splits are also fairly close with the exception of the western region which reveals a greater use of motor carriers, with a corresponding decline in rail usage, than the other two.

Transport by BEA - Exhibits 3-36 and 3-37 depict freight tonnage originations (outbound) and terminations (inbound), respectively, by corridor BEA. Southern California, the Mississippi and Ohio River Corridors near St. Louis, Appalachia and the Pittsburgh area are the largest freight origination regions within the study corridor. The highest tonnage termination areas are Southern California and the St. Louis area.

Origin and Destination Pairs - Data have been ordered to determine traffic flows from one region to another.

Exhibit 3-35
CORRIDOR FREIGHT TRAFFIC BY REGION AND BY MODE

MODE	INBOUND TONNAGE (millions)		PERCENT OF TOTAL	OUTBOUND TONNAGE (millions)		PERCENT OF TOTAL
	Metric	Tons		Metric	Tons	
EAST REGION						
Rail	268	295	36	346	381	41
Truck	339	374	46	348	384	41
Air	--	--	--	--	--	--
Water	132	146	18	147	162	18
TOTALS	**739**	**815**	**100**	**841**	**927**	**100**
MIDWEST REGION						
Rail	223	246	41	172	190	31
Truck	239	264	44	246	271	45
Air	--	--	--	--	--	--
Water	84	93	15	133	147	24
TOTALS	**546**	**603**	**100**	**551**	**608**	**100**
WEST REGION						
Rail	96	106	24	63	70	20
Truck	227	250	56	211	233	68
Air	--	--	--	--	--	--
Water	83	92	20	44	49	14
TOTALS	**406**	**448**	**100**	**318**	**352**	**100**

SOURCE: Reebie Associates, compiled by Wilbur Smith Associates.

Exhibit 3-36

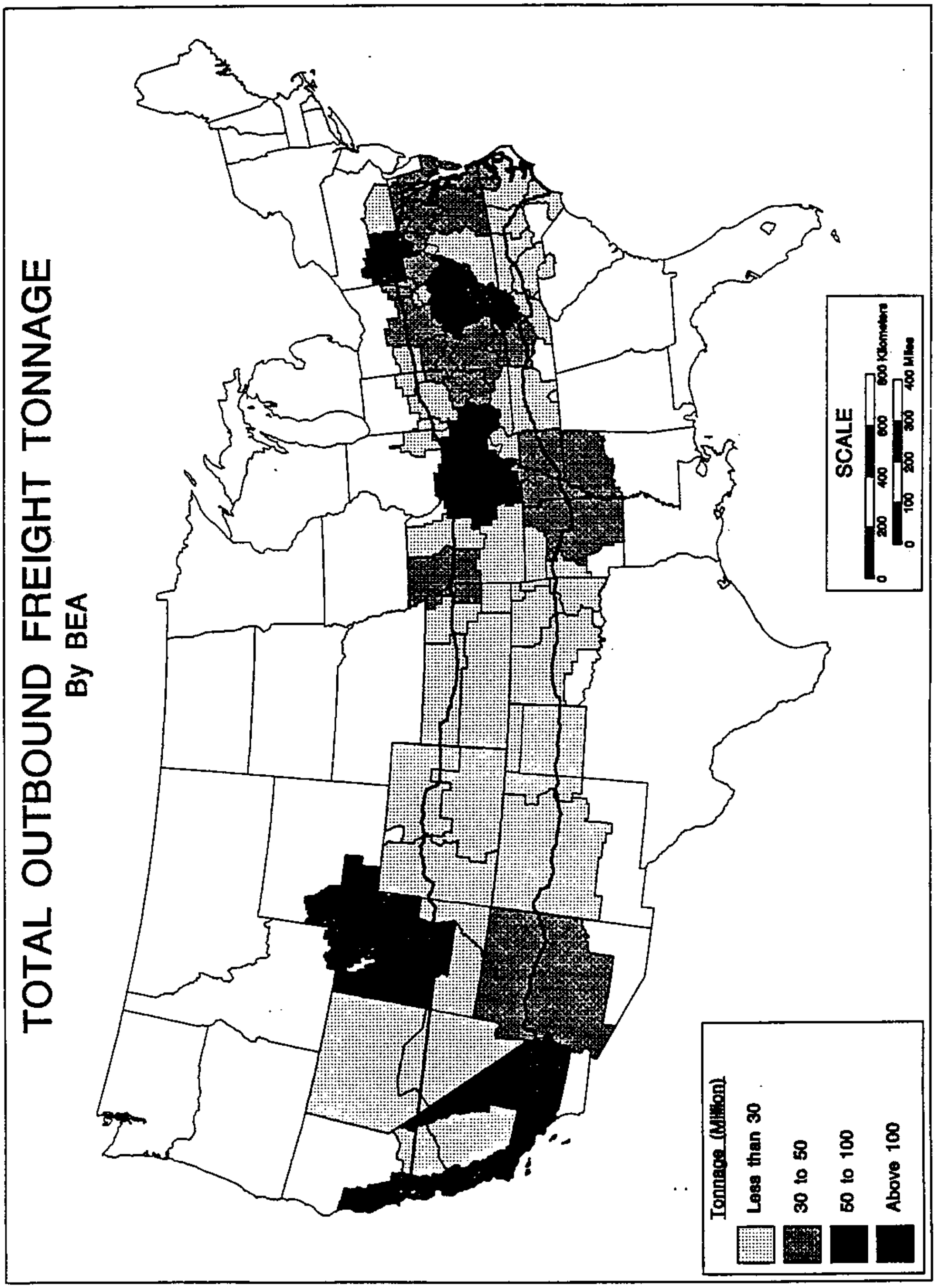
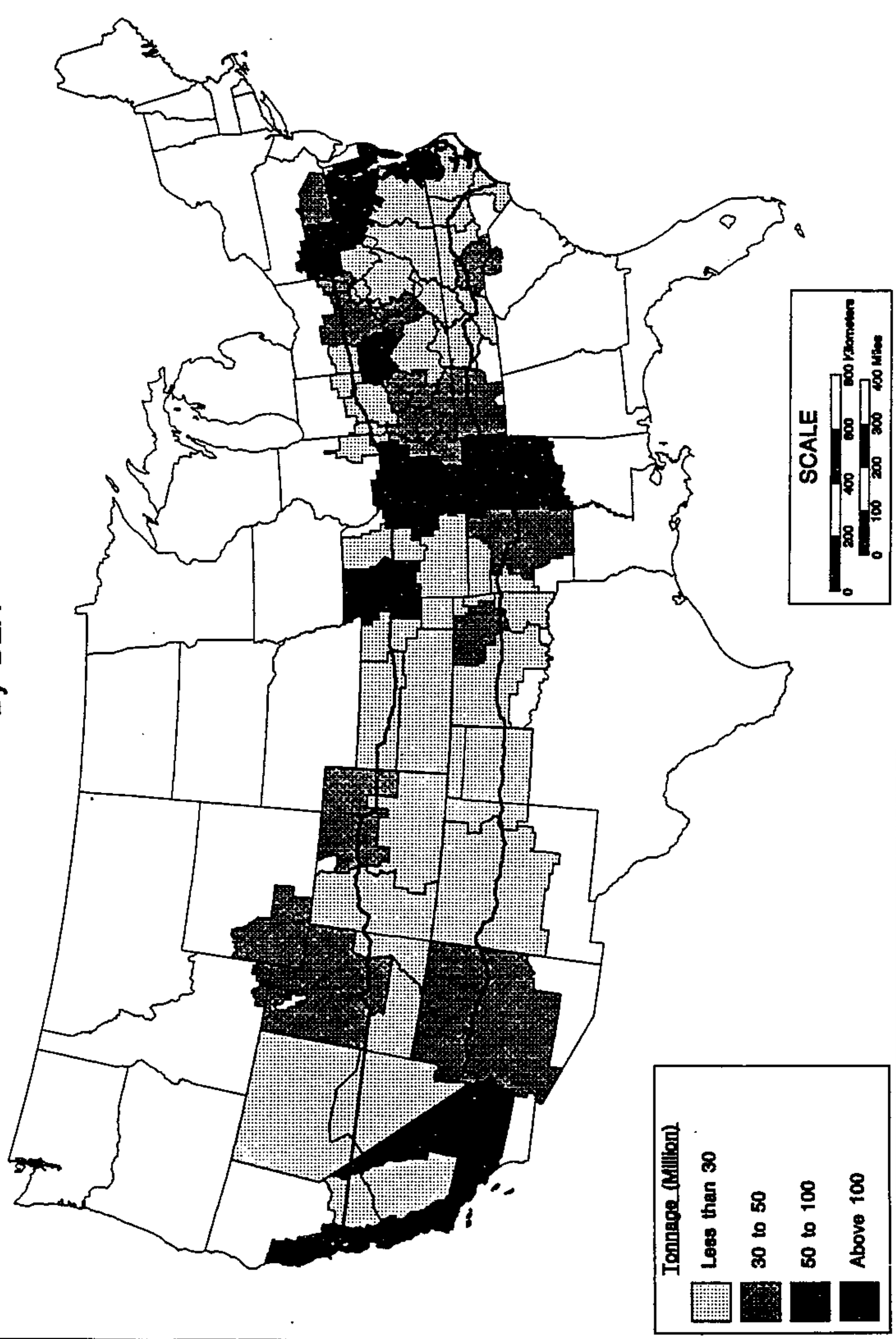

TOTAL OUTBOUND FREIGHT TONNAGE
By BEA
SCALE
0 200 400 600 800 Kilometers
0 100 200 300 400 Miles
Tonnage (Million)
Less than 30
30 to 50
50 to 100
Above 100

Exhibit 3-37

TOTAL INBOUND FREIGHT TONNAGE
By BEA



Chapter 4
21st CENTURY OPPORTUNITIES

This study of the Transamerica Transportation Corridor had a time horizon of 30 to 50 years in the future, i.e., the period of 2020 to 2040. Given this perspective, the Steering Committee decided that the study should consider not only a conventional interstate highway concept but also other concepts involving emerging transportation technologies. This chapter summarizes the analysis of transportation concepts which were studied.

POTENTIAL FUNCTIONS OF THE CORRIDOR

The prospective functions of a new transportation facility in the Transamerica Transportation Corridor should be consistent with national policy. As defined by the Intermodal Surface Transportation Efficiency Act (ISTEA), this policy is currently:

> *"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 people and goods in an energy efficient manner."*

Further, ISTEA declares that the National Highway System shall promote economic development; support international commerce; provide improved access to ports and airports; contribute to increased productivity; be adaptable to "intelligent vehicles," magnetic levitation systems and other new technologies wherever feasible and economical; and help implement national goals relating to mobility. If it is found to be feasible, the Transamerica Transportation Corridor would logically be a key element of this national system of the future. Indeed, the Transamerica Transportation Corridor was identified in ISTEA as one of 21 high priority corridors to be included in the National Highway System proposed to Congress in December 1993.

As the 19th Century saw a transformation of the nation's economic base and growth patterns as an outgrowth of the development of an extensive network of railroads, the 20th Century has seen another transformation based on development of the National System of Interstate and Defense Highways - the Interstate System. With the passing of ISTEA, Congress declared that the Interstate System authorizations contained therein "are the final authorizations of appropriations and apportionments for completion of construction of such system." Thus, completion of the Interstate System (as we know it) in this decade is a matter of national policy, and a new facility for the Transamerica Corridor needs to reflect a new vision for the 21st Century. This new vision can either incorporate concepts which can now be viewed as conventional or they can be dramatic and innovative departures from the past. Alternatives which are representative of both options were considered in this study.

The alternatives classified as departures from the conventional reflect opportunities offered by emerging new technologies, as well as changing needs and national priorities. Among the new technologies of relevance are those which comprise Intelligent Vehicle Highway Systems (IVHS) and those which enable the development of High Speed Ground Transportation (HSGT) guideway systems including, (but not limited to), magnetic levitation. The 21st Century vision upon which options for the Transamerica Transportation Corridor were based, includes (1) higher speeds for long-distance travel; (2) improved travel safety; (3) automation of at least some functions now performed manually; (4) increased efficiency in the use of land and energy resources; and (5) recognition of national goals defined in the ISTEA legislation.

Based on this generalized vision of the nation's transportation objectives, candidate concepts for a new facility in the Transamerica Transportation Corridor were defined to serve one or more of the following general service functions:

- Provision of conventional east-west interstate highway services for areas located between I-40 and I-70, the two existing interstate highways which delineate the Transamerica Transportation Corridor;

- Improved access to under-developed and/or economically depressed areas not presently served by modern transportation facilities linked effectively with the nation's interstate system;

- Removal of long-distance interstate through traffic from congested freeways in cities through which I-40 and I-70 pass (such as Albuquerque, Oklahoma City, Denver, Kansas City, St. Louis, Memphis, Nashville, Indianapolis, Knoxville, etc.) by providing transcontinental express services with connections to these major cities via feeder systems;

- Faster and safer inter-city highway travel for motorists, which might be provided by a "second generation" interstate highway designed for speeds in excess of 160 km/h (100 mph) and incorporating emerging intelligent vehicle highway system (IVHS) technologies. This second generation Interstate highway could be either a "super-service freeway" or an advanced design toll road with automated fee collection.

- New high speed fixed guideway (rail or maglev) ground transportation services for long-distance trips, which could be provided either by up-grading and interconnecting existing underutilized (or abandoned) rail lines and/or building new fixed guideway facilities within the rights-of-way of a new highway; or by building segments of a new fixed guideway system on separate rights-of-way. The objectives here would be to provide an effective and reliable ground transportation alternative to the auto and to air travel for east-west inter-city trips in the 300 - 1,300 km (200-800 mile) range, and to provide a high speed cross-country linkage between other high-speed rail systems currently planned or under development in California, Texas, Ohio, Missouri, the Southeast Corridor (Virginia, Georgia, the Carolinas and Florida), and the Northeast Corridor.

- Improved transportation facilities for cargo transport - by separate roadways designed to accommodate heavy and/or multiple-trailer trucks; special cargo vehicles for use in fixed guideway operations; IVHS applications of relevance to commercial vehicle operations; freight container pipelines; or other innovations in the development of a new system which emphasize freight transport efficiency.

- Service to recreation-oriented passenger travel in some segments of the corridor by providing a new facility which links urban areas with areas of scenic/tourist interest.

INTELLIGENT VEHICLE/ HIGHWAY SYSTEMS (IVHS)

A new highway in the Transamerica Transportation Corridor could (and probably should) incorporate emerging intelligent vehicle highway system (IVHS) technologies of various types and degrees of automation. IVHS refers to a broad range of systems based on sophisticated microelectronics and telecommunications, both in the vehicle and on the roadway. Some IVHS technologies are in practical use today or are in advanced stages of development and/or demonstration.

Of particular relevance to intercity travel in the 21st Century is the group of IVHS technologies which comprise Advanced Vehicle Control Systems (AVCS). The basic concept, as currently defined, is that AVCS vehicles would rely on in-vehicle and wayside substations to obtain information about their position relative to other vehicles and highway features to operate automatically and safely at speeds up to about 160 km/h (100 mph) (or higher eventually) and at closer headways than would be safe with manual operation. Research and development programs are underway involving electronically equipped vehicles which would operate on dedicated instrumented lanes. The vehicles would enter and leave these instrumented lanes under manual control but would be under systems control while in these lanes. One concept involves the electronic linking of vehicles with common destinations in platoons which are controlled to maintain safe spacing and speed. Still another concept under study would load the car onto an active guideway (an automated pallet) which would be controlled by the system.

A long-term strategic plan for the development and deployment of IVHS in the United States over the long term (20 years) has been prepared by IVHS America, an association of public and private sector agencies formed to advise the USDOT on IVHS matters and to promote IVHS development and deployment. The IVHS America strategic plan set as a goal the first fully automated roadway or test track by

1997 -- a very ambitious target. Other analysts have suggested that the full integration of AVCS systems to provide automated highways will require 15 to 30 years. In either case, the planning of any new highway for the Transamerica Transportation Corridor should anticipate the deployment of IVHS technologies to eventually include an Advanced Vehicle Control System during the 21st Century. The deployment of various other advanced technology systems would be incorporated into the construction of the new (or upgraded) highway even if it were built in the 1990s.

TRUCK TRANSPORTATION OPPORTUNITIES

Various research projects have been completed or are currently in progress which focus on truck size and weight issues relating to productivity, safety and cost trade-offs. The size and weight of truck trailers has continued to increase over time with the desire to increase capacity and unit productivity. Increasing the number of trailers which can be pulled by a tractor is another means of increasing truck capacity and productivity; longer combination vehicles (LCVs) are permitted on certain highways in eight of the Transamerica Transportation Corridor states (Ohio, Indiana, Kansas, Oklahoma, Colorado, Oregon, Utah and Nevada) and on various existing toll roads. Along with increased size, higher allowable weights in excess of the typical single trailer 36,500 kilograms (80,000 pounds) would increase truck productivity; weights up to 61,600 kilograms (135,000 pounds) are currently allowable for turnpike doubles in some states.

Recent research strongly suggests that a new Transamerica highway designed to accommodate LCVs would offer opportunities for greater productivity in the 21st Century if various concerns relating to the potential impacts of LCVs on other roads could be resolved. Although the operating costs of LCVs are about 15 percent higher than conventional semi-trailer trucks, the ton-km (mile) cost savings are reported to range from 20 to 50 percent.

Additional opportunities for improved freight transportation relate to the new emphasis on intermodalism -- recognition of the need to view all modes as a multimodal system with efficient intermodal connections. These opportunities stem from both potential institutional changes and technological or operational innovations.

The trend is toward double-stacking of a standard intermodal cargo container unit; introduction of automation in the handling of containers in intermodal freight facilities; and the provision of a "seamless" multimodal (water-rail-truck) shipping network. Approaches to achieve intermodal efficiency in key areas such as ports include special truck access roadways or lanes; selective access permitting; grade separation of truck access roadways; off-dock receiving/staging; and relocation of container yards away from congested waterfront areas to inland locations with efficient truck and rail access. Double-stack containers may become larger and heavier (up to 22,000 kilograms or 48,000 pounds each). Preliminary work is under way to define a new series of standardized containers for the future, including wide body containers; intermodal utility and structural integrity are key issues. International standard container lengths currently range between 3 and 12 meters (10 and 40 feet), and the standard width is eight feet; future containers could be wider (2.6 meters or 8.5 feet) and longer (15 meters or 49 feet). Domestic container lengths range up to 16 meters (53 feet). Further efforts to standardize container sizes and structural features to enhance intermodal shipping efficiency can be expected.

Opportunities for improvement in freight transportation also stem from the IVHS program -- the Commercial Vehicle Operations (CVO) element in particular. Advances in technology relating to CVO applications which can be expected to evolve include:

- Driver/Vehicle Real-Time Safety Monitoring
- Hazardous Materials Information Systems
- Driver Warning Systems
- Site-Specific Highway Warning Systems for Trucks
- Automated Mayday Capabilities
- Electronic Mileage Recording and Trip Logs
- Automated Credential and Weight Checking
- Automated (Electronic) Toll Collection
- Automated Vehicle Location Tracking, and Dispatching Systems

RANGE OF ALTERNATIVES

In order to facilitate the definition and assessment of the full range of possibilities, potential transportation concepts were sorted into three basic categories:

1. Mode and technology options;
2. Joint use options; and
3. Corridor options.

As shown in Exhibit 4-1, the mode/technology options were further grouped in three categories:

1. Highway options;
2. Fixed guideway options; and
3. Multimodal options.

New and emerging technologies exist for each of the above mode/technology options. Similarly, shared use options may exist for any of the mode/technology options.

HIGHWAY OPTIONS

The highway options for long range development in the Transamerica Transportation Corridor are defined in the following sections.

Conventional Interstate-Type Highway

A new controlled access highway designed to conform to Interstate system design standards to serve mixed traffic at a maximum speed of 105 km/h (65 mph) (or lower where mountainous terrain or other corridor-specific conditions may require). In application, there would be numerous sub-alternatives consisting of locational and design variations.

At least a basic level of IVHS technology deployment would logically be associated with the development of a new interstate highway. This "base case" would include lane departure warning devices, driver performance monitoring, obstacle detection, road environment sensing, lane change assist technology, and smart cruise control. These devices and systems will, in the aggregate, be expected to significantly enhance the safety of driving.

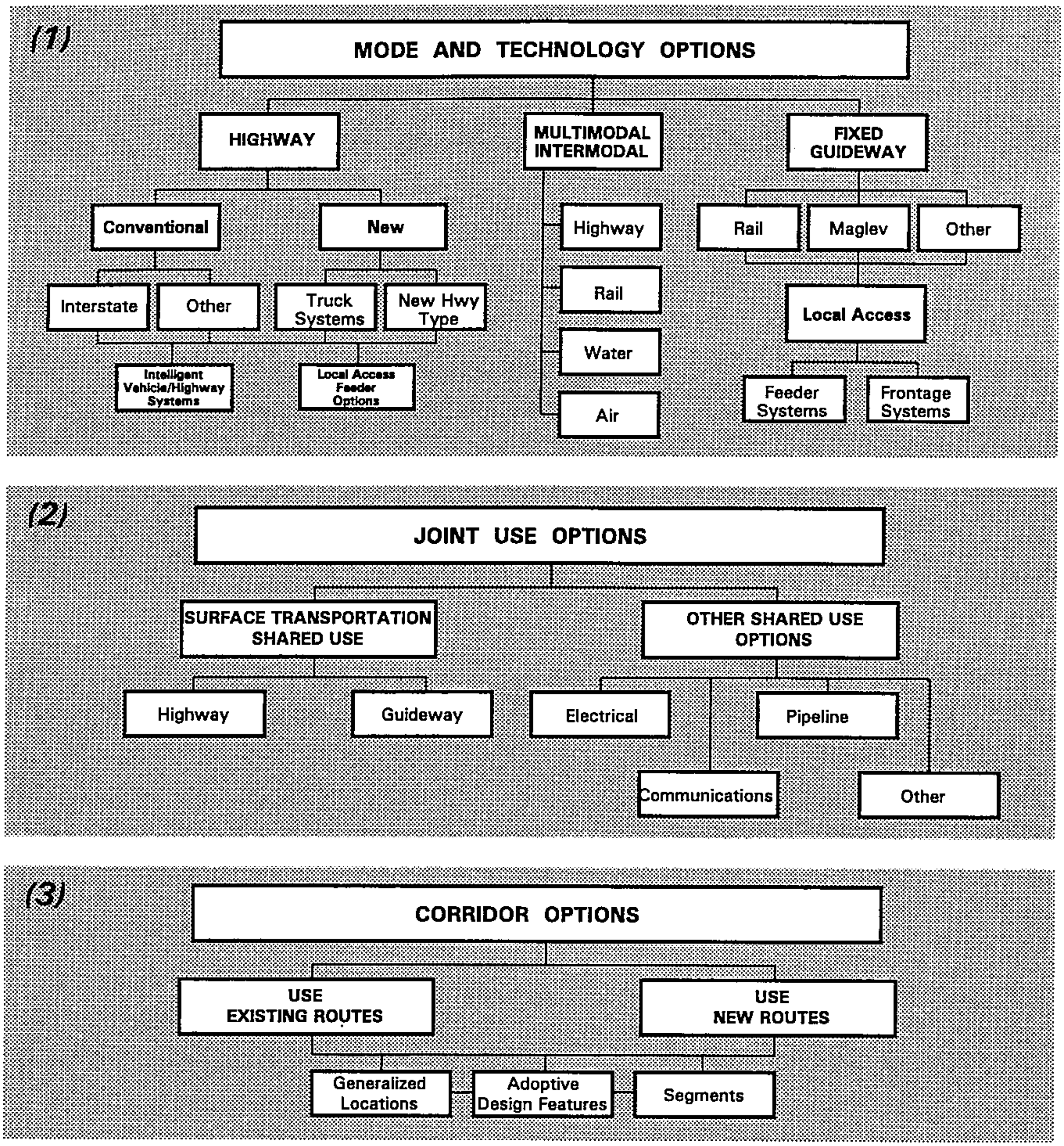
Super-Highway

A "second generation" interstate freeway designed for rural travel at higher speeds -- 130, 160 or even 250 km/h (80, 100 or even 150 mph). The primary function of this option would be express travel for relatively long trips - at speeds high enough to divert substantial volumes of intercity trips from I-40 and/or I-70.

Three different concepts for a new "super- highway" were defined for further consideration in this study:

Exhibit 4-1

SYSTEM ALTERNATIVES TO BE CONSIDERED



- High Speed Interstate Highway (130 km/h or 80 mph) with limited AVCS functions (AVCS-1);
- Super-Highway (160/190 km/h or 100/120 mph) with intermediate level of AVCS (AVCS-2); and
- Super-Highway (190/240 km/h or 120/150 mph) with full automation.

The AVCS-1 technology is the same as that assumed for the Conventional Interstate-Type Highway. In this case, however, it is further assumed that the resulting safety improvement is so significant that an increase in vehicle speed limits is justified. This speed increase is achieved by developing a separated lane as part of the construction of a new Interstate link.

AVCS-2 might be termed "semi-automatic" operation. The warning systems of the AVCS-2 level now become driver monitored control systems. The car is guided down its lane by a lateral guidance system. Its speed is controlled to an infrastructure dictated value. A merge assistance system is added. Vehicle to vehicle communications propagate speed change information back along a line of vehicles to prevent catastrophic accidents. And, of course, all systems are automatically checked before the vehicle enters the roadway. Such a combination of features should allow roadway speed to be further raised. The range of 160 to 190 km/h (100 to 120 mph) is assumed reasonable. Again, a special lane is assumed as part of a new Interstate link.

Further AVCS enhancements would result in a fully automated roadway. The result is assumed to be a roadway speed of 140 to 240 km/h (120 to 150 mph). In terms of the routine operating speeds currently being obtained on the German Autobahn, this assessment might appear to be highly conservative. This is especially true if a 30 to 50 year period to attainment is considered.

Truckway

A new roadway designed especially for high-speed operation by heavy trucks (i.e., longer combination vehicle configurations). Two truckway alternatives were defined for study purposes, viz.:

- LCV Truckway (105 km/h or 65 mph); and
- High Speed Truckway (130 km/h or 80 mph) with a separate heavy weight design roadway for LCVs and AVCS for commercial vehicle "trains."

Application of AVCS driver-assist concepts could, over the next 30 to 50 years, permit vehicle trains of lengths that can only be postulated at this time, and higher speeds.

Advanced Tollway

A variation of the super-highway concept which incorporates advanced technology concepts for toll collections. These concepts incorporate, inter alia, Automatic Vehicle Identification (AVI) technology for electronic fare collection and traffic management (ETTM); Weigh-in-Motion technology for enforcing load weight restrictions without stopping trucks; and Automatic Vehicle Locator (AVL) technology for maintaining real time information on commercial vehicle locations.

Parkway

A new controlled-access highway designed for pleasure travel and improved access to recreational areas. There are two fundamentally different parkway concepts. One of these conforms to the conventional definition of a parkway as a highway for non-commercial traffic with full or partial access control. A representative example of this concept is the Blue Ridge Parkway in Appalachia. The alternative parkway concept is represented by the Kentucky parkways, which permit use by trucks. With both concepts, the emphasis is on pleasure and/or access functions as distinct from high speed, and alignments are selected in response to these particular functional priorities.

Given the differences in terrain which exist between segments of the corridor, it is not unreasonable to conceive of two applications of either of the above parkway concepts -- one which extends coast-to-coast and another which applies the parkway concept only within some corridor segments (i.e., selected mountainous areas) with high-speed, super-highway standards applied on other segments.

FIXED GUIDEWAY OPTIONS

The 21st century undoubtedly will see the emergence of high speed ground transportation (HSGT) in this country. Surface transportation fixed guideway technologies are in operation today in Europe and Japan that can operate safely at speeds in the 210-290 km/h (130-180 mph) range, and improvements to these existing systems can be expected which could raise these top speeds to 320 km/h (200 mph) or more by the end of this decade. Speeds in the 450-510 km/h (280-320 mph) range have been achieved on test tracks. Technology advances, such as "tilt trains," already permit conventional passenger rail services to operate at higher average speeds than has been the case in the past. (See Exhibit 4-2.)

Exhibit 4-2
X2000 Tilt-Train

Photograph compliments of ABB Traction, Inc.

The rationale for HSGT (defined here as a rail or maglev fixed guideway system capable of operating speeds in excess of 200 km/h or 125 mph) includes various modal rebalancing considerations relating to energy problems, the adverse environmental consequences of adding transportation capacity through highway expansion, air quality implications, new approaches to regional development, and airport access and airport expansion constraints, as well as the fundamental social objective of providing an effective alternative to auto and air travel.

Several things could happen that would make HSGT implementation more feasible in this country in the 21st century. First, the high cost of constructing guideways could come way down as a result of the development of new construction materials, new tunneling technology and lower cost subsystems relating to power pick-up, heat dissipation, etc. Second, the cost of travel by other modes could go up substantially; gasoline taxes, for example, are extremely low in this country compared with those imposed in Europe. Third, air traffic congestion could become even more of a deterrent to air travel as travel demands increase in the face of airport expansion constraints. And finally, the new emphasis on modal integration and intermodal linkages in the nation's multimodal transportation system is likely to enhance the utilization of fast and efficient line-haul ground transportation modes with adequate feeder systems.

Various alternatives for the provision of fixed guideway ground transportation services in the Transamerica Transportation Corridor were defined, each representing a different (successively higher) level of capital investment and level of performance. These fixed guideway alternatives were defined for this study as follows:

- Conventional Railroad (< 127 km/h or 79 mph)
  - existing diesel locomotive technology; passenger trains would share the tracks with freight trains (except on heavy-traffic segments).

- Low Cost Conventional Railroad Upgraded (< 180 km/h or 110 mph)
  - FRA Class 6 track conditions (a relatively high standard in this country) and an upgraded signal system.

- High Cost Conventional Railroad Upgraded (< 200 km/h or 125 mph)

- additional investments in track, some grade-separation, electrification, and possible introduction of new technology rolling stock such as tilt-trains which enable higher speeds on curves.

- High Speed Rail Line (< 240-320 km/h or 150-200 mph)
  - second generation stage of the French TGV technology; requires fully grade-separated track on new right-of-way (with limited shared-use of existing facilities with slower passenger trains on approaches to urban centers, if necessary). (See Exhibit 4-3)

Exhibit 4-3
FRENCH TGV ATLANTIQUE

Photograph courtesy of GEC/Alsthom/Bombardier

- Very High Speed New Technology (< 400-480 km/h or 250-300 mph)
  - Maglev technology such as those under development in Germany (the electromagnetic suspension - EMS - technology) and Japan (electrodynamic suspension technology). (See Exhibit 4-4).

MULTIMODAL OPTIONS

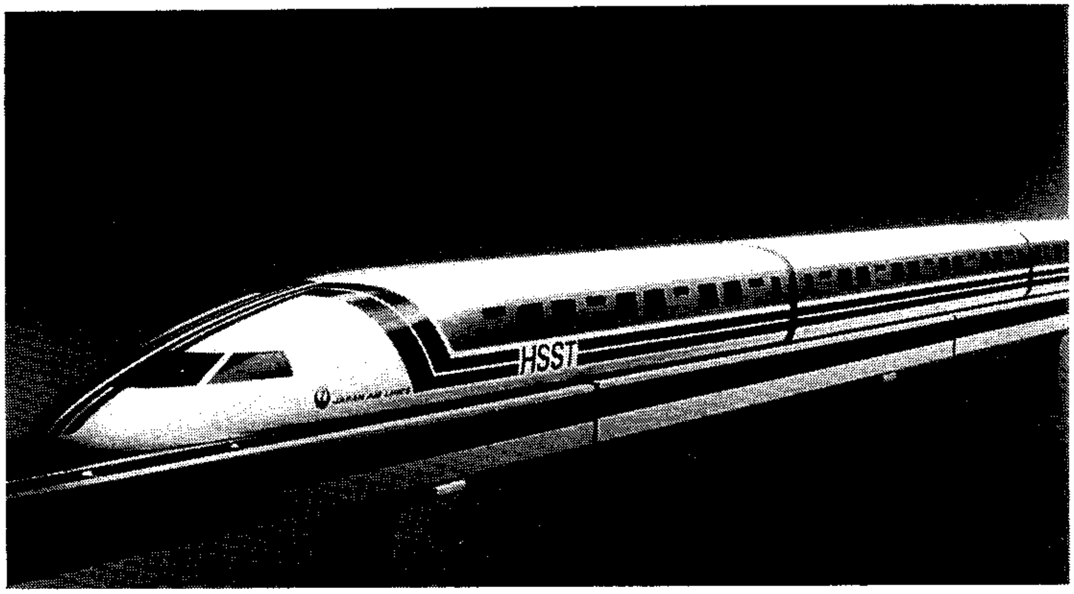
In keeping with the Study's objective to investigate a wide range of alternatives which may contribute to national objectives regarding future transportation system development, several options were reviewed which involved combinations of modal technologies. This is in keeping with language in ISTEA which establishes a government policy to develop high speed guideway technology *"capable of operating along Federal-aid highway rights-of-way, as part of a national transportation system of the United States."*

Four options were identified for study purposes as follows:

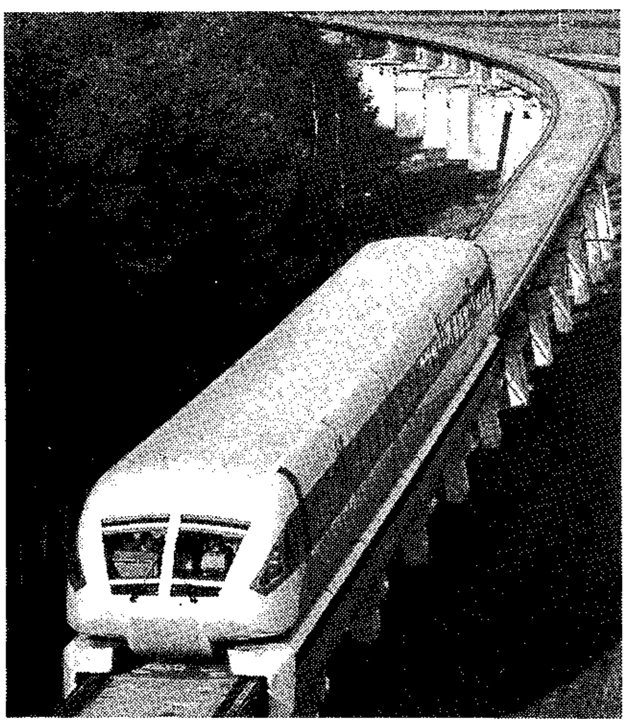
- Conventional Highway (Interstate) and Conventional or Upgraded Railroad (127-200 km/h or 79-125 mph)
  - This alternative could recognize opportunities to utilize and link up several unused and underutilized rail lines which exist in various segments of the corridor. This would influence the location of the highway; the geometric standards for the rail line would need to conform to the alignment standards of the highway. This alternative could involve tilt-train rail technology.

- Super-Highway and High Speed Rail or MAGLEV (290-320 km/h or 180-200 mph)
  - With this multimodal concept, the geo-metric standards of the high speed guideway mode would significantly influence the alignment of the highway. While highway location would be dictated by terrain and other constraints, highway geometry would need to anticipate requirements of the high speed guideway system.

Exhibit 4-4
VERY HIGH SPEED FIXED GUIDEWAY TECHNOLOGY (MAGLEV)



Japanese HSST - 300 (MAGLEV) - <205 mph
Under Development



West German Transrapid (MAGLEV) - <252 mph
Under Development

- Conventional Interstate Highway and Truckway (105 km/h or 65 mph)
  - The truckway element would involve a separate lane or multi-lane roadway for the exclusive use of trucks, including heavy trucks.

- Super-Highway and Truckway (190 and 130 km/h or 120 and 80 mph)
  - This alternative would include AVCS-equipped lanes which would be available to use only by authorized vehicles. The essential differences between the last two alternatives are geometric standards stemming from the design speed and the related degree of automation.

JOINT USE OPPORTUNITIES

The Transamerica Transportation Corridor has been designated to provide for surface transportation. In addition to the multimodal options noted above, other joint use opportunities expand this concept to include compatible transmissions or transports, such as pipelines, within the same right-of-way. Potential joint uses are summarized in the following sections.

Natural Gas and Oil Pipelines

It is conceivable that a new trunk pipeline or connecting feeder branches to existing trunk lines could be constructed along the Transamerica Transportation Corridor alignment. Oil and natural gas pipelines, however, are seldom installed parallel to one another and, for safety reasons, natural gas pipelines are usually not installed in populated or heavily traveled areas.

Slurry Pipelines

Coal slurry pipelines are one example of slurry transport. They consist of underground pipelines that carry a 50-50 mixture of ground coal and water from preparation plants located near mines to delivery sites such as electric utility plans or shipping points. Two coal slurry pipelines have been used in the U.S. (only the Black Mesa pipeline remains in operation). This scarcity of coal slurries is believed to be a result of direct competition with the railroads for the transport of coal.

Fiber-Optics

Recently, many state and local governments have begun to realize the importance of a comprehensive, reliable fiber-optics network to attract industry and stimulate local economic development. While there are some safety concerns, mainly dealing with the access for repair and maintenance creating a distraction to drivers, fiber-optic cable can be easily and efficiently installed along the highway right-of-way and the practice has been strongly supported by the telecommunications industry. Several toll roads in the United States have leased or sold right-of-way access to telecommunications companies to lay fiber-optic lines.

Electric Utilities

Like fiber-optic cable, electric transmission lines are another prime candidate for highway right-of-way usage. However, the safety concerns with electricity transmission lines are even greater, due to the high voltage and the fact that lines are more often above ground, rather than below the surface.

Water Pipelines

The Transamerica Transportation Corridor right-of-way could provide a potential location for a water pipeline to supply water for municipal, industrial, and agricultural use. In some states, gaining access to surface or ground water involves many complex legal and regulatory issues involving water rights and allocations that are unique to each water source. In the study corridor, there is particular interest from the westernmost states for the joint development of water pipelines.

Hydraulic Capsule Pipeline

Hydraulic Capsule Pipeline (HCP) is a new concept in pipelines in which freight is transported in cylindrical containers (capsules) moving through pipelines that are filled with water. The technology of HCP is actively being developed in the United States and in several other nations -- mainly Japan, Canada, Australia, South Africa and the Netherlands.

Hydraulic capsule pipelines have been discussed as a potential means to transport farm products, especially grain, produced in the United States, either to domestic market or to ports for export. As with all joint use opportunities, there will be a need to interface with a comprehensive feeder service.

NETWORK INTEGRATION OPPORTUNITIES

The ability of passenger and freight traffic to access the Transamerica Transportation Corridor is dependent on the feeder system provided. A system of feeders will provide local, regional and even international access to the corridor. The efficiency with which the proposed facility can be accessed will directly impact the number of users. Providing efficient access to the corridor is critical to ensuring that the benefits afforded by the proposed facility are extended to as large an area as possible.

On a regional basis, the low population density of the study area increases the need for an extensive feeder system. This low density dictates that trips must be attracted from large metropolitan areas that border the corridor. They include, for example, metropolitan areas such as Cincinnati, Memphis, St. Louis, Kansas City, Denver and Albuquerque along the northern and southern edges of the study area.

A "transportation spine" concept was adopted as a fundamental aspect in this study. Under this concept, the Transamerica Transportation Corridor would be located between the major activity centers, providing connections through a feeder system extending north and south. Exhibit 4-4 illustrates this concept. These regional connections can include existing facilities as well as proposed facilities.

A transportation spine concept in reality will be connected to a larger network. As the state highway network is integrated with the interstate system, a nation-wide high speed rail network, for example, could be integrated with the Transamerica Transportation Corridor facility. Exhibit 4-5 illustrates high speed rail systems proposed by the American Public Transit Association along with Amtrak, the High Speed Rail/Maglev Association, the Community Transportation Association of America, and others. The Transamerica Transportation Corridor could be connected to this proposed system in two ways. The Transamerica Transportation Corridor could be developed as a highway option with intermodal connections to a high speed rail network. Alternatively, it could be developed as a high speed rail facility and work as an east/west spine to the various rail segments illustrated.

Method of Interface

The interface between the feeder system and the proposed Transamerica Transportation Corridor facility is a fundamental consideration. Two basic scenarios exist. In the first scenario, vehicles which operate on the feeder system can access and operate on the proposed facility. Under the second scenario, intermodal or intramodal transfer stations are necessary.

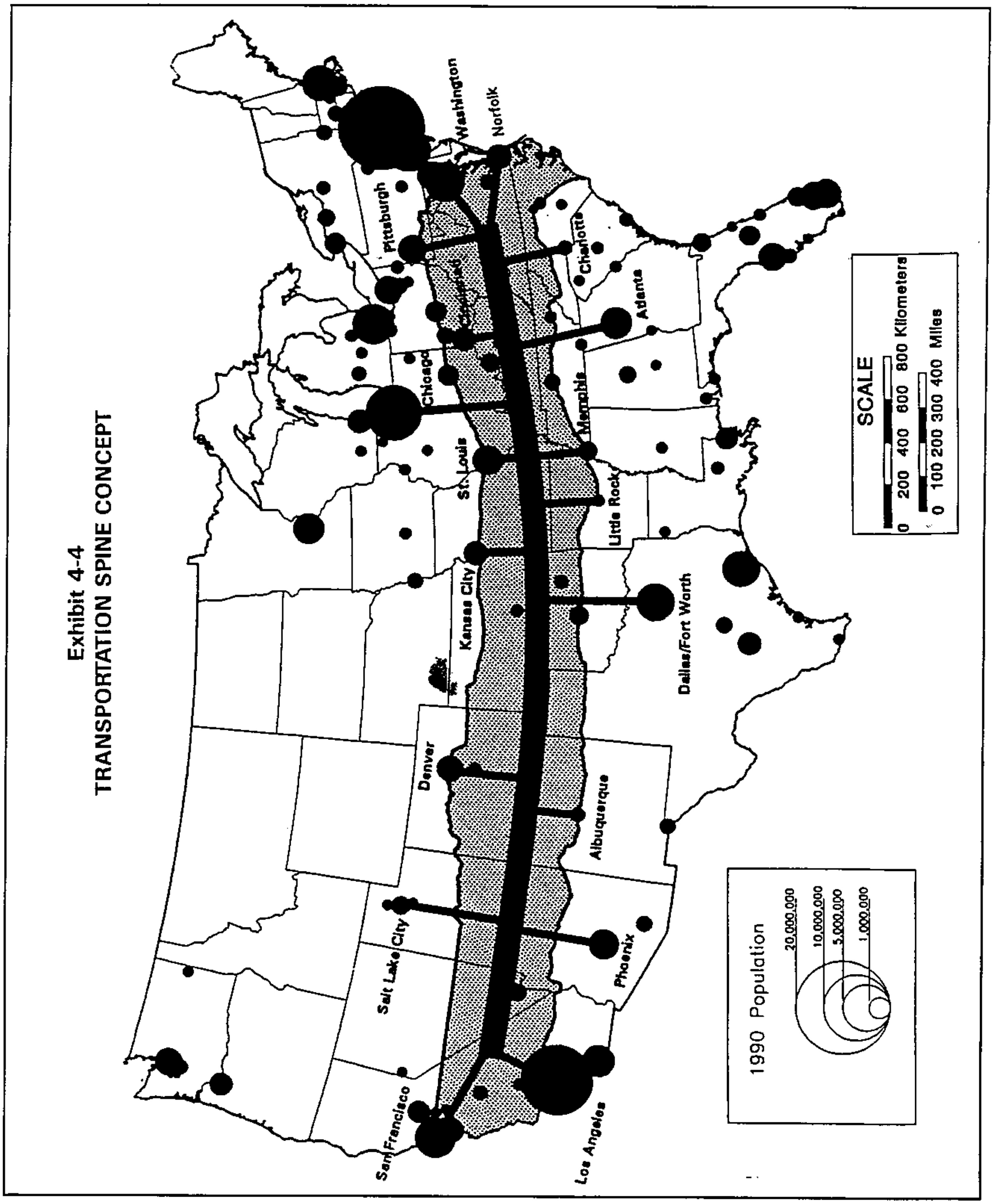
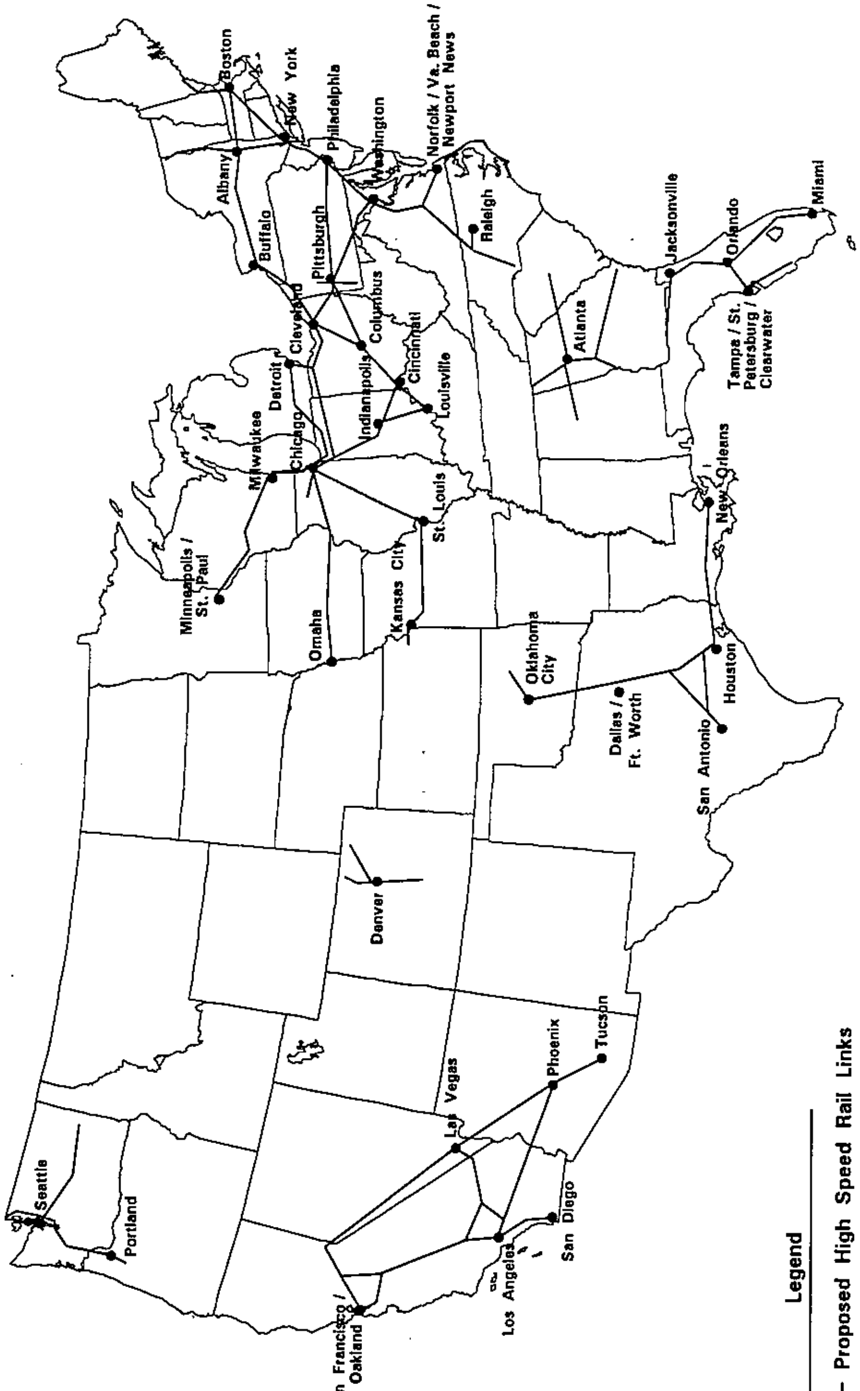


Exhibit 4-4
TRANSPORTATION SPINE CONCEPT

Exhibit 4-6

NATIONAL HIGH SPEED RAIL PROPOSALS



Legend

— Proposed High Speed Rail Links

Source for Proposed High Speed Rail Links:
The American Public Transit Association along with Amtrak, The High Speed Rail / Maglev Association, The Community Transportation Association of America and others, 1993.

A typical interstate facility illustrates the first scenario. The vehicle which travels on the facility can also travel on the feeder system. Under this scenario the interface between the corridor and the feeders is a facility interchange (physical connections).

Under the second scenario the interface between the proposed facility and the feeders is much more complex. In this case, a transfer station is required where passengers and cargo would be moved from the feeder vehicle to the corridor vehicle. For example, a user would drive an automobile to a corridor rail station and then transfer to the high speed rail vehicle. In essence, this type of operation resembles the air transportation mode.

LINKAGES WITH THE PORTS

A new transportation corridor will need to have efficient connections with seaports (and possibly riverports) to be effective. More than 90 percent of the nation's international trade volume moves through its seaports, and the volume of exports is expected by the maritime industry to triple over the next 25 years. There is a clear need to find ways to move goods to and from the ports more efficiently. In effect, the role of the Transamerica Transportation Corridor in improving the efficiency of goods movement depends in large part on the effectiveness of the intermodal linkages provided with the ports and key domestic market areas.

Ports represent the intermodal linkages for the transfer of cargo between the landside highway and rail facilities which might be provided in the Transamerica Transportation Corridor and the maritime industry. Effective landside access is critically important, and the trend in terminal facilities is to bring rail into container areas of the port facility. Available shoreside locations for the expansion of intermodal facilities at ports are diminishing. However, container yards can be moved away from the waterfront and can provide strong surface linkages between truck and rail if located in areas readily accessible to both modes. A greater emphasis in bi-modal shipments of cargo is to be anticipated in the Transamerica Transportation Corridor in the 21st Century. In addition, cargo shipping innovations based on "just-in-time" concepts require efficiency in intermodal linkages. There is growing recognition of and support for a "seamless network" and "transparent borders" in the multimodal freight transportation system of the 21st Century.

Chapter 5
ALTERNATIVE TRANSPORTATION CONCEPTS

As noted in the preceding Chapter, this study considered a wide variety of transportation system alternatives. Some were traditional (e.g., conventional interstate highway), some were of the emerging technology variety (e.g., IVHS, high speed rail), and some were more visionary in nature (e.g., a second generation Interstate highway with yet higher speeds, etc.). As noted, certain combinations of the technologies potentially could be viable propositions. Incremental development also is a possibility, as discussed further in Chapter 15.

For study purposes, the most efficient approach to handle this wide range of alternatives was to first consider all conceivable transportation options, and to eliminate progressively the least viable options as the study proceeded. Thus, transportation options were first evaluated as "concepts" without reference to specific features of the designated Transamerica Transportation Corridor. Later, they were assessed within the context of the designated transcontinental corridor (see Chapter 6).

Study tasks were designed so as to enable a "sequential screening and evaluation process," where all options were initially considered, and the least viable were rejected. Those that remained then were evaluated as "packages" of transportation concepts and again the least viable were eliminated from further consideration. Those that remained were viewed as the "most viable candidate concepts," and were evaluated in yet greater detail. These candidates were then applied to the designated corridor, to see which make the most sense in the corridor. Those that were found to be less applicable, were rejected. Those that survived at that point were subjected to a more detailed "feasibility assessment," including various economic assessments (see Chapters 8, 9, 10 and 11) and financial assessments (see Chapter 12).

INITIAL SCREENING

Initially, the concepts identified in Chapter 4 were organized into some 19 specific transportation alternatives (as shown in Exhibit 5-1). The screening process used for these initial 19 alternatives was designed to use general evaluation criteria in a systematic process which facilitated identification

Exhibit 5-1
INITIAL MODE/TECHNOLOGY OPTIONS

HIGHWAY CONCEPTS
- Alternative 1: Conventional Interstate-Type Highway
- Alternatives 2, 3 & 4: Super-Highway Concepts
- Alternatives 5 & 6: The Truckway
- Alternatives 7 & 8: Advanced Tollway Concepts
- Alternatives 9 & 10: The Parkway Options

FIXED GUIDEWAY CONCEPTS
- Alternative 11: Conventional Railroad
- Alternative 12: Low-Cost Conventional Railroad Upgrade
- Alternative 13: High-Cost Conventional Railroad Upgrade
- Alternative 14: High Speed Rail
- Alternative 15: Very High Speed Fixed Guideway - New Technology

MULTIMODAL CONCEPTS
- Alternative 16: Conventional Interstate-Type Highway & Conventional Railroad
- Alternative 17: Super-Highway & High-Speed Rail or MAGLEV
- Alternative 18: Conventional Highway (Interstate) & Truckway
- Alternative 19: Super-Highway & Truckway

of the alternative transportation concepts that warranted further investigation. At this stage, it was neither feasible or necessary to have detailed quantifications and assessments of the attributes of each option. Instead, it was possible to employ a range of general evaluation criteria as the screening mechanism.

The primary considerations used in the initial screening to select alternatives for further definition and quantitative study were as follows.

Development and Productivity Objectives

One criterion was conformity with National policy as documented in ISTEA with reference to the development of a National Intermodal Transportation System. Thus, the potential effectiveness of the alternatives in promoting economic development, supporting international commerce, and increasing productivity was a consideration.

Any of the alternatives defined for consideration would contribute, at least to some degree, to goals for economic development and increased productivity. Those which would offer the prospect of contributing most are the super-highway, the truckway, and the tollway concept which incorporates provisions for heavy longer combination (LCV) trucks. The concepts which would contribute least to productivity include the conventional low-speed railroad options and the parkway. The latter option would provide economic development benefits in certain areas.

High Speed/Safety/ Automation

This criterion considered the extent to which each alternative was in conformity with the generalized 21st Century vision for the Corridor outlined in Chapter 4 of this report. This vision prescribes as objectives higher speeds for long distance travel; improved travel safety; automation of travel functions; and efficiency in the use of resources.

Some of the options offer significant increases in safe speeds, significant reductions in travel times for intercity trips in the 300-1,300 km (200-800 mile) range, and the prospect of providing an effective alternative to air travel, thereby conforming well with the 21st Century vision prescribed for this Corridor. The super-highway concept (the ""second-generation Interstate") and the high-speed fixed guideway concept would fulfill this vision of the future. An advanced design tollway which offers similar benefits is a valid alternative which warrants consideration because of the scope it offers for "privatization" and public/private sector collaboration. Conventional highway and railroad options and the parkway concept do not conform well with the long-range vision of higher safe speeds, a high degree of automation, and increased productivity in the movement of goods.

Traffic Diversion Potentials

Another criterion was the potential capability of each alternative transportation concept to perform key transportation service functions of the types defined in Chapter 4 of this report. In particular, the potential ability of each alternative to attract substantial volumes of intercity traffic between the major cities located at the outer edges of the Corridor was an important consideration.

In the context of the Transamerica Transportation Corridor, it is important to recognize that project justification will depend in large part on the Corridor's ability to attract and serve intercity trips and cargo movements between the major urban areas located along I-40 and I-70. This will require both high speed operations in the Corridor and effective feeder systems to connect the Corridor and these cities. Again, the super-highway would offer most promise in this area, particularly because the essential feeder system is already available in the form of existing state highways.

Freight Transport Efficiency

Prospective benefits for the transport of freight as well as for passenger transportation was another criterion.

Even modest improvements in freight transport efficiency can translate to large economic/ productivity benefits. Those options which enable the use of larger, heavier and higher performance trucks warrant consideration, especially those which combine the attributes of the "truckway" with provisions for high-speed automobile travel -- such as the super-highway and advanced tollway. The freight transport benefits from the fixed guideway options and the conventional highway options are likely to be more limited.

Adaptability to Technology Innovations

Another criterion was the adaptability of a transportation concept to future innovations in the fields of intelligent vehicle highway systems (IVHS) and magnetic levitation (Maglev) for high speed fixed guideway systems (an objective cited in ISTEA).

All of the highway alternatives, if planned correctly at the outset, would be adaptable, at least to some degree, to technology innovations relating to IVHS. The primary point of discrimination among alternatives is that the conventional railroad concepts are not readily adaptable to very high speed technologies.

Adaptability to Increment Implementation

This criterion encompassed both transitional and segmental implementation potentials.

It is important to note that some of the alternatives can be viewed as early stages of the ultimate development of other alternatives. Thus, for example:

- The fully automated super-highway alternative could be viewed as the ultimate stage of upgrading from AVCS-1 and AVCS-2 (as defined in Chapter 4).

- The high cost conventional railroad upgrade alternative could be viewed as the ultimate stage of upgrading from a lower cost upgrade.

The highway options can be implemented in relatively short segments; on the other hand, high-speed fixed-guideway options, to be effective, would need to be analyzed carefully to determine reasonable operating segments.

Alternatives Selected for Further Study

Based on the criteria outlined above, the initial screening by the Steering Committee resulted in the following alternative transportation concepts being subjected to further study. (As a result of these more detailed analyses, some of these alternatives were redefined in the latter stages of this feasibility study. See the last section of this Chapter.)

Alternative A: Conventional Interstate-type Highway - This alternative would represent a base case for comparison with other options selected for study. Existing interstate geometric design standards would apply. Some segments of the corridor through mountainous areas of Kentucky could utilize the alignments of existing "parkways." IVHS technology would be deployed incrementally with this option.

Alternative B: Conventional Interstate-type Highway and Upgraded Railroad - This multi-modal concept would be based on the premise that the development of the new rail lines would be achieved by utilizing segments of existing abandoned or underutilized railroad lines to the maximum extent possible (and linking them on new alignments as required). The ultimate maximum speed of the rail line would be 200 km/h (125 mph). This alternative could be implemented incrementally. The location of the highway would be influenced by the locations of abandoned rail lines.

Alternative C: Super-Highway (AVCS) - Geometric standards for this concept would provide for 200 km/h (125 mph) speeds; actual operating speeds in early stages would be lower and consistent with the availability of suitable AVCS technology for safe operations at higher speeds. Lower standards would apply in mountainous areas. IVHS technology would be deployed incrementally. Provisions would be made for separation of trucks and passenger cars, and the truck roadway would be of "heavy weight" design.

Alternative D: Super-Highway Plus Very High Speed Fixed Guideway - This multimodal concept would be planned from the start with geometric standards suitable for fixed guideway operations at speeds in the 320-400 km/h (200-250 mph) range. The super-highway concept would be equivalent to Alternative C and would incorporate provisions for a heavy truck roadway. Implementation would be incremental; fixed guideway implementation could be deferred pending further technology advances relating to Maglev. Relatively long minimum operating segments of the fixed guideway would be involved.

Tollway Concept - The tollway concept also was retained for further study. It was viewed as a financing concept rather than a technology concept despite the advanced toll collection processes which are proposed for this alternative.

EVALUATION OF BASIC TRANSPORTATION CONCEPTS

Following the initial screening, the four transportation alternatives were subjected to more detailed evaluations. This evaluation consisted of several steps.

Description of Alternative Concepts

The principal features of each alternative were defined so that costs and usage estimates could be developed. For each highway alternative, the main features defined were design speeds, access control provisions, right-of-way, cross-section, bridge design loadings, interchange spacing, IVHS features, trucking characteristics, network characteristics and joint uses. For the fixed guideway alternatives, definitions were developed regarding speed characteristics, power source, cross-section, right-of-way, grade separations, markets served, train sets, freight and passenger operational features, spacing of stations, passenger fares, service frequencies, intermodal freight transfer stations, connections to other rail lines and joint uses.

For the very high speed fixed guideway alternative, there are two principal technology options, i.e., a high speed rail technology (such as the French TGV) or a maglev technology. Rather than specify a specific technology for these evaluations, a generic description of the fixed guideway was developed.

Transportation Demand Analysis

Order of magnitude estimates were developed regarding the number of people and, for highway alternatives, the number of road vehicles that would use each alternative. The volume of freight that would be attracted to each alternative also was forecast. A 50-year forecast was developed, utilizing procedures discussed in Chapter 7 of this report.

Generalized Costs

Generalized costs per kilometer (mile) for project construction along with costs per kilometer (mile) for operation and maintenance were developed for each technology. Costs were developed for construction of each facility type in four different terrain categories. The terrain categories were: flat, rolling, hilly and mountainous. The costs were estimated to allow comparison between technologies and are not corridor specific.

Quality of Service

General assessments were made of the quality of service attributes of each alternative. This considered such factors as the availability of an alternative modal choice, levels of congestion, travel speeds, automation of driving functions, number of traffic lanes (freedom to maneuver), etc.

Financial Considerations

Assessments were made of possible funding sources and relative comparisons of revenue potentials were developed. The impacts of tolls on travel demands also was estimated.

Conclusions

Based on these evaluations, conclusions were reached regarding the relative merits of the four alternative transportation concepts. These may be summarized as follows.

Alternative A: Conventional Interstate-type Highway - Alternative A is estimated to serve significant volumes of automobile and truck traffic. It also will provide an improved quality of service relative to I-40 and I-70 because of congested conditions in the vicinity of urban areas along those routes (Alternative A, as all other alternatives, would avoid penetration of urban areas). It involves the lowest cost of the four alternatives. The Steering Committee determined that Alternative A should be retained for future study.

Alternative B: Conventional Interstate-type Highway and Upgraded Railroad - This alternative would have substantially higher costs than Alternative A because of its multimodal feature. However, it also has additional financing possibilities. Highway traffic would not be significantly different from Alternative A but additional freight and passenger traffic would be attracted by the upgraded railroad. Primarily because of its multimodal features, the Steering Committee determined that Alternative B should be retained for further study.

Alternative C: Super Highway (AVCS) - Current IVHS activities, including those associated with a national Automated Highway System (AHS) initiative, strongly support the likelihood that automated highways will be reality sometime within the 50-year timeframe of the Transamerica Transportation Corridor Study. This corridor would provide an opportunity to incorporate provisions for AVCS into a new facility as contrasted with retrofitting an existing highway.

With Alternative C, project costs are virtually double those estimated for a conventional highway. This is reflective of the 8-lane cross-section which is assumed to be required to accommodate both instrumented and non-instrumented vehicles. Nevertheless, the substantially higher safe speeds associated with the AVCS technology will attract much larger volumes of traffic than would a conventional Interstate highway.

Because Alternative C provides an opportunity for a second generation Interstate highway system, it was retained for further study by the Steering Committee.

Alternative D: Super Highway Plus Very High Speed Fixed Guideway - The capital costs of a steel rail technology would approximately double the project costs of Alternative C. The capital cost of a maglev technology would be even more expensive.

Ridership on the guideway technology would depend upon a variety of factors, particularly pricing policies for air travel plus the potential effects of airport congestion.

Alternative D involves an extremely high level of service. Indeed, the Transamerica Transportation Corridor would have, with this alternative, the highest quality of ground travel service of any corridor in the world.

Alternative D also involves a huge addition of travel capacity in a corridor which currently has modest east-west travel demands.

It was considered highly doubtful that a single corridor could ever hope to attract financing of the magnitude required by Alternative D. This is especially true given that the tremendous leap in traffic capacity would have to come at the expense of additional capacity in transportation corridors which already are congested.

Accordingly, it was decided by the Steering Committee that Alternative D should be revised to include only the very high speed fixed guideway element. This decision also permitted further analysis to distinguish clearly between the merits of the super highway (Alternative C) and the HSGT (Alternative D).

FURTHER REFINEMENT OF TRANSPORTATION CONCEPTS

The focus of the Transamerica Transportation Corridor Study was on the feasibility of a transportation facility rather than its precise location. Nevertheless, following the definition of basic transportation concepts, analyses were conducted to determine the impacts of applying the four alternatives within the Transamerica Transportation Corridor. These analyses are reported in Chapter 6 which follows.

The corridor application analyses identified representative corridors for the four transportation concepts. While these do not constitute preferred or recommended alignments, the representative corridors provided a basis for realistic assessment of the costs associated with each alternative and with the impacts (positive and negative) that would derive from the application of these technologies within the Transamerica Transportation Corridor.

As a consequence of these corridor application analyses, further refinements were made to Alternative B. The initial intent of Alternative B was to provide a multimodal transportation concept that was based on currently available technology. As previously noted, the location of Alternative B was driven by the desire to utilize existing abandoned or under-utilized railroad lines to the maximum extent possible, linking them together on new alignment as necessary. Consequently, the location of the highway component of Alternative B was determined by the location of these rail lines. Examination of them revealed a feasible means of creating a coast-to-coast rail facility. However, it also meant that the highway would basically serve areas which currently are well served by existing highways, particularly I-40 and I-70. Because of this duplication, the Steering Committee determined to redefine Alternative B to consist only of the upgraded rail technology involving tilt trains such as the X2000 which Amtrak recently tested.

Based on these decisions, the final alternatives that were subjected to further detailed study were as follows:

<u>Alternative A: Conventional Interstate-type Highway</u>

The main features of this alternative are:

- Built to Interstate standards
- Somewhat higher speeds than other interstate highways because urban areas are not penetrated
- Includes basic level of IVHS technologies
- Longer combination trucks accommodated

<u>Alternative B: Upgraded Rail</u>

This alternative features:

- Tilt train technology
- Speeds ranging from 200 to 220 km/h (125 to 135 mph)

<u>Alternative C: Super-highway and Truckway</u>

Features of this alternative include:

- Vehicle speeds up to 240 km/h (150 mph)
- Substantial deployment of IVHS technologies, including Advanced Vehicle Control Systems (AVCS)
- Separated truck roadway

<u>Alternative D: Very High Speed Fixed Guideway</u>

This alternative is distinguished by the following features:

- Considers both high speed rail and maglev
- Design speeds from 200 km/h (125 mph) in mountainous terrain to over 480 km/h (300 mph) in flat terrain
- Electrically-powered trains on primarily new alignments

Chapter 6
CORRIDOR APPLICATIONS

This chapter identifies three corridor locations in which the four alternative TTC technologies were applied. The corridor location process began by first reviewing existing conditions (See description in Chapter 2). This chapter summarizes the remaining analyses that took place including the identification of the following:

- Major opportunities and constraints
- Full range of initial study corridor options
- Corridor segment-by-segment data
- Recommended analysis corridors
- Corridor costs estimates
  - Capital
  - Operation and Maintenance
- Environmental concerns related to corridor locations

OPPORTUNITIES AND CONSTRAINTS

Opportunities

There are various opportunities for locating corridors in the study area. For example the presence of the shown major metropolitan areas present opportunities to locate corridors to increase service potential. The lack of urbanization or the prevalence of low density rural areas present opportunities for less costly and less disruptive construction of a TTC facility.

Existing plans for compatible and complementary east/west transportation facilities, combined with the presence of major urban areas along routes provided a starting point for identifying initial study corridors. Existing plans considered included regional and statewide plans, existing and abandoned rail lines, and proposals for high speed rail as described by the HSR Association.

Constraints

The topography that was described in Chapter 2 was an important constraint in applying TTC technologies to a corridor location. The major challenges were the extreme elevations of the Rocky Mountain and West Coast Ranges.

The other major constraints are environmental. The major natural resource constraints that contributed to identifying the initial study corridors are illustrated in Exhibit 6-1. Environmentally sensitive areas include but are not limited to wetlands, natural preserves, forests, and wildlife refuges. Air quality problems in major urban areas are also a major constraint particularly for applying any TTC technology that would contribute to existing problems. These environmental factors are addressed more fully in Chapter 12: Other Impacts and Implications.

SCREENING PROCESS

The segments resulting from the consideration of the above opportunities and constraints are illustrated in Exhibit 6-2: Study Segment Map. *(Note: Even though the lines shown represent 80-km (50-mile) wide study corridors, they are drawn narrower so the viewer can differentiate the lines.)* Before a segment by segment comparative analysis was conducted, a first level screening took place concerning the considerations of Indian lands.

Indian Lands

The consultant team met with some of the major indian tribes in the TTC to determine tribal transportation plans and to receive input on the initial segments. The critical area under consideration is in Southern Colorado and Northern New Mexico. Meetings were conducted with the major tribes in this area: the Navaho Nation, Jicarilla-Apache, Mountain Ute and Southern Ute. There was a general agreement that the middle of the corridor was preferred over the southern part of corridor in the I-40 area.

Suggestions were made that the specific alignment not cross through Wolf Creek Pass, but rather through the Almosa Plain and south across U.S. 60. This is in the Southern Ute territory near the Four Corners area. The Mesa Verde area must be avoided. A new segment was created to address these concerns. Opposition concerned the presence of numerous heavily protected Pueblo lands that represent major TTC alignment constraints particularly outside of the existing I-40 right of way. High speed rail should not be considered in this corridor.

Exhibit 6-1

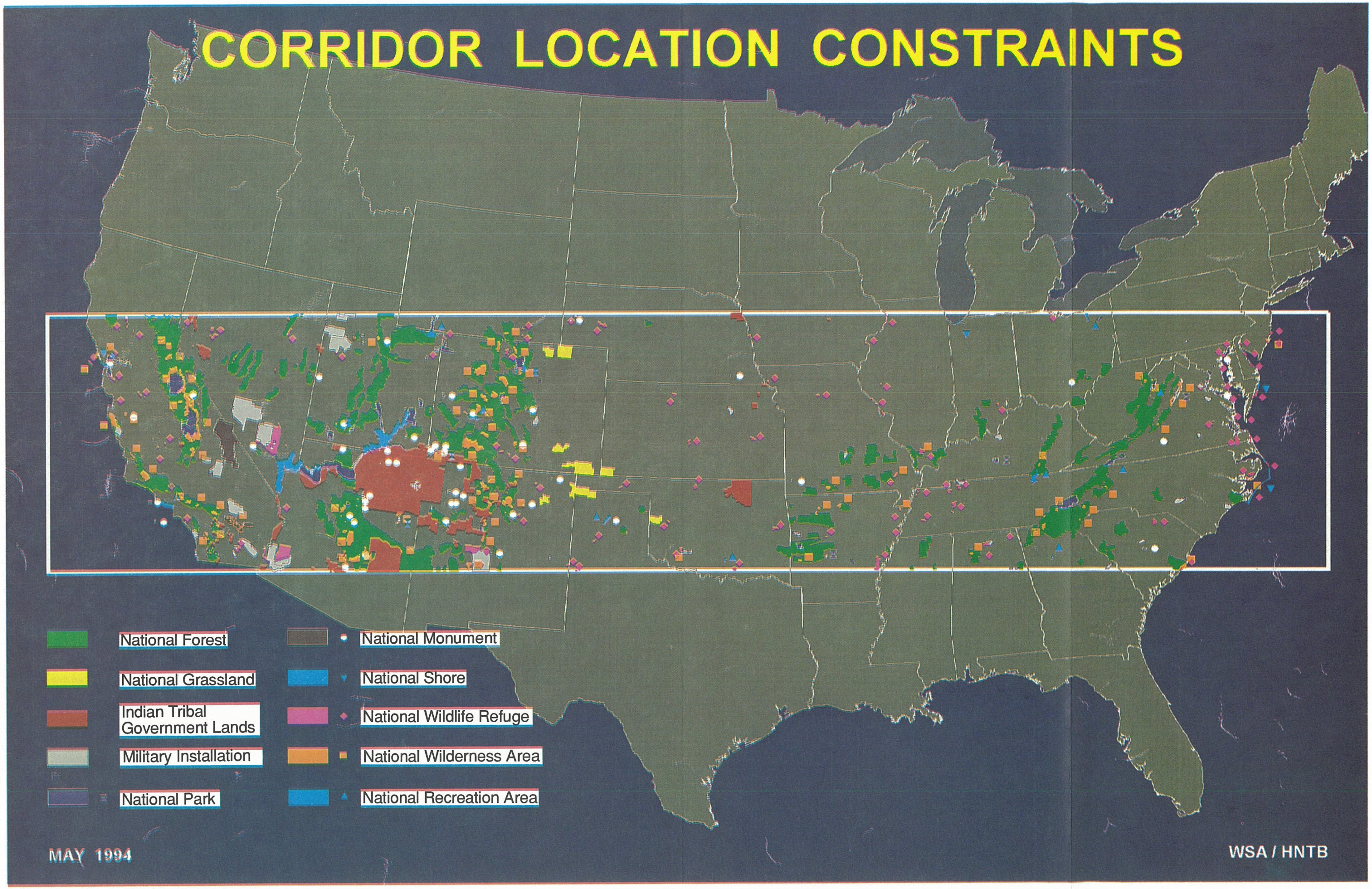
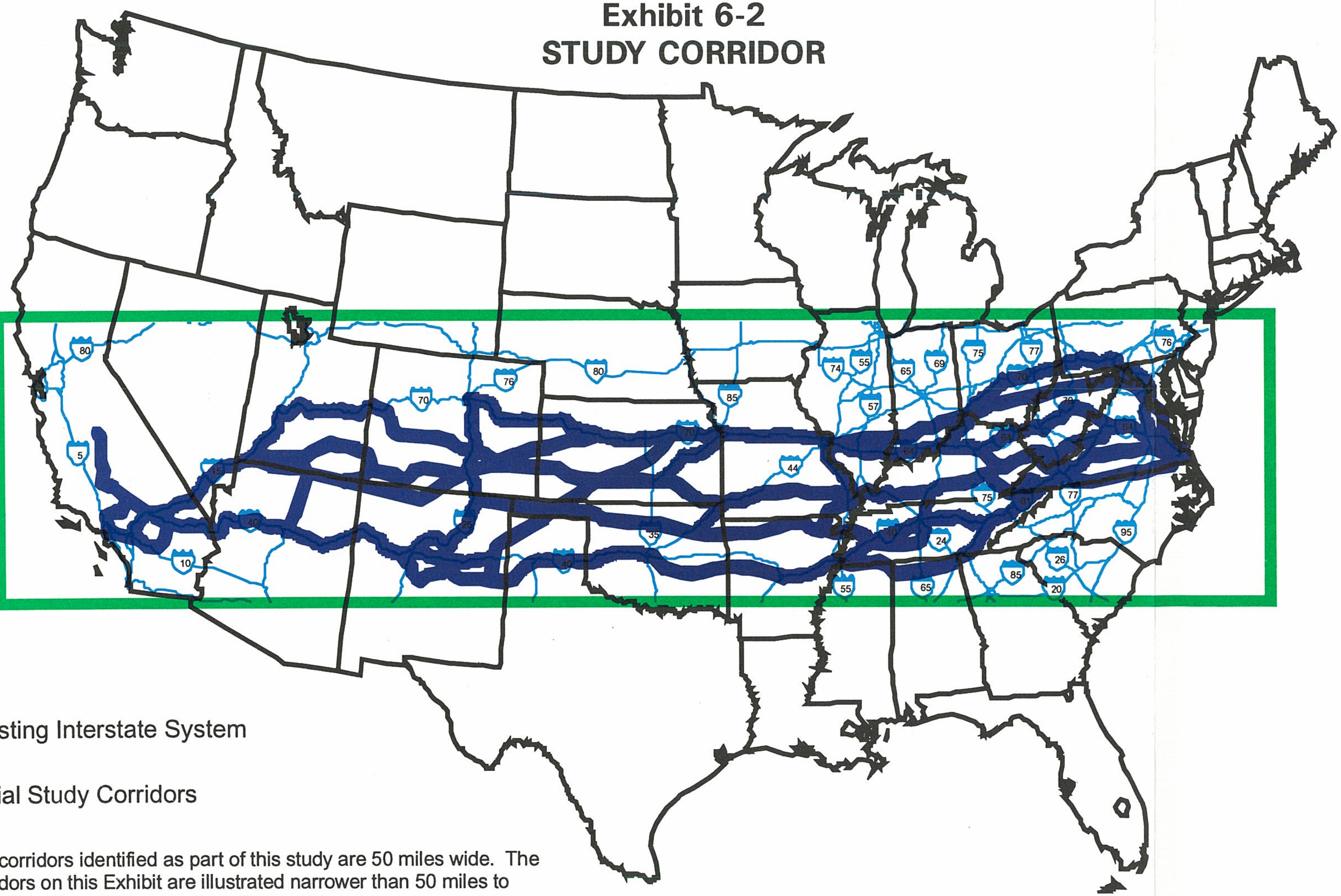

CORRIDOR LOCATION CONSTRAINTS
National Forest
National Grassland
Indian Tribal Government Lands
Military Installation
National Park
National Monument
National Shore
National Wildlife Refuge
National Wilderness Area
National Recreation Area
MAY 1994
WSA / HNTB

Exhibit 6-2
STUDY CORRIDOR



Existing Interstate System

Initial Study Corridors

NOTE: The corridors identified as part of this study are 50 miles wide. The corridors on this Exhibit are illustrated narrower than 50 miles to allow for differentiation of alternative corridors.

There is interest in the economic development opportunities that could be afforded by a TTC facility. Local access however is crucial to achieving economic development objectives. There is concern among the tribes over the impacts and safety of high speed rail alignments in or near Indian lands.

Methodology

Data was collected on each of the sixty-three segments.

A description was compiled of the cities located at the beginning, end and within each corridor segment. The cities are roughly located along the 80-km (50-mile) wide corridor's centerline. An actual facility alignment could ultimately pass through the cites, bypass the cities or only pass within 40 km (25 miles).

Terrain

A segment length and percentage breakout of terrain types for each segment was developed. The segment lengths included the added length which will result from the ultimate curvilinear alignment of the proposed facility. The terrain type breakout included the percentage of each corridor segment that is flat, rolling, hilly and mountainous.

Cost

The segment length and terrain type percentages were used along with the per unit costs to calculate a segment cost for each technology. In corridors with facilities known to be constructed to interstate standards the segment cost was reduced to reflect incorporation of these existing facilities. The segment cost used was ten percent of total cost in order to account for implementation of IVHS and minimal safety enhancement.

Environmental Data

Environmental information summarized for each segment included river crossings, public lands impacts, non-attainment areas within a corridor and other general environmental data. This data is presented in Appendix B: Environmental Inventory. The river crossing lists include rivers, large swamps and lakes, but no creeks. Lakes which can be avoided within the 80-km (50-mile) wide corridor were not included. Similar to lakes, public lands included the larger areas which cannot be avoided within a corridor.

All air quality non-attainment areas were listed which fall within a corridor segment.

Jurisdictional Boundaries

Jurisdictional issues summarized included native american land impacts, military bases, proposed projects and general comments received from state transportation agencies. Indian reservations which could not be avoided within a corridor were listed for each segment. Military bases listed were the larger bases which include ranges.

Transportation Systems

Transportation system implications included parallel facilities, the feeder system and intermodal opportunities. Parallel facilities were summarized to assist in locating the corridor and identifying competing facilities. The transportation facilities summarized as part of the feeder system included interstates and proposed high speed rail lines. Intermodal facilities included airports with commercial service and locations where segments intersect navigable inland waterways.

Analysis Corridors

This task identified Analysis Corridors. These corridors were identified based on very broad-brush planning studies. The purpose of "Analysis Corridors" was to evaluate a reasonable, real-world corridor application of the previously identified TTC technologies. Subsequent, detailed location studies may reveal that the analysis corridors identified here are not the "best" alignments. However, they should permit a realistic assessment of the expected costs, benefits, and impacts of implementing the candidate technologies within the designated TTC study area.

The analysis of the super-segment alternatives indicates that certain corridor alternatives are better suited for certain technology alternatives than for others. In some cases, this is due to service demand while in others it is due to environmental concerns, existing transportation facilities, or planned corridor transportation improvements. For example, the study corridor along I-70 from Kansas City to St. Louis is better suited to rail alternatives because of the higher potential level of freight and passenger travel demand and because of the consideration of this route in previous high-speed rail planning. It is not well-suited to highway-oriented TTC alternatives because of the presence of I-70 and because of the air quality concerns of St. Louis and Kansas City.

If a single representative coast-to-coast corridor alignment were selected at this point in the analysis, it could have the effect of indirectly designating the technology alternative before an even-handed feasibility analysis can be undertaken. Just as the alternative technologies could not be evaluated fully without consideration of the corridor applications of the technologies, the feasibility of corridor alignments cannot be evaluated independent of technology type. Therefore, separate analysis corridor alignments were identified for each of the technology alternatives.

The purpose of the Analysis Corridors is to evaluate a reasonable real-world corridor application of the previously-identified TTC technologies. Although logical association of each technology alternative and its respective Analysis Corridor has been established, future analysis may lead to the refinement and modification of any one corridor. Any one of the technology alternatives is physically feasible in any of the Analysis Corridors.

Below is a summary of the Analysis Corridors.

Analysis Corridor 1: Conventional Interstate Highway and Super Highway

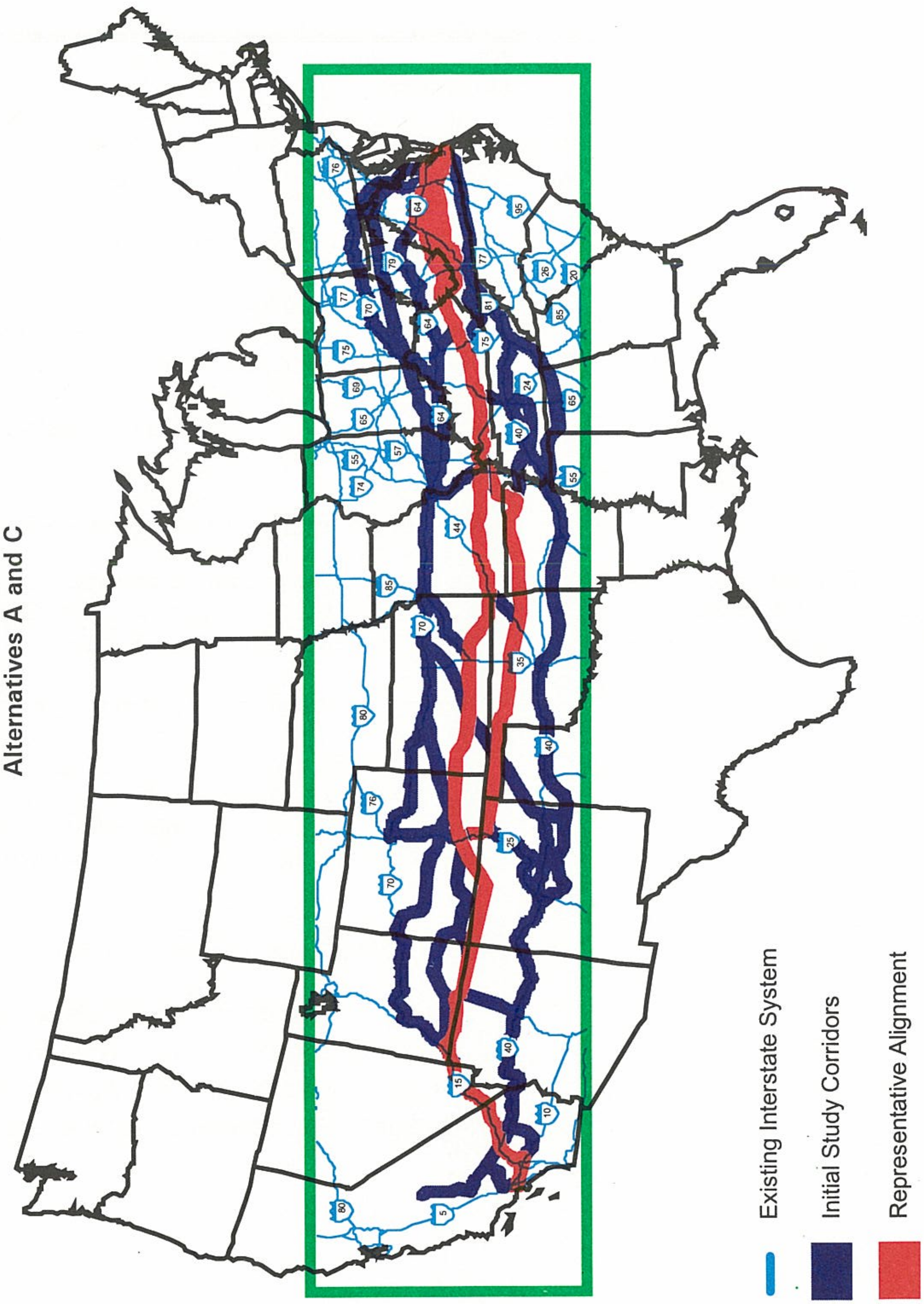
This corridor was chosen to analyze the technology of conventional Interstate-type highway and Super Highway (Technology Alternatives A and C). (Exhibit 6-3)

Corridor 1 is located generally in the center of the TTC study corridor. Two options on the East Coast and in the Midwest were identified because the corridor analysis did not reveal enough difference between them that would rule one out over the other. Cost and environmental impact data were calculated separately, however, for each north and south option.

There are four combinations of these options:

Option 1: East (North) and Midwest (North)
Option 2: East (South) and Midwest (North)
Option 3: East (North) and Midwest (South)
Option 4: East (South) and Midwest (South)

Exhibit 6-3
ANALYSIS CORRIDOR 1 FOR THE TWO HIGHWAY OPTIONS
Alternatives A and C



The representative alignments are purely for analysis purposes and are not meant to be considered as specific alignments.

The options include the following routes:

MIDWEST	EAST
(North)	(North)
Walsenburg, CO	Pikeville, KY
La Junta, CO	Staunton, VA
Bucklin, KS	
Wichita, KS	
Joplin, MO	
Cairo, IL	
(South)	(South)
Walsenburg, CO	Pikeville, KY
Guymon, OK	Hampton, VA
Tulsa, OK	
Imboden, AR	
Cairo, IL	

This corridor avoids urban areas in order to not contribute to existing and expected metropolitan air quality problems. The corridor provides major new east-west service and takes advantage of suitable topography in the West.

Analysis Corridor 2: Upgraded Rail

This corridor was chosen to analyze the technology of upgraded rail (Technology Alternative B). (Exhibit 6-4)

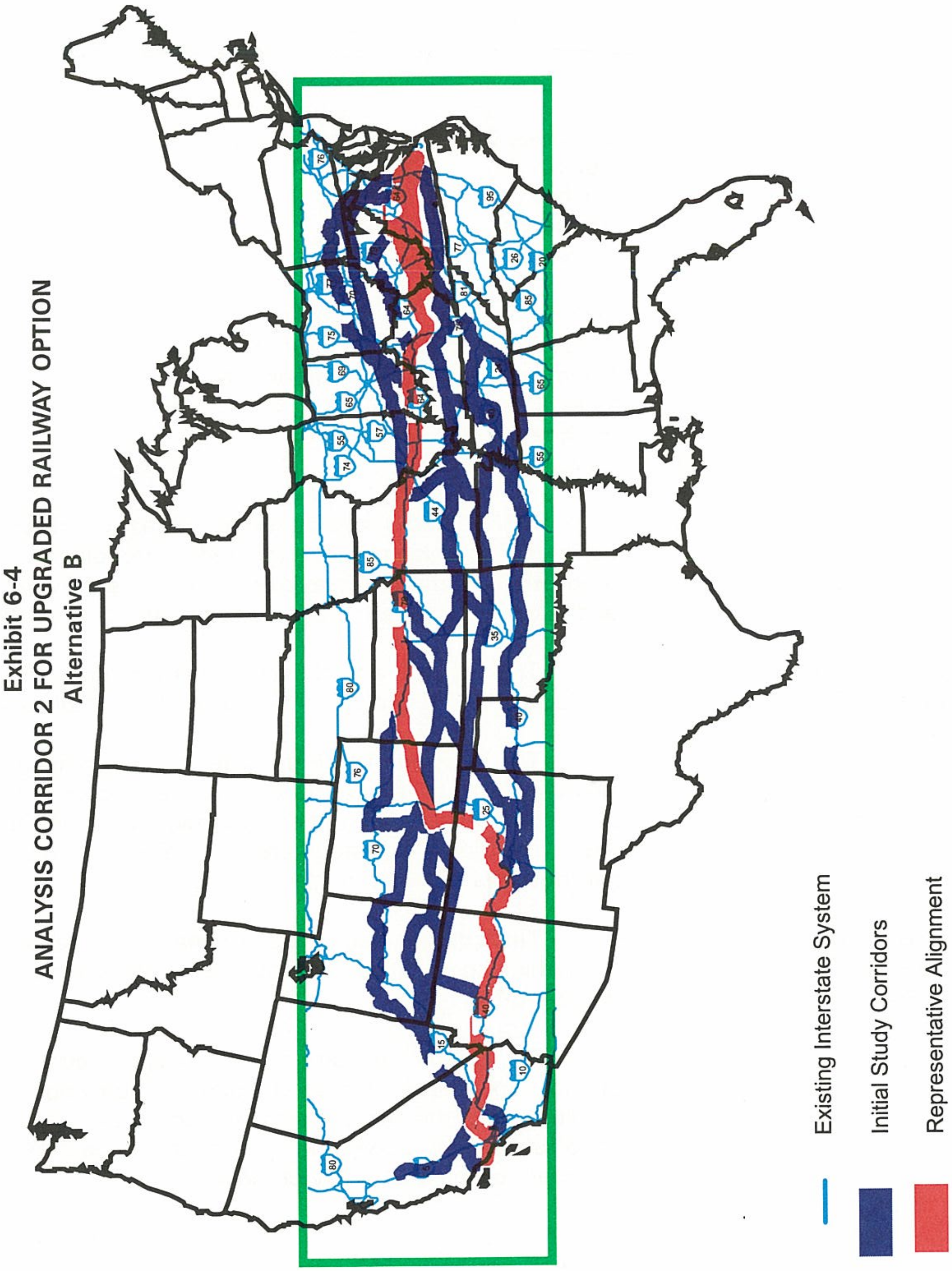
The location of Corridor 2 is influenced almost exclusively by the presence of existing rail rights-of-way and population centers. An optional corridor was identified in the eastern section of the study area. The East option (north and south) is described on the previous page.

Analysis Corridor 3: High Speed Fixed Guideway

This corridor was chosen to analyze the technology of a very high speed fixed guideway (Technology Alternative D). (Exhibit 6-5).

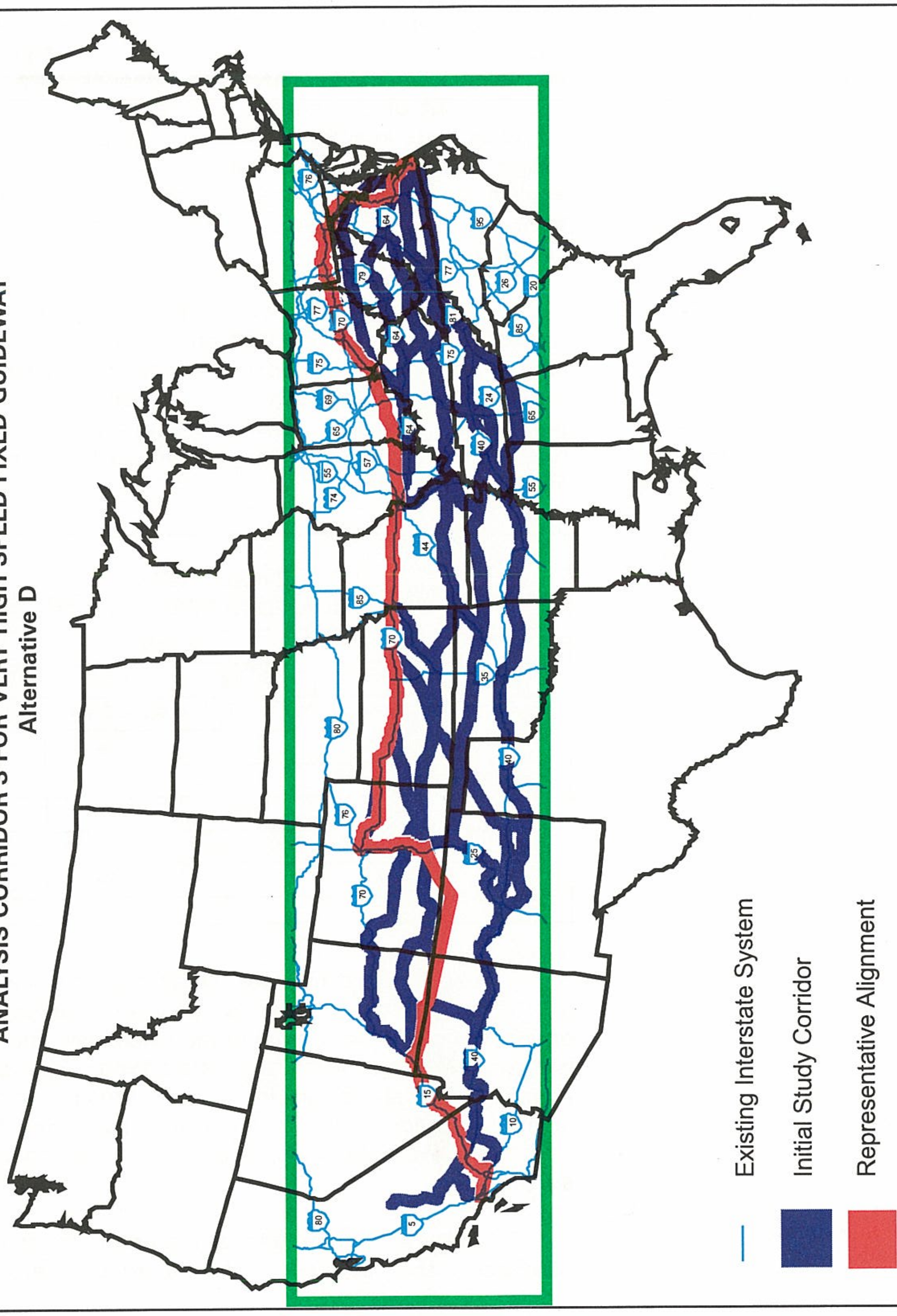
The location of Corridor 3 is influenced by the location of high speed rail or maglev routes in previous planning studies. Also, the corridor was located so as to increase the opportunities to serve major population centers on the boundary of the TTC study corridor.

Exhibit 6-4
ANALYSIS CORRIDOR 2 FOR UPGRADED RAILWAY OPTION
Alternative B



The representative alignments are purely for analysis purposes and are not meant to be considered as specific alignments.

Exhibit 6-5
ANALYSIS CORRIDOR 3 FOR VERY HIGH SPEED FIXED GUIDEWAY
Alternative D



The representative alignments are purely for analysis purposes and are not meant to be considered as specific alignments.

CAPITAL COST ESTIMATES

Capital cost estimates for the four TTC technology concepts were developed on a per km (and on a per mile) basis that reflects local terrain. The analysis corridors identified for each transportation concept were used in the development of the capital cost estimates. The analysis corridors were analyzed to classify the terrain as either flat, rolling, hilly or mountainous and the per kilometer costs were applied to develop a total capital cost estimate for the transportation concepts in their representative analysis corridors.

Terrain designations were developed using 1 to 1,000,000 and 1 to 250,000 scale USGS topographic mapping. The 1 to 250,000 scale mapping was generally used in the hilly and mountainous terrain. Exhibit 6-6 summarizes the terrain distribution for each of the analysis corridors. The total corridor summaries were developed by summing the km of terrain by segment.

Exhibit 6-6
ANALYSIS CORRIDOR TERRAIN SUMMARY

Analysis Corridor	TERRAIN			
	Flat	Rolling	Hilly	Mountainous
Corridor 1 - Conventional Interstate-type Highway & Super Highway				
	21%	36%	36%	7%
Corridor 2 - Upgraded Rail				
	15%	52%	27%	6%
Corridor 3 - Very High Speed Fixed Guideway				
	18%	52%	24%	6%

The upgraded highway, super highway and upgraded rail transportation concept's analysis corridors include optional alignments. The upgraded highway and the super highway have two locations where options are available. As a result four analysis corridor combinations are possible. The analysis corridor for upgraded rail includes one location where options are available, thus two analysis corridor combinations are possible.

Capital cost estimates for the proposed transportation concepts in their selected analysis corridors were developed from per kilometer costs developed for each transportation concept in varying types of terrain. The per kilometer costs were applied to the analysis corridor segments, based on the distribution of terrain types within the segments. Credit for incorporating existing facilities into the new facility was given for the conventional interstate-type highway and the upgraded rail concepts. The segment costs were then summed to determine the estimated capital costs for implementation of the transportation concept on the representative alignment.

The per kilometer capital costs were developed for construction of each transportation concept in four different terrain categories.

The methodology used to develop the costs per kilometer for each transportation concept varied. The conventional Interstate-type highway costs were developed using cost data from actual projects along with cost estimates from various corridor studies. The super highway costs were developed by adjusting the interstate-type highway costs to reflect the differences in cross section and geometric criteria. The upgraded rail costs were developed from historical project data, and the very high speed fixed guideway costs were developed from various feasibility studies' cost estimates.

In general, the rougher the terrain the greater the number of assumptions that were required. With construction of a facility in hilly or mountainous terrain, the percentage of total project cost required for earthwork, tunneling and structures increases. These components of the cost are the most sensitive to location specific characteristics, thus the variation in cost per kilometer can be large. The cost per kilometer in mountainous terrain is the most sensitive because of the extremely high cost of tunneling.

Some of the transportation concepts have very little actual historical construction cost information. As an example, maglev technology has only been in service on test tracks in Germany and Japan. Where available, historical cost data either were used directly in developing the costs per kilometer or were used to validate the costs developed for use in this study.

The capital costs related to an IVHS system in a rural environment are very minimal. Most of the implementation cost of IVHS will be paid by the individual vehicle owners. The most significant fixed facility cost related to IVHS is the communication system.

Capital Costs: Conventional Interstate-type Highway

Development of the project costs per kilometer for the Interstate-type highway concept was based on historical project cost data. The resulting costs per kilometer are presented in Exhibit 6-7.

Exhibit 6-7
UPGRADED HIGHWAY CAPITAL COSTS
Millions of 1993 Dollars

	TERRAIN							
	Flat		Rolling		Hilly		Mountainous	
	Per KM	Per Mile	Per KM	Per Mile	Per KM	Per Mile	Per KM	Per Mile
Construction	$2.1	$3.3	$3.2	$5.1	$4.7	$7.5	$7.0	$11.2
Right-of-way	$0.1	$0.2	$0.1	$0.2	$0.1	$0.2	$0.1	$0.2
Subtotal	$2.2	$3.5	$3.3	$5.3	$4.8	$7.7	$7.1	$11.4
Eng. & Admin. (20%)	$0.4	$0.7	$0.7	$1.1	$0.9	$1.5	$1.4	$2.3
Vehicles	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Subtotal	$2.6	$4.2	$4.0	$6.4	$5.7	$9.2	$8.5	$13.7
Contingencies (20%)	$0.5	$0.8	$0.8	$1.3	$1.1	1.8	$1.7	$2.7
Total	$3.1	$5.0	$4.8	$7.7	$6.8	$11.0	$10.2	$16.4

Total project costs were taken from past studies and various state projects. The costs were categorized by terrain and were factored to 1993 dollars using the Means construction cost index. The project costs for each terrain category were then averaged to determine a cost per kilometer for an Interstate-type highway in each type of terrain. The resulting average capital costs appear reasonable and consistent with costs per kilometer provided by various states.

With the Interstate-type highway concept it is believed that existing highways constructed to near interstate standards can be incorporated into the proposed facility at reasonable cost. For these segments or portions of segments, ten percent of the basic per kilometer cost was used.

The minimal cost for these segments will account for implementation of IVHS and safety enhancements as required.

The per kilometer costs for the Interstate-type highway were applied to the individual segments that make up the analysis corridors. Exhibit 6-8 summarizes the alignment length, and the split between existing and new facility. The estimated capital costs for the four Interstate-type highway analysis corridors ranges from $16.7 billion to $19.8 billion. These total costs were averaged to determine a representative capital cost for the Interstate-type highway concept coast to coast. Exhibit 6-9 summarizes the representative capital costs.

Exhibit 6-8
UPGRADED HIGHWAY
ANALYSIS CORRIDOR 1 LENGTHS

Representative Alignment Options	Length in Kilometers (miles)					
	Existing		New		Total	
No. 1 - East (North)/Midwest (North)	1,566	(973)	2,882	(1,791)	4,448	(2,764)
No. 2 - East (South)/Midwest (North)	1,036	(644)	3,447	(2,142)	4,483	(2,786)
No. 3 - East (North/Midwest (South)	1,736	(1,079)	2,839	(1,764)	4,575	(2,843)
No. 4 - East (South)/Midwest (South)	1,207	(750)	3,404	(2,115)	4,611	(2,865)

Exhibit 6-9
ALTERNATIVE A: Upgraded Highway Representative
Capital Cost Estimates
(Billions of 1993 Dollars)

	Capital Cost
Construction	$12.6
Right-of-way	$0.2
Subtotal	$12.8
Engineering & Admin. (20%)	$2.5
Vehicles	$0.0
Subtotal	$15.3
Contingencies (20%)	$3.0
Total	$18.3

Capital Costs: Upgraded Rail

The per kilometer capital costs for upgraded rail on new and existing alignment, presented in Exhibit 6-10 and 6-11 respectively, were developed from historical unit cost data. The major components included in the upgraded rail costs include track bed/track work, signal/communication system, structures, earthwork, tunnels, terminals and maintenance facilities.

Exhibit 6-10
UPGRADED RAIL - NEW ALIGNMENT
CAPITAL COSTS
Millions of 1993 Dollars

	TERRAIN							
	Flat		Rolling		Hilly		Mountainous	
	Per KM	Per Mile	Per KM	Per Mile	Per KM	Per Mile	Per KM	Per Mile
Construction	$3.8	$6.1	$5.3	$8.6	$7.4	$12.0	$12.8	$20.6
Right-of-way	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1
Subtotal	$3.9	$6.2	$5.4	$8.7	$7.5	$12.1	$12.9	$20.7
Eng. & Admin. (20%)	$0.7	$1.2	$1.0	$1.7	$1.5	$2.4	2.5	$4.1
Vehicles	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1
Subtotal	$4.7	$7.5	$6.5	$10.5	$9.1	$14.6	$15.5	$24.9
Contingencies (20%)	$0.9	$1.5	$1.3	$2.1	$1.8	$2.9	$3.1	$5.0
Total	$5.6	$9.0	$7.8	$12.6	$10.9	$17.5	$18.6	$29.9

Exhibit 6-11
UPGRADED RAIL - EXISTING ALIGNMENT
CAPITAL COSTS
Millions of 1993 Dollars

	TERRAIN							
	Flat		Rolling		Hilly		Mountainous	
	Per KM	Per Mile	Per KM	Per Mile	Per KM	Per Mile	Per KM	Per Mile
Construction	$3.5	$5.6	$3.9	$6.3	$4.9	$7.9	$8.4	$13.5
Right-of-way	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Subtotal	$3.5	$5.6	$3.9	$6.3	$4.9	$7.9	$8.4	$13.5
Eng. & Admin. (20%)	$0.6	$1.1	$0.8	$1.3	$1.0	$1.6	$1.6	$2.7
Vehicles	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1
Subtotal	$4.2	$6.8	$4.8	$7.7	$6.0	$9.6	$10.1	$16.3
Contingencies (20%)	$0.9	$1.4	$0.9	$1.5	$1.1	$1.9	$2.1	$3.3
Total	$5.1	$8.2	$5.7	$9.2	$7.1	$11.5	$12.2	$19.6

The costs per kilometer for upgraded rail represent a basic two track facility. Passing tracks were assumed to be provided as needed along the facility and at major terminal areas additional tracks were assumed. Interlockings were assumed at an average interval of 80 km (50 miles). These interlockings are not essential for basic operation, but are required for maintenance activities. The interlockings also increase the flexibility of the facility. The track bed section includes concrete ties and continuously welded rail.

The signal and communication system includes automatic block signaling, speed control, interlockings and centralized traffic control. This signal system will allow trains to operate in either direction on any track with complete signal protection for following and opposing train movements. This will allow sections of the main track to be taken out of service for maintenance while still maintaining headways in both directions.

The earthwork and structural costs were developed using historical information from projects such as the 130-km (81-mile) long Timber Ridge rail project which ran through rough terrain in British Columbia. The average grading cost per kilometer for the project was \$1.4 million per km (\$2.3 million per mile) for a single track facility.

To estimate the cost of terminal facilities it was assumed that two major multi-modal freight and passenger terminals would be required along the route.

The major items that reduce the costs for upgraded rail on existing rail alignment are right-of-way and grading. Some reduction in the unit cost for track bed construction was also applied.

The per kilometer costs for the upgraded rail concept were applied to the individual segments that make up the two analysis corridor options. The total length for each option is summarized in Exhibit 6-12. The two representative alignments' total capital costs were averaged to determine a representative cost for the upgraded rail technology. Exhibit 6-13 summarizes the representative capital costs.

Capital Costs: Super Highway

The per kilometer capital cost estimates for the super highway were developed by factoring the per kilometer Interstate-type highway costs to reflect cost impacts from the

Exhibit 6-12
UPGRADED RAIL
ANALYSIS CORRIDOR 2 LENGTHS

ANALYSIS CORRIDOR OPTION	LENGTH IN KILOMETERS (Miles)					
	Existing		New		Total	
Option 1 - North	3,870	(2,405)	864	(537)	4,735	(2,942)
Option 2 - South	3,666	(2,278)	1,117	(694)	4,783	(2,972)

Exhibit 6-13
ALTERNATIVE B: UPGRADED RAIL REPRESENTATIVE
CAPITAL COST ESTIMATES
Billions of 1993 Dollars

	CAPITAL COST
Construction	$22.8
Right-of-Way	$0.1
Subtotal	$22.9
Engineering & Admin.	$4.6
Vehicles	$0.1
Subtotal	$27.6
Contingencies	$5.5
Total	$33.1

different cross section and from geometric requirements for a 241 kilometers per hour (150 mph) design speed. A two step procedure was used to factor the costs. The resulting project costs per kilometer are presented in Exhibit 6-14.

The first step was to split the costs per kilometer for Interstate-type highways in each terrain into the categories of grading, pavement, drainage, structures, miscellaneous, contingencies and right-of-way. A project from each type of terrain was analyzed to determine the percentage distribution of the cost. By multiplying the average costs per kilometer by the percentage developed for each cost item, a cost per kilometer matrix reflecting terrain and cost items was developed.

Two factors were developed and applied to the costs per kilometer of the Interstate-type highway in order to

Exhibit 6-14
SUPER HIGHWAY CAPITAL COSTS
Millions of 1993 Dollars

	TERRAIN							
	Flat		Rolling		Hilly		Mountainous	
	Per KM	Per Mile	Per KM	Per Mile	Per KM	Per Mile	Per KM	Per Mile
Construction	$3.9	$6.3	$5.7	$9.2	$10.7	$17.2	$21.4	$34.5
Right-of-way	$0.2	$0.3	$0.2	$0.3	$0.2	$0.3	$0.2	$0.3
Subtotal	$4.1	$6.6	$5.9	$9.5	$10.9	$17.5	21.6	$34.8
Eng. & Admin. (20%)	$0.8	$1.3	$1.2	$1.9	$2.1	$3.5	4.4	$7.0
Vehicles	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Subtotal	$4.9	$7.9	$7.1	$11.4	$13.0	$21.0	$26.0	$41.8
Contingencies (20%)	$1.0	$1.6	$1.4	$2.3	$2.7	$4.2	$5.2	$8.4
Total	$5.9	$9.5	$8.5	$13.7	$15.7	$25.2	$31.2	$50.2

determine super highway costs per kilometer. The first factor reflects cost increases resulting from the difference in cross section, and the second factor was developed to reflect the cost implications resulting from the more restrictive geometric criteria. The type of terrain does effect the geometric factor, but not the cross section factor.

The following considerations went into development of the cross section factors:

- **Grading** - The added width of the roadway cross sections resulted in increased cuts and fills.
- **Pavement** - The increase in number of lanes and shoulders were included along with an average increase of pavement thickness.
- **Drainage** - The increased width of the cross section along with the need for additional median drainage which occurs with the barrier sections.
- **Bridges** - The increase in width along with an increase in design loading.
- **Right-of-way** - The increase in the proposed right-of-way width was used.

The following considerations went into development of the restrictive geometrics factors:

- **Grading** - The increased restrictions on the vertical alignment, such as flatter allowable grades and longer vertical curves, result in larger cuts and fills. The restrictive horizontal alignment criteria limits the ability to adjust the horizontal alignment to reduce earthwork.

- **Pavement** - No increase in cost per kilometer.

- **Drainage** - No increase in cost per kilometer (the impact of skewed river crossings is included in the bridge factor).

- **Bridges** - The bridge factor reflects the increased number of locations where fills are so high that a structure is required (hilly and mountainous terrains only) and increased average skew which will result from less horizontal alignment flexibility.

- **Right-of-way** - No increase in cost per kilometer (the proposed right-of-way envelope should handle the increase fill and cut sections).

The miscellaneous cost was calculated by developing an average percentage of the combined grading, pavement, drainage and bridges costs. This average was then applied to the subtotal of the adjusted costs per kilometer.

The analysis corridor lengths for the super highway concept are presented in Exhibit 6-15. The capital costs for each of the four options were averaged to develop a representative cost for the super highway technology. The capital costs for the four super highway options ranged from $54.2 billion to $56.5 billion. The representative cost is summarized in Exhibit 6-16.

Capital Costs: High Speed Fixed Guideway

Two cost estimates for high speed fixed guideway were developed: steel wheel on steel rail and magnetic levitation technology (maglev). The maglev concept's cost is considerably higher than the more conventional rail concept. The costs per kilometer for high speed rail are shown in Exhibit 6-17 and the maglev costs are shown in Exhibit 6-18.

Exhibit 6-15
SUPER HIGHWAY
ANALYSIS CORRIDOR 1 LENGTHS

Analysis Corridor Option	Length in Kilometers (Miles)	
Option 1 - East (North) and Midwest (North)	4,448	(2,764)
Option 2 - East (South) and Midwest (North)	4,484	(2,786)
Option 3 - East (North) and Midwest (South)	4,575	(2,843)
Option 4 - East (South) and Midwest (South)	4,611	(2,865)

Exhibit 6-16
SUPER HIGHWAY
REPRESENTATIVE CAPITAL COSTS
Billions of 1993 Dollars

	CAPITAL COST
Construction	$37.7
Right-of-way	$0.8
Subtotal	$38.5
Engineering & Admin. (20%)	$7.7
Vehicles	$0.0
Subtotal	$46.2
Contingencies (20%)	$9.2
Total	$55.4

The costs for each fixed guideway concept were developed based on cost data found in TRB Special Report 233 *In Pursuit of Speed*[1] and from other historical cost data.

The unit costs provided in the TRB report did not reflect a corridor which passed through any mountainous

1 Transportation Research Board, National Research Council, *In Pursuit of Speed — New Options for Intercity Passenger Transport*, Special Report 233, 1991.

Exhibit 6-17
HIGH SPEED RAIL CAPITAL COSTS
Millions of 1993 Dollars

	TERRAIN							
	Flat		Rolling		Hilly		Mountainous	
	Per KM	Per Mile	Per KM	Per Mile	Per KM	Per Mile	Per KM	Per Mile
Construction	$4.7	$7.6	$6.4	$10.4	$8.8	$14.3	$14.7	$23.7
Right-of-way	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1
Subtotal	$4.8	$7.7	$6.5	$10.5	$8.9	$14.4	$14.8	$23.8
Eng. & Admin. (20%)	$0.9	$1.5	$1.3	$2.1	$1.8	$2.9	$2.9	$4.8
Vehicles	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1
Subtotal	$5.8	$9.3	$7.9	$12.7	$10.8	$17.4	$17.8	$28.7
Contingencies (20%)	$1.2	$1.9	$1.5	$2.5	$2.2	$3.5	$3.6	$5.7
Total	$7.0	$11.2	$9.4	$15.2	$13.0	$20.9	$21.4	$34.4

Exhibit 6-18
MAGLEV CAPITAL COSTS
Millions of 1993 Dollars

	TERRAIN							
	Flat		Rolling		Hilly		Mountainous	
	Per KM	Per Mile	Per KM	Per Mile	Per KM	Per Mile	Per KM	Per Mile
Construction	$9.9	$16.0	$10.5	$17.0	$11.7	$18.9	$15.2	$24.5
Right-of-way	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1
Subtotal	$10.0	$16.1	$10.6	$17.1	$11.8	$19.0	$15.3	$24.6
Eng. & Admin. (20%)	$2.0	$3.2	$2.2	$3.4	$2.4	$3.8	$3.1	$4.9
Vehicles	$0.1	$0.2	$0.1	$0.2	$0.1	$0.2	$0.1	$0.2
Subtotal	$12.1	$19.5	$12.9	$20.7	$14.3	$23.0	$10.8	$29.7
Contingencies (20%)	$2.4	$3.9	$2.5	$4.1	$2.8	$4.6	$2.2	$5.9
Total	$14.5	$23.4	$15.4	$24.8	$17.1	$27.6	$13.0	$35.6

terrain. To develop a cost per kilometer for mountainous terrain the grading cost was increased, the structure cost was increased and some tunneling was assumed. It was assumed that on average 15 percent of the alignment through the mountains would be in a tunnel. A terminal was assumed to occur on average every 805 km (500 miles) for both technologies.

Only one analysis corridor option resulted from the corridor selection process for the very high speed fixed guideway technology. The analysis corridor's length, the capital costs for very high speed rail and the capital costs for maglev are presented in Exhibit 6-19.

Exhibit 6-19
VERY HIGH SPEED FIXED GUIDEWAY
REPRESENTATIVE CAPITAL COSTS
Billions of 1993 Dollars

	CAPITAL COST	
	RAIL	MAGLEV
Construction	$35.1	$53.5
Right-of-way	$0.3	$0.3
Subtotal	$35.4	$53.8
Engineering & Admin.	$7.1	$10.7
Vehicles	$0.3	$0.6
Subtotal	$42.8	$65.1
Contingencies (20%)	$8.6	$13.0
Total	$51.4	$78.1
Length kilometers (miles)	4,830 km (3,019)	4,830 km (3,019)

OPERATION AND MAINTENANCE COSTS

Annual operation and maintenance costs for the various alternative concepts were estimated. Operation and maintenance costs for the highway facilities differ from a fixed guideway facility. Both facility types require maintenance of the fixed facilities, but the fixed guideway facilities incur additional on-going costs for maintenance of vehicles, labor costs, energy, passenger amenities and system administration. With the highway facilities these costs are borne by the individual users.

Highway Annual Maintenance and Operation Costs

If either of the highway options (A: Conventional Interstate-type highway, or C: Super Highway) is built, there will be a net increase in the kilometers of road to maintain, administer, police, and operate. Such maintenance and operations costs occur annually. Periodic rehabilitation is also needed.

The annual highway operations and maintenance costs were estimated, based on average costs for state highway agencies, on a per route kilometer annualized basis and multiplied by the net increase in highway route kilometers. The results, at constant 1993 price levels, are presented on Exhibit 6-20. In the life cycle cost analysis, these annual values are taken as a cost every year, 1994-2040.

Exhibit 6-20
ANNUAL INCREASE IN HIGHWAY MAINTENANCE AND OPERATIONS COST

HIGHWAY O & M COST ITEM	A: INTERSTATE-TYPE HIGHWAY			C: SUPER HIGHWAY		
	Annual Cost		Annual Cost In Entire Corridor ($Million)	Annual Cost		Annual Cost in Entire Corridor ($ Million)
	Per KM	Per Mile		Per KM	Per Mile	
Administration[a]	$3,210	$5,166	$10.09	$3,210	$5,166	$10.09
Maintenance[a]	$9,567	15,396	30.07	$19,263	$31,000	73.90
Highway Patrol[a]	$7,208	11,600	22.65	$7,208	$11,600	13.55
Communications[b]	$901	1,450	4.08	$1,802	$2,900	8.16
TOTAL COST	$20,886	$33,612	$66.89	$31,482	$50,666	$91.94

(a) Per km cost times 3,143 "new" km (1,953 miles) of highway for Interstate-type highway and 3,837 km (2,384 miles) for super highway.
(b) Per km cost times 4,530 km (2,815 miles) total TTC miles.

Railway Operations

If either of the rail guideway options (B: Upgraded Railway, or D: Very High Speed Guideway) is built, there will be a new coast-to-coast guideway system to operate and maintain.

To develop the guideway operating and maintenance costs, guideway operating plans were developed based on estimated passenger and freight use. For Alternative B, the upgraded railway option, both freight and passenger services are contemplated; Alternative D, the very high speed guideway, is restricted to the movement of people.

Both freight and passenger demand were converted to an equivalent number of trains by route segment. For passenger service, train-sets of eight passenger carrying cars with an average capacity of 60 persons each and a load factor of 65 percent were adopted as the standard, based on other high-speed studies. Freight train consists of 50 double-stack wells with average commodity weights of 15.2 metric tons (16.8 tons) per container, with appropriate east and west bound load factors, were adopted. The 50-well train is shorter than typical double-stack train as a concession to design operating speeds.

The train maintenance of way costs were calculated based on the kilometers of track needed to be maintained. The rail operating costs reflect the number of trains per day, their train kilometers, and their train hours.

Exhibit 6-21 depicts the estimated numbers of passengers and freight in the year 2040. The calculations indicate that, in the year 2040:

- **Alternative B: Upgraded Railway** will need between 10 and 13 daily passenger trains, and between 8 and 38 freight trains per day, with the greatest frequency in the Nation's mid-section.

- **Alternative D: Very High Speed Guideway** will need between 9 and 44 trains per day, with the greatest frequency between California and Las Vegas, and again on the east end of the TTC.

Rail Cost Estimates

Operating and maintenance costs for both rail passenger services options were estimated using the methodology set forth in Appendix B of *In Pursuit of Speed*.[2] The methodology is based on the results of studies of high-speed rail feasibility conducted in the United States. Cost components consist of the items listed below:

- Maintenance of Way
- Maintenance of Equipment
- Energy
- Operation of Service
- Operation of Stations
- Operation of Signals and Communications
- Administration, Sales, and Insurance

The cost computation is based on factors applied to capital costs and projected operating parameters such as annual passengers, seat-km, route-km, and others. Adoption of this methodology is believed appropriate given the un-

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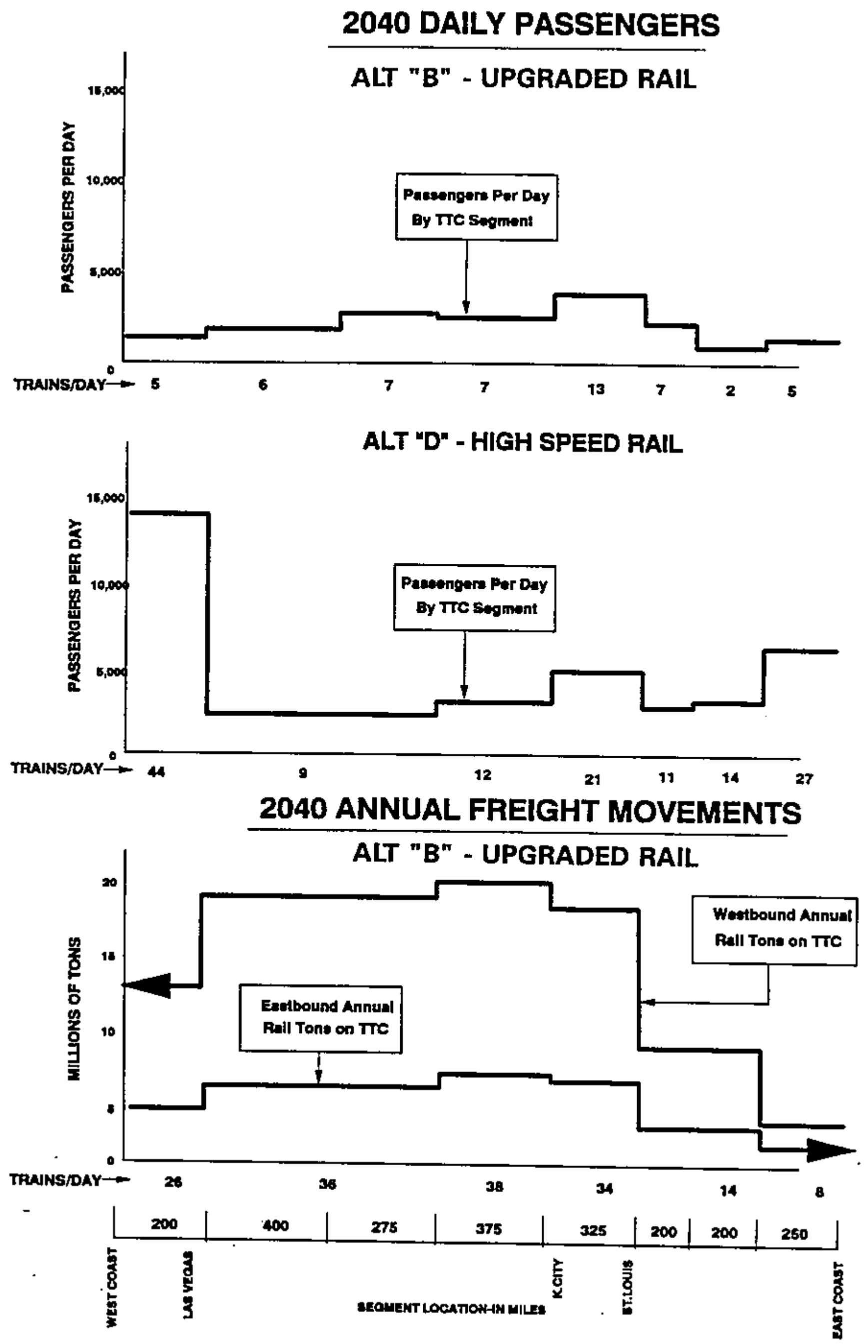
[2] Transportation Research Board, National Research Council, *In Pursuit of Speed — New Options for Intercity Passenger Transport*, Special Report 233, 1991.

Exhibit 6-21
TRAINS PER DAY BY TTC RAIL SEGMENTS



knowns involved (i.e., no real U.S. experience base). The methodology was not adopted out-of-hand, however, as selected "reality checks" were performed.

Examples of the cost calculations for the two rail passenger options are the subject of Exhibits 6-22 and 6-23. These Exhibits include rail maintenance of way costs in their entirety, and passenger train operating costs, per the Pursuit of Speed methodology. They exclude freight train operating costs.

Exhibit 6-22
ESTIMATED RAIL PASSENGER OPERATIONS AND MAINTENANCE COSTS FOR UPGRADED RAILWAY
Year 2040

SYSTEM OR SERVICE PARAMETER	QUANTITY		FACTOR[1]	COST ELEMENT[2] ($ million)	
	Metric	British		Metric	British
Capital cost (millions)	$33,120	$33,120	0.0053	$175.536	$175.536
Route distance	4,484	2,786	0.0341	152.904	95.003
Track distance	8,968	5,572	0.0191	171.270	106.425
Number of stations	28	28	1.0846	30.369	30.369
Annual seat-distance[3]	6,284	3,905	0.0053	33.305	20.696
Annual seat-hours[4]	42.048	42.048	3.0142	126.741	126.741
Annual passengers[5]	4.197	4.197	1.0269	4.310	4.310
TOTAL COST				$627.972	$559.079

1. Alternative 5, Table A-13, *In Pursuit of Speed.*
2. Cost elements are determined by multiplying quantity by factor.
3. Annual seat-distance is determined as follows: 8 trains per day (total both directions) x 60 seats per car x 8 cars per train x 644 km [400 miles] per trip x 365 days per year (in millions).
4. Annual seat hours is determined as follows: 8 trains per day (total both directions) x 365 days per year x 30 hours per trip x 480 seats per train (in millions).
5. In millions.

Exhibit 6-23
ESTIMATED RAIL PASSENGER OPERATIONS AND MAINTENANCE COSTS FOR VERY HIGH SPEED GUIDEWAY
Year 2040

SYSTEM OR SERVICE PARAMETER	QUANTITY		FACTOR[1]	COST ELEMENT[2] ($millions)	
	Metric	British		Metric	British
Capital cost (millions)	$51,385	$51,385	0.00455	$233.802	$233.802
Route distance	4,828	3,000	0.0400	193.120	120.000
Track distance	9,656	6,000	0.0267	357.817	160.200
Number of stations	15	15	1.4105	21.158	21.158
Annual seat-distance[3]	14,380	8,935	0.00665	95.626	59.419
Annual seat-hours[4]	43.187	43.187	3.4811	150.388	150.338
Annual passengers[5]	15.330	15.330	1.2335	18.909	18.909
TOTAL COST				$882.245	$763.825

1. Alternative 5, Table A-13, *In Pursuit of Speed.*
2. Cost elements are determined by multiplying quantity by factor.
3. Annual seat-distance is determined as follows: 8 trains per day (total both directions) x 60 seats per car x 8 cars per train x 644 km [400 miles] per trip x 365 days per year (in millions).
4. Annual seat hours is determined as follows: 8 trains per day (total both directions) x 365 days per year x 30 hours per trip x 480 seats per train (in millions).
5. In millions.

Freight transport costs are based on the cost structure shown in Exhibit 6-24. These costs were adjusted to compensate for the cost changes associated with higher speed operations -- fuel costs were doubled while labor and equipment ownership were reduced by the estimated time savings as shown in Exhibit 6-25. The unit costs shown in Exhibit 6-25 are based on estimated ton-km (ton-miles) of freight in 1990 and 2040 which are 54 (37) and 63 (43) billion, respectively.

Upgraded rail and very high speed rail annual operating and maintenance costs are summarized in Exhibit 6-26.

Since the maintenance of way and structures is common to both freight and passenger operations, this cost element is separated from total costs. As evident from examination of Exhibit 6-27, maintenance of way costs account for a large portion of overall costs.

Exhibit 6-24
COST STRUCTURE COMPARISON BY MODE

MODE	TOFC/ COFC		OWNER-OPERATOR		TRUCKLOAD SUPERCARRIER		DOUBLE-STACK	
DIRECT COSTS:								
Labor Cost	$0.04	($0.07)	$0.15	($0.25)	$0.13	($0.21)	$0.02	($0.03)
Fuel Cost	$0.04	(0.07)	$0.11	(0.17)	$0.07	(0.11)	$0.04	(0.06)
Pick-Up and Delivery Cost	$0.16	(0.25)	$0.00	(0.00)	$0.00	(0.00)	$0.16	(0.25)
Equipment Ownership Cost	$0.07	(0.10)	$0.13	(0.21)	$0.11	(0.17)	$0.02	(0.04)
Fixed Running Cost[1]	$0.06	(0.09)	$0.09	(0.14)	$0.07	(0.12)	$0.03	(0.05)
TOTAL DIRECT COST	$0.37	($0.58)	$0.48	($0.77)	$0.38	($0.61)	$0.27	($0.43)
INDIRECT COSTS:								
Circuitry Factor		(x 1.15)		(x 1.00)		(x 1.00)		(x 1.15)
Adjusted Cost	$0.42	($0.67)	$0.48	($0.77)	$0.38	($0.61)	$0.31	($0.50)
Admin., Sales & Marketing, Etc. Cost	$0.12	(0.20)	$0.15	(0.24)	$0.11	(0.18)	$0.10	(0.16)
SUBTOTAL	**$0.54**	**($0.87)**	**$0.63**	**($1.01)**	**$0.49**	**($0.79)**	**$0.41**	**($0.66)**
Deadhead Factor (Empty Backhaul)		÷ 0.65		(÷ 0.85)		(÷0.92)		(÷ 0.80)
TYPICAL COST PER LOADED KM	**$0.83**	**($1.33)**	**$0.74**	**($1.19)**	**$0.51**	**(0.86)**	**$0.51**	**($0.82)**

SOURCE: *A Look Ahead - Year 2020*, Transportation Research Board, National Research Council, 1988, p. 348.
NOTE: All costs per trailer/container kilometer (mile).
(1) Includes equipment maintenance, insurance, licensing, etc.

Exhibit 6-25
UPGRADED RAILROAD DOUBLE STACK COST

COST ITEM	UNIT COSTS	
	Old	New
Labor	$0.02 ($0.03)	$0.01 ($0.02)
Fuel	$0.04 ($0.06)	$0.06 ($0.09)
Pick-Up & Delivery	$0.16 ($0.25)	$0.16 ($0.25)
Equipment Ownership	$0.02 ($0.04)	$0.02 ($0.03)
Fixed	$0.03 ($0.05)	$0.03 ($0.05)
		$0.28 ($0.44)
	x Circuit	1.15
	Subtotal	$0.32 ($0.51)
Administration, Sales		$0.10 ($0.16)
	Subtotal	$0.42 ($0.67)
Deadhead Factor		÷0.80
Typical Cost		$0.52 ($0.83) per container-km (mile) 9.5 metric tons/container, (16.8 tons/container)

NOTE: All cost per trailer/container kilometer (mile). Container weight is 9.5 metric tons (16.8 tons).

Exhibit 6-26
ANNUAL FIXED GUIDEWAY OPERATING AND MAINTENANCE COSTS

SERVICE AND TIME PERIOD	ANNUAL ESTIMATED COST ($ millions)			
	Maintenance of Way & Structures	Passenger Operations	Freight Operations	TOTAL COST
Alternative B: Upgraded Railway				
1990	$119	$364	$2,356	$2,839
2040	120	439	2,756	3,315
Alternative D: Very High Speed Guideway				
1990	$164	$490	0	$654
2040	167	597	0	764

Chapter 7
TRAVEL DEMAND FORECASTS

Travel demand forecasts for passengers and freight are presented in this Chapter. Passenger and freight estimates are provided for two years, 1990 and 2040.

PASSENGER TRAVEL DEMAND FORECASTS

Passenger travel demand forecasts have been prepared for each of the four candidate options and for a base case. Basic assumptions on growth rates which apply to all options are described first. Forecasts are then presented for the base case and each option in turn.

GROWTH FORECASTS

Growth forecasts are presented for intercity trips by passenger car and by air.

Intercity Car Trip Forecasts

Projections of population and per capita income to the year 2040 have been developed by the Bureau of Economic Analysis, U.S. Department of Commerce. The same source provides historical values consistent with the projections for selected years (1973, 1979, 1983 and 1988). These projections are shown in Exhibit 7-1.

Population trends and projections for the United States are shown in Exhibit 7-2. Between 1973 and 1988 the average annual increase in population was 1.01 percent. The rate of increase in population between 1990 and 2040 is projected to moderate to an average of 0.38 percent per year.

Trends and projections for per capita income (in constant 1982 Dollars) are shown in Exhibit 7-3. The average rate of increase in per capita income between 1973 and 1988 was 1.59 percent. This rate of increase is projected to average 0.84 percent per year from 1990 to 2040.

The product of population and per capita income (or total income) is used as an indicator of intercity automobile travel in the demand model described in Chapter 3. It is therefore of interest to compare the change in total income with the change in intercity auto travel during the 1973 to

Exhibit 7-1
BEA PROJECTIONS
U.S. Population and Per Capita Income

YEAR	POPULATION (million)	PER CAPITA INCOME (in 1982 dollars)
1973	211.340	$10,449
1979	224.564	$11,551
1983	234.254	$11,623
1988	245.803	$13,245
1995	259.613	$14,469
2000	267.741	$15,345
2005	275.079	$16,065
2010	282.050	$16,693
2020	293.839	$17,721
2040	301.282	$20,646

Exhibit 7-2
U.S. POPULATION TRENDS AND PROJECTIONS

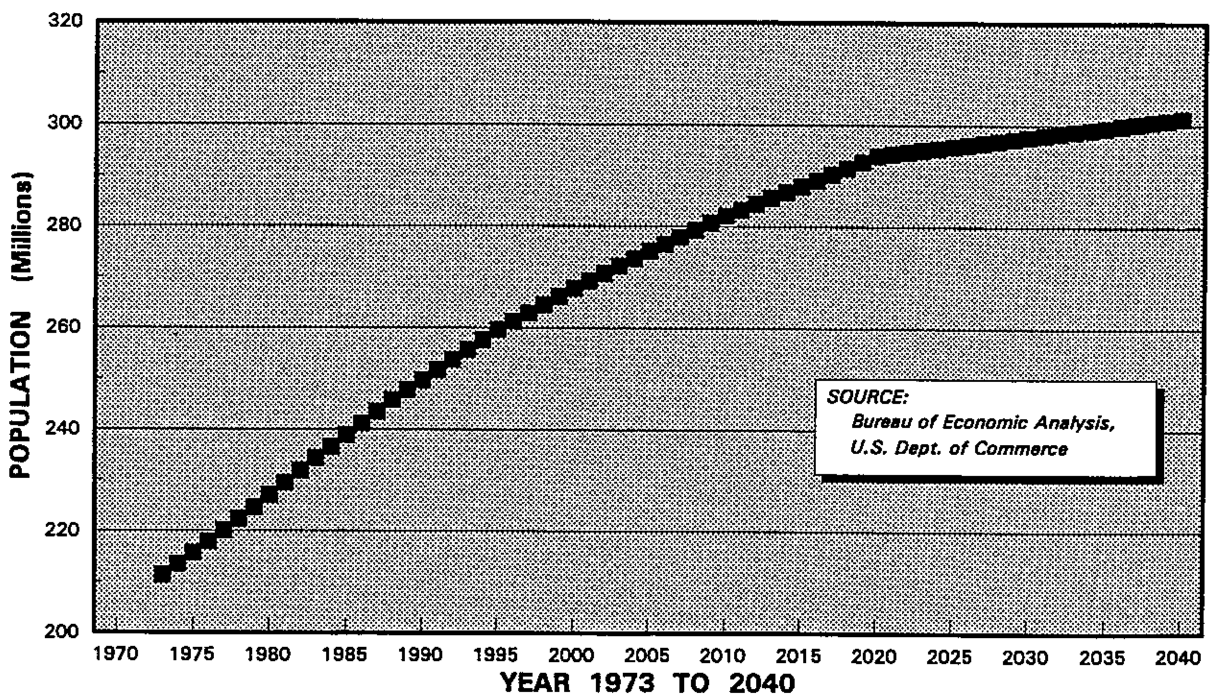
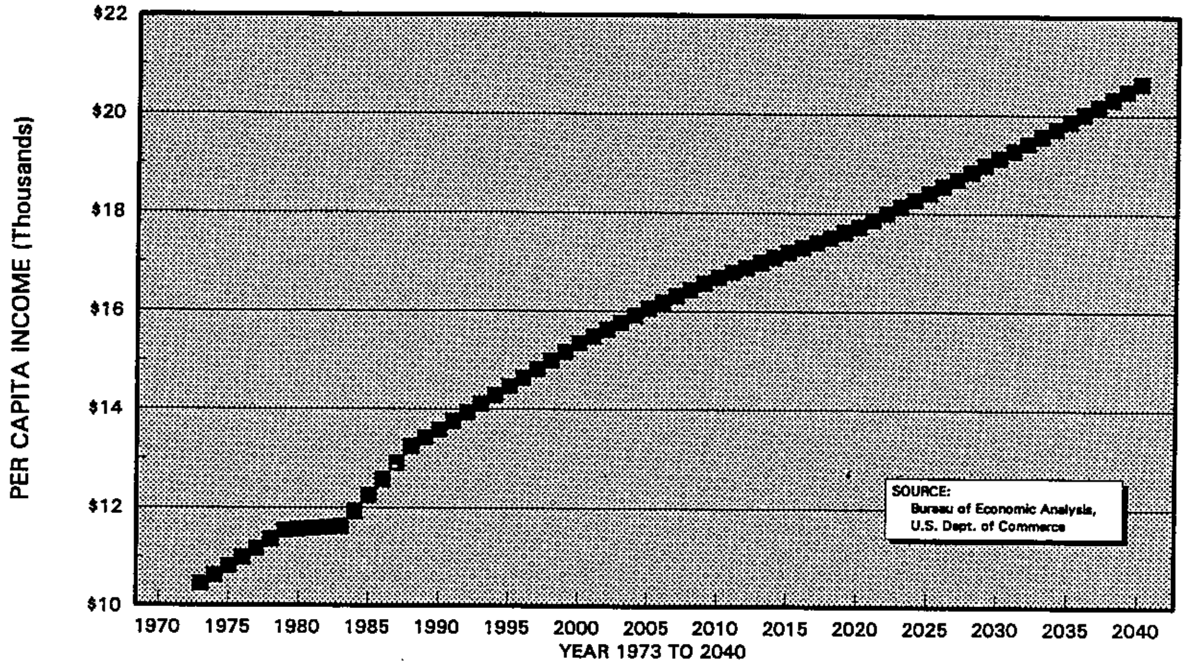


Exhibit 7-3
U.S. PER CAPITA INCOME TRENDS AND PROJECTIONS



1988 period. Exhibit 7-4 shows vehicle-km (vehicle-miles) of travel on rural interstates between 1966 to 1991.

During the period between 1973 and 1988 vehicle-km on rural interstates increased at an average rate of 2.45 percent. During this same period total income increased at an annual average rate of 2.62 percent. Based on this relationship and BEA's projected rate of increase in total income of 1.22 percent per year between 1990 and 2040, rural interstate vehicle-km may be projected to grow at 1.14 percent per year. This would result in a projected 366,400 million vehicle-km (229,000 million vehicle-miles) of travel on rural interstates by 2040, representing an increase of 76 percent from the 208,000 million vehicle-km (130,000 million vehicle-miles) recorded in 1990. This projection is shown in Exhibit 7-5.

This rate of growth is used to develop basic projections for intercity auto trips in the year 2040. These basic

Exhibit 7-4
RURAL INTERSTATES

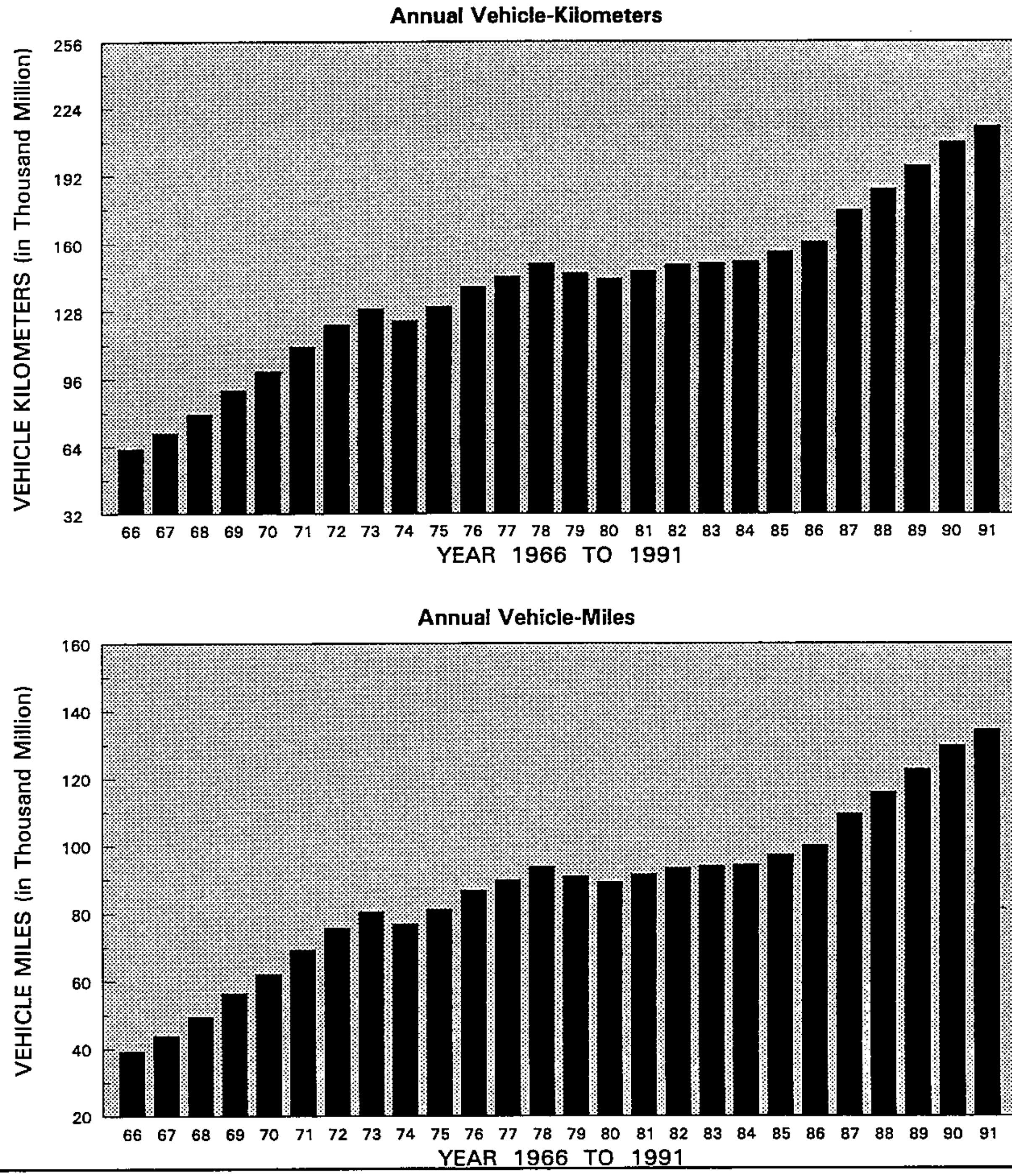
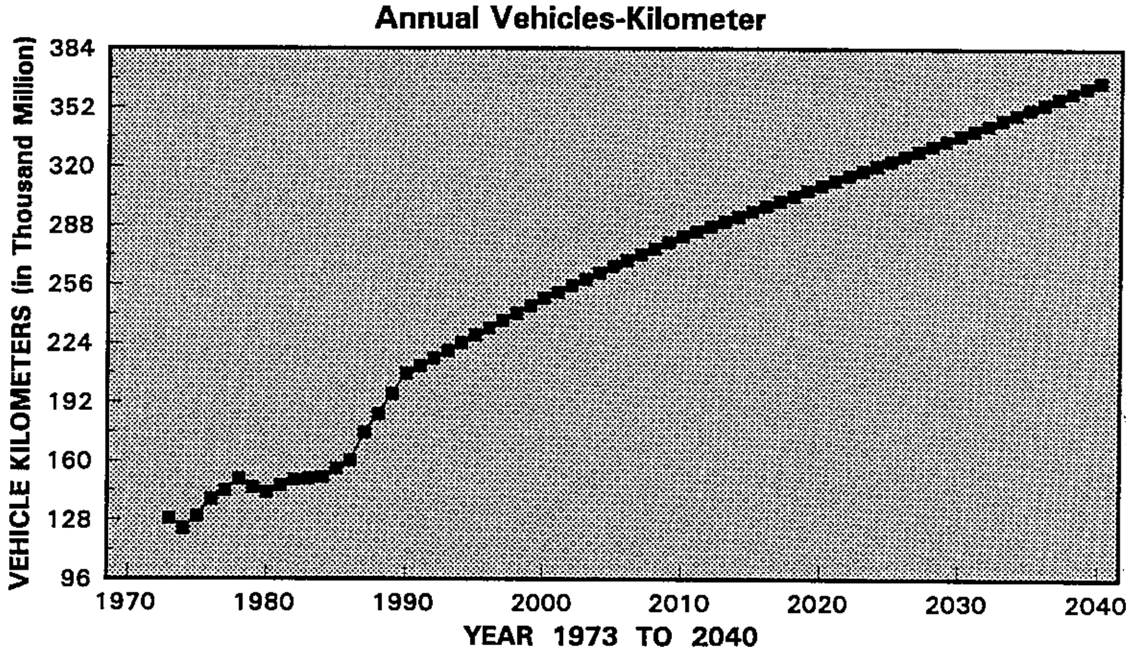
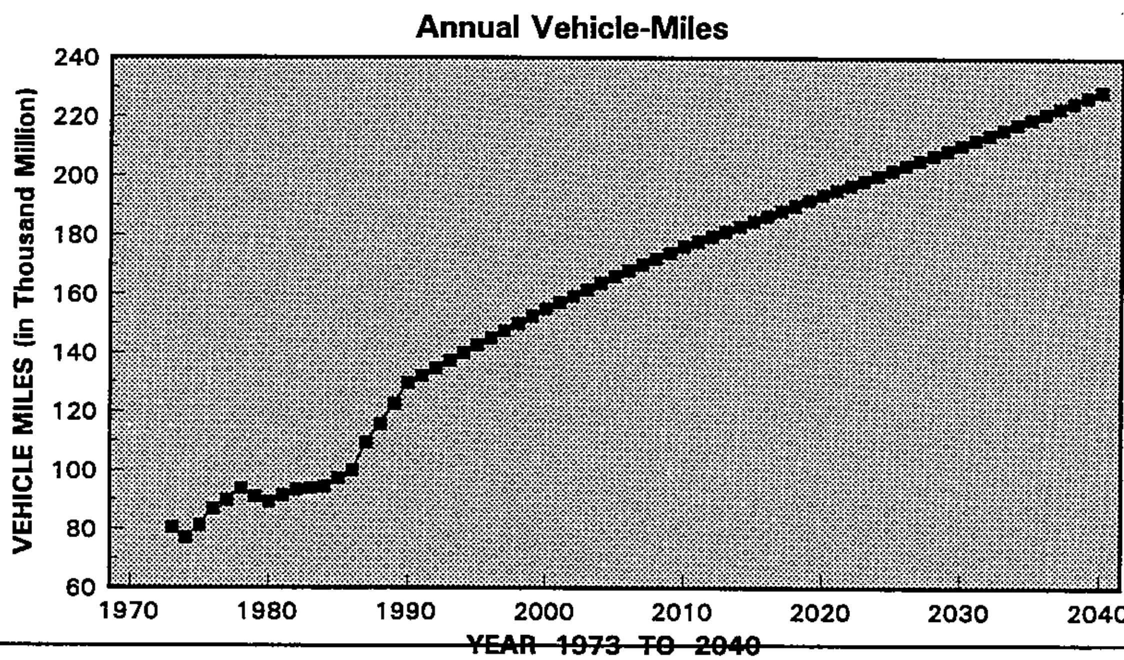


Exhibit 7-5

RURAL INTERSTATE TRENDS AND PROJECTIONS





projections are then adjusted to account for situations for which historical trend analysis is not adequate such as induced travel resulting from new or improved transportation facilities. These adjustments differ for each of the alternative technologies considered for the Transamerica Corridor.

The basic projections for intercity auto trips have been compared to an independent estimate of highway travel growth. Travel demand growth assumed in the HPMS Analytical Process[1] assumes that the average rate of growth in highway travel will decline gradually beyond 1990 to a level of slightly above one percent by 2009, resulting in an increase in annual vehicle-km of approximately 62 percent between 1990 and 2009.

The HPMS growth rates support the use of lower growth rates for future years in comparison to growth rates observed in the past 10 to 20 years. They also support the use of growth rates of approximately one percent per year for the more distant future, say 2005 and beyond. However, the HPMS growth rates also indicate that the basic projections for intercity auto trips used in this study for the year 2040 may be conservative.

Projections of interurban travel may be particularly conservative in the midwest region of the country where BEA zones are large. Intrazonal travel, which tends to be more significant in larger zones, is not explicitly considered by the travel demand model. The model calibration process took the effect of intrazonal travel into consideration but it is not known to what extent intrazonal travel is fully reflected in projected volumes in different regions of the country.

Air Travel Projections

As may be expected with travel projections which extend to near the middle of the next century, projections of air passenger traffic through to 2040 vary widely and are subject to a high degree of uncertainty. In "Future Development of the U.S. Airport Network"[2] air passenger demand in

1 Report of the Secretary of Transportation to the United States Congress; *The Status of the Nation's Highways and Bridges: Conditions and Performance*, September 1991.

2 *Future Development of the U.S. Airport Network, Preliminary Report and Recommended Study Plan*, Transportation Research Board, national Research Council, Washington, DC, 1988.

2050 was estimated to increase from 1985 levels by a factor of between two and six. This range reflects uncertainties in factors contributing to air travel demand, including growth in the GNP and fares. Based on TRB's base projections for GNP and fares, it was assumed for the purposes of this study that air passenger demand will increase between 1990 and 2040 by a factor of 3.0.

Travel Time by Mode

Typical travel times by the existing modes of road, rail and air are shown in Exhibit 7-6. Hypothetical travel time over various distances are also shown for the three alternatives involving new technologies, namely tilt train (B), super highway (C) and Very High Speed Rail (D).

The impact on mode of travel time is further illustrated in Exhibit 7-7, which indicates the distance ranges over which the modes of conventional highway, high speed train and air may provided the fastest way to travel. This graphic was developed by Aerobus Industries.

BASE CASE PASSENGER FORECASTS

The base case represents a "Do Nothing" alternative. It provides a common reference point in comparing the four options. The base case network was taken as the existing system of Interstate highways.

Information was gathered and consideration was given to including "committed" highway projects in the base case network. However data received on committed projects was unevenly distributed among states in the corridor. Consequently, no committed highways were added to the base case, to avoid distorting the density of highways in the network within different regions.

The base case network of existing Interstates is illustrated in Chapter 3, Exhibit 3-1. Passenger car flows at eight screenlines across the corridor as projected for the year 2040 are shown in Exhibit 7-8.

Exhibit 7-6
TYPICAL TRAVEL TIMES BY MODE

ROAD DISTANCE		EXISTING MODES					
Kilometers	Miles	Road (hours)	Rail (hours)	AIR (hours)	ALT B RAIL (hours)	ALT C SUPER HWY (hours)	ALT D HSGT (hours)
320	200	3.5	5.3	2.7	2.9	1.7	2.2
640	400	7.1	9.3	3.0	4.9	3.4	3.3
960	600	10.6	13.4	3.4	6.8	5.1	4.5
1,280	800	26.2	17.5	3.9	8.7	6.8	5.7
1,600	1,000	29.7	21.6	4.4	10.7	8.5	6.8
1,920	1,200	33.2	25.7	4.8	12.6	10.2	8.0
2,240	1,400	48.8	29.7	5.2	14.5	11.9	9.2
2,560	1,600	52.3	33.8	5.7	16.5	25.5	10.3
2,880	1,800	55.9	37.9	6.0	18.4	27.2	11.5
3,200	2,000	59.4	42.0	6.4	20.3	28.9	12.7
3,520	2,200	74.9	46.1	6.8	22.3	30.6	13.8
3,840	2,400	78.5	50.2	7.1	24.2	32.3	15.0
4,160	2,600	82.0	54.2	7.5	26.1	34.0	16.2
4,480	2,800	97.5	58.3	7.8	28.1	35.7	17.3
4,800	3,000	101.1	62.4	8.1	30.0	49.4	18.5

Notes: **Existing Road:** Assumes 104 km/h (65 mph), with 15% time added for rest stops, meals, etc. Includes allowance for a 12-hour overnight stop for every 12 hours of driving.

Existing Rail: Effective travel speed of 78 km/h (49 mph), based on review of 107 city pairs. Access and terminal time of 35 minutes assumed at both origin and destination.

Existing Air: Effective travel speed based on distance. Access and terminal time of 55 minutes assumed at both origin and destination.

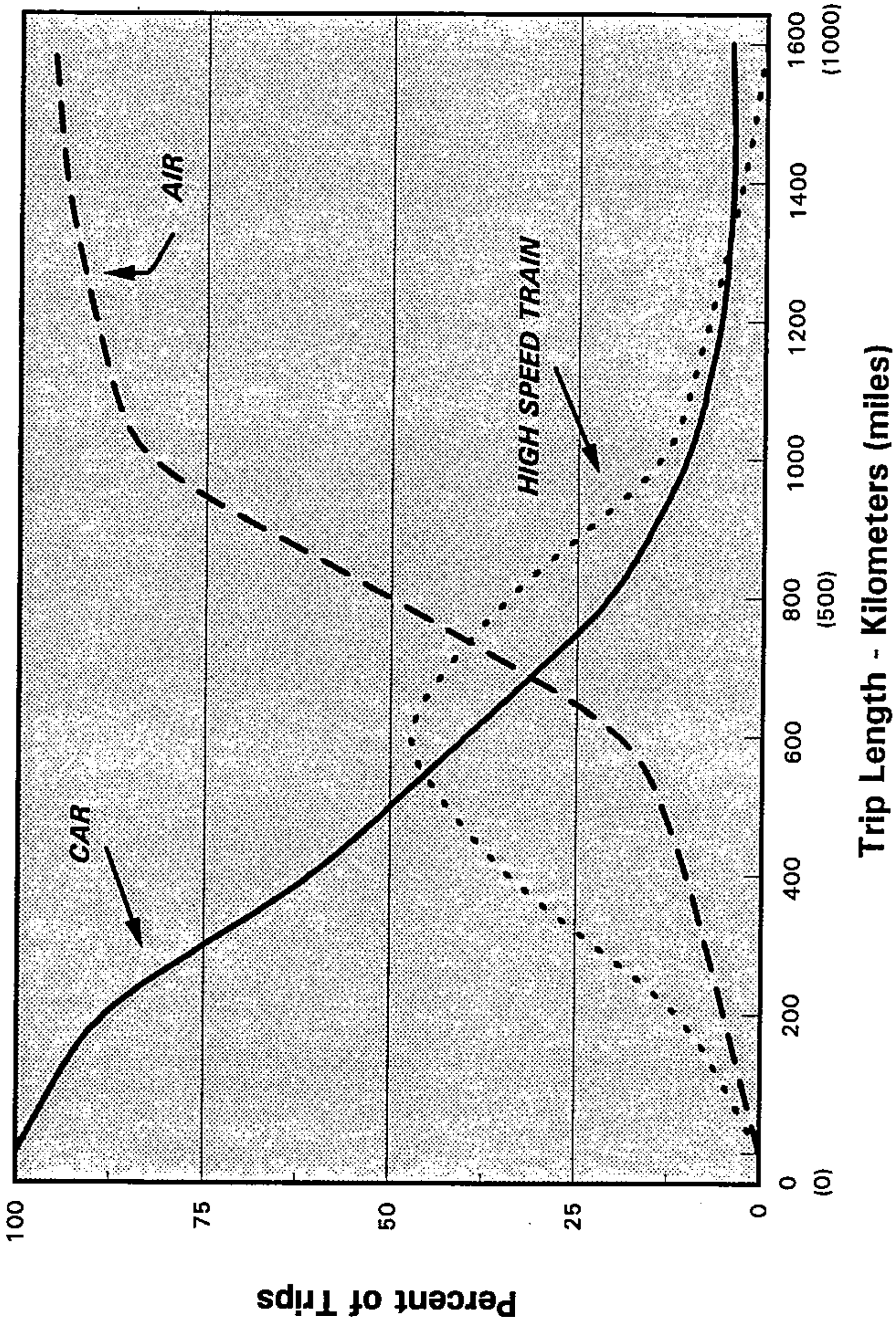
ALT "B" Rail: Based on average travel speed of 200 km/h (125 mph), with 10 minute station stops every 160 km (100 miles). Also includes access and terminal time as for existing rail.

ALT "C" Super Highway: Assumes average running speed of 208 km/h (130 mph), with 10% time added for rest stops, meals, etc. Includes allowance for a 12-hour overnight stop for every 12 hours of driving.

ALT "D" HSGT: Assumes an average running speed of 320 km/h (200 mph), based on maximum speeds of 480, 320 and 200 km/h (300, 200 and 125 mph) for Flat, Rolling and Mountainous terrain, respectively. Assumes 10-minute station stop every 320 km (200 miles) and access and terminal time as for existing rail.

Exhibit 7-7

PREFERRED MODE OF TRANSPORTATION



SOURCE: The Economist, Aerobus Industries

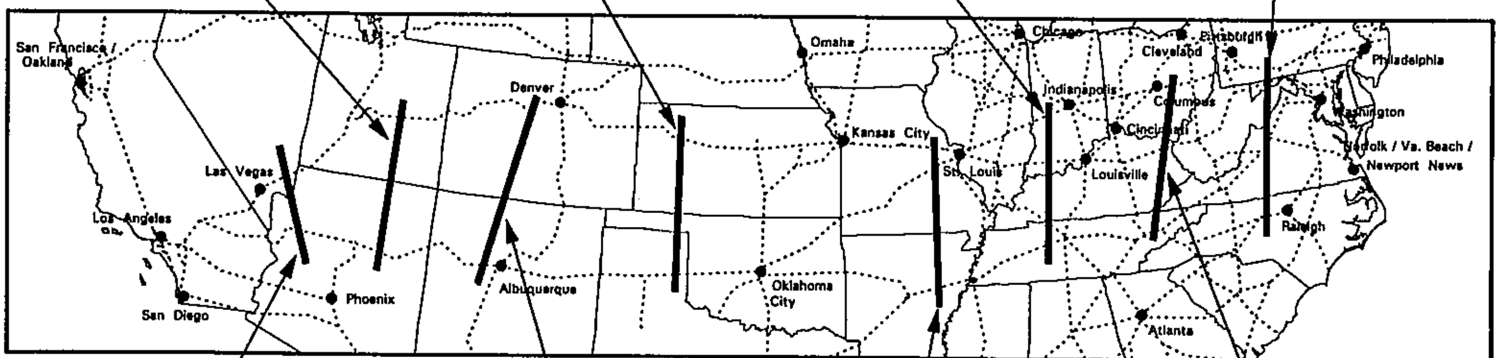
Exhibit 7-8
BASE CASE 2040 DAILY PASSENGER VEHICLE SCREENLINE FLOWS

Screenline 7	
I - 70	7,300
TTC	---
Other	---
I - 40	12,200
Total	19,500

Screenline 5	
I - 70	7,400
TTC	---
Other	5,800
I - 40	13,100
Total	26,300

Screenline 3	
I - 70	23,600
TTC	---
Other	34,400
I - 40	29,000
Total	87,000

Screenline 1	
I - 70	39,100
TTC	---
Other	26,700
I - 40	34,600
Total	100,400



Screenline 8	
I - 70	---
TTC	---
I - 15	13,900
I - 40	10,400
Total	24,300

Screenline 6	
I - 70	7,100
TTC	---
Other	---
I - 40	12,200
Total	19,300

Screenline 4	
I - 70	29,700
TTC	---
Other	20,600
I - 40	24,000
Total	74,300

Screenline 2	
I - 70	34,000
TTC	---
Other	19,700
I - 40	44,200
Total	97,900

Vehicle-km of passenger car travel on the base case network are estimated as:

	1990	2040
Daily Car VKmT, million (Daily Car VMT, million)	643 (402)	1,133 (708)
Annual Car Vkmt, billion (Annual Car VMT, billion)	235 (147)	413 (258)

Vehicle-km of interurban travel are conservatively projected to increase by 76 percent over the 50 year period.

ALTERNATIVE A PASSENGER FORECASTS

Alternative A consists of a new highway constructed to Interstate standards. Exhibit 7-9 shows the corridor in which this highway is assumed to lie for the purpose of study analyses. The corridor extends from Norfolk, Virginia to I-15 near Washington, Utah, generally avoiding urban areas. From Washington, Utah, the corridor follows existing I-15 to Long Beach, California. As mentioned previously in this Report, alternative alignments have been identified for two portions of the corridor. A compromise alignment midway between the alternatives was used for analysis purposes.

In addition to existing interstates and the study corridor, the Alternative A network also included a number of feeder corridors. For analysis purposes, high priority corridors within the National Highway System (as identified in ISTEA) were considered as feeder links. With two exceptions, high priority corridors which cross or touch the study corridor were included in the Alternative A network. Exhibit 7-10 lists ISTEA high priority corridors and identifies those included in the network. The inclusion of a particular corridor in the network should not be considered as an endorsement of a particular corridor's viability. Two high priority corridors within the study area were not included in the network for reasons indicated in Exhibit 7-10.

Estimated daily passenger vehicle flows across corridor screenlines are shown for the year 2040 in Exhibit 7-11, assuming no tolls are charged on the TTC. Total vehicle-km of travel by passenger vehicles on the TTC alignment are estimated for both toll free and with tolls scenarios, as follows:

Exhibit 7-9
ALTERNATIVE A NETWORK

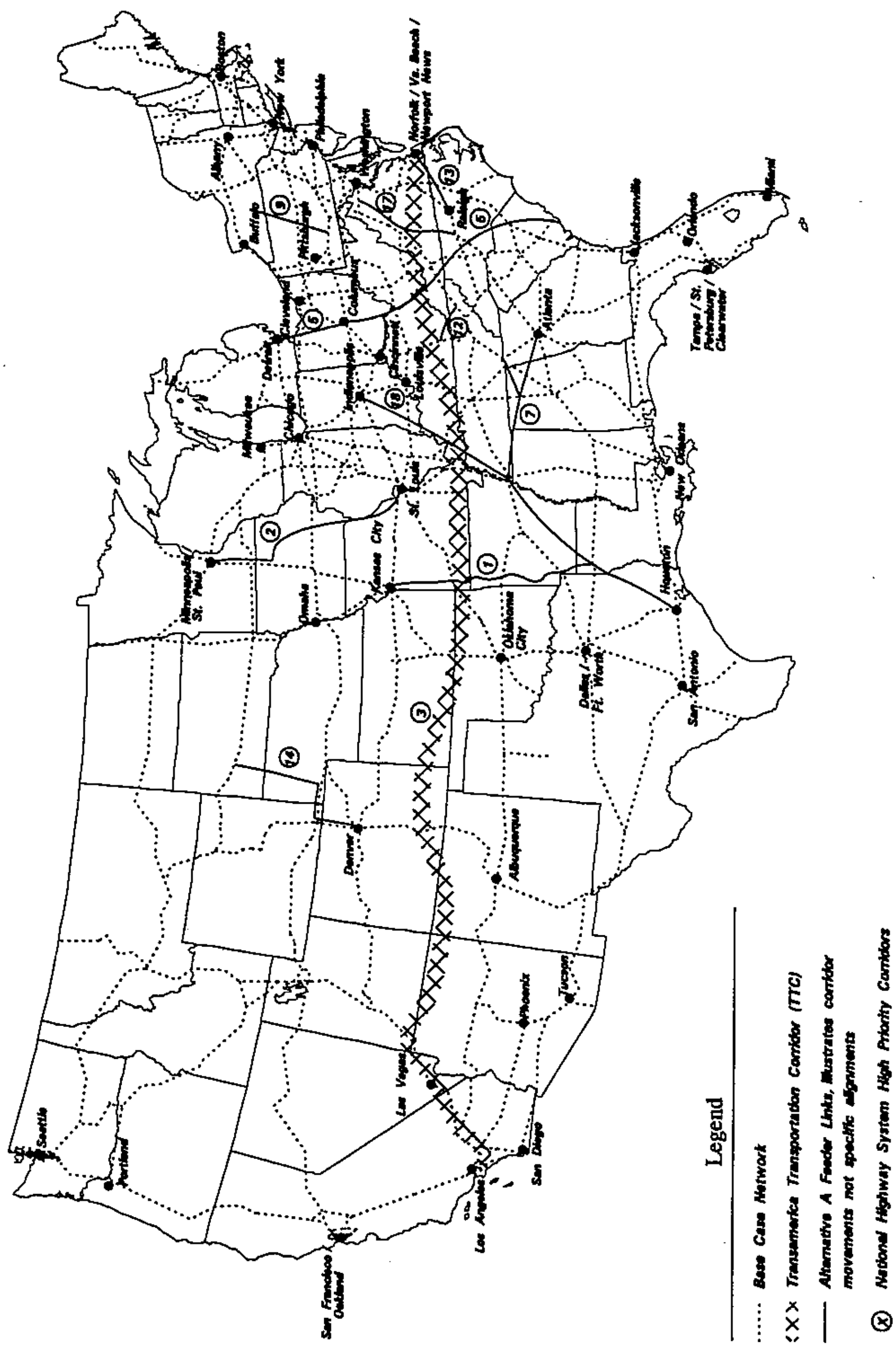


Exhibit 7-10
NATIONAL HIGHWAY SYSTEM HIGH PRIORITY CORRIDORS
Transamerica Transportation Corridor

NATIONAL HIGHWAY SYSTEM HIGH PRIORITY CORRIDORS (From Pages 105 STAT 2032, 2033 of ISTEA, 1991)	N/S or E/W	Crosses or in TTC	Alt A Feeder
1. NS Corridor from Kansas City, MO to Shreveport, LA	N/S	YES	YES
2. Avenue of the Saints; St. Louis, MO to St. Paul, MN	N/S	Touches	YES
3. East-West Transamerica Corridor	E/W	YES	N.A.
4. Hoosier Heartland Industrial Corridor from Lafayette, IN to Toledo, OH	E/W	NO	NO
5. I-73/74 NS Corridor from Charleston, SC; via Winston-Salem, NC to Portsmouth, OH to Cincinnati, OH and Detroit, MI	N/S	YES	YES
6. US Route 80 Corridor from Meridian, MI to Savannah, GA	E/W	NO	NO
7. EW Corridor from Memphis, TN; via Huntsville, AL to Atlanta, GA and Chattanooga, TN	E/W	Touches	YES
8. Hwy 412 E/W Corridor from Tulsa, OK through Arkansas to US 62/63/65 to Nashville, TN	E/W	YES	NO[1]
9. US 220 and Appalachian Thruway from Business 220 in Bedford, PA to Corning, NY	N/S	Touches	YES
10. Appalachian Regional Corridor X; Tupelo, MS to Birmingham, AL via US 78	E/W	NO	NO
11. Appalachian Regional Corridor V; Batesville, MS to Huntsville, Al than US 72 to I-24 in Tennessee	E/W	NO	NO
12. US 25E Corridor from Corbin, KY to Morristown, TN via Route 58 in Cumberland Gap Historical Park, VA	N/S	YES	YES
13. Raleigh-Norfolk Corridor from Raleigh, NC to Norfolk, VA	E/W	YES	YES
14. Heartland Expressway from Denver, CO via Scottsbluff, NE to Rapid City, SD	N/S	Touches	YES
15. Urban Highway Corridor along M-59 in Michigan	E/W	NO	NO
16. Economic Lifeline Corridor along I-15 and I-40 in California, Arizona and Nevada	E/W	YES	NO[2]
17. Route 29 Corridor from Greensboro, NC to Washington, DC	N/S	YES	YES
18. Corridor from Indianapolis, IN to Houston, TX; via Evansville, IN; Memphis, TN and Shreveport, LA	N/S	YES	YES
19. US 295 from US/Canadian border to Reno, NV	N/S	NO	NO
20. US 59 Corridor from Laredo, TX to Texarkana, TX via Houston, TX	N/S	NO	NO
21. US 219 Corridor from Buffalo, NY to intersection of US 17 near Salamanca, NY	N/S	NO	NO

NOTES: (1) Closely parallels Alternative "A" alignment.
(2) Base Case network already includes I-15 and I-40.

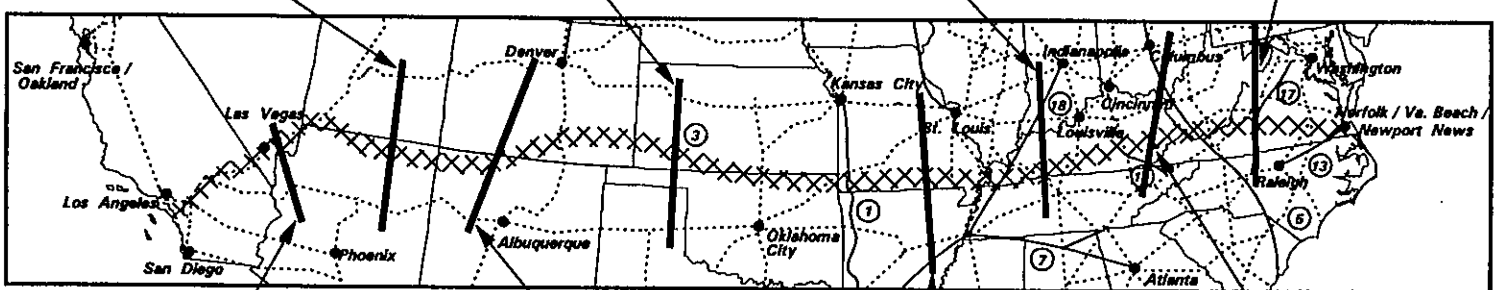
Exhibit 7-11
ALTERNATIVE A 2040 DAILY PASSENGER VEHICLE SCREENLINE FLOWS

Screenline 7	
I - 70	5,200
TTC	7,000
Other	---
I - 40	7,300
Total	19,500

Screenline 5	
I - 70	5,800
TTC	9,000
Other	---
I - 40	11,500
Total	26,300

Screenline 3	
I - 70	24,600
TTC	11,700
Other	35,700
I - 40	15,000
Total	87,000

Screenline 1	
I - 70	37,600
TTC	6,700
Other	22,800
I - 40	33,300
Total	100,400



Screenline 8	
I - 70	---
TTC	---
I - 15	16,200
I - 40	8,100
Total	24,300

Screenline 6	
I - 70	4,900
TTC	7,000
Other	---
I - 40	7,400
Total	19,300

Screenline 4	
I - 70	25,500
TTC	10,600
Other	20,700
I - 40	17,500
Total	74,300

Screenline 2	
I - 70	30,300
TTC	7,000
Other	30,600
I - 40	30,000
Total	97,900

	DAILY PASSENGER VEHICLE VKmT (VMT) (millions)			
	1990		2040	
Toll Free				
Long Beach, CA to Washington, UT	8.27	(5.17)	15.89	(9.93)
Washington, UT to Hampton, VA	15.63	(9.77)	28.14	(17.59)
TOTAL	23.90	(14.94)	44.03	(27.52)
With Tolls				
Long Beach, CA to Washington, UT	7.94	(4.96)	15.25	(9.53)
Washington, UT to Hampton, VA	9.66	(6.04)	18.14	(11.34)
TOTAL	17.60	(11.00)	33.39	(20.87)

The segment from Long Beach, CA to Washington, Utah is identified separately as this follows the existing I-15 corridor and includes existing I-15 traffic.

An estimate of trips likely to remain using the TTC highway with tolls applied was made by comparing overall costs of travel on the TTC and other non-toll alternatives. Based on this analysis approximately 76 percent of auto trips on the TTC highway would continue to use it if tolls were applied at the current average rate of 2.02 cents per km (3.23 cents per mile). Exhibit 7-12 lists typical intercity toll rates, used to derive the average toll.

ALTERNATIVE B PASSENGER FORECASTS

This alternative envisions the use of tilt train technology for passenger services, with speeds of up to 216 km/h (135 mph). The alignment for this option, based on existing railroad rights-of-way, is illustrated in Exhibit 7-13.

This exhibit also shows the feeder network of rail services assumed to be in place to support this TTC option. The feeder network is based on proposed High Speed Rail Links identified by the American Public Transit Association along with Amtrak, The High Speed Rail/Maglev Association, The Community Transportation Association of America and others. For purposes of this analysis, the feeder rail services are assumed to operate with similar characteristics as the TTC. The rail network totals some 22,400 km (14,000 miles) in length, of which the TTC represents approximately 20 percent of the total.

Exhibit 7-12

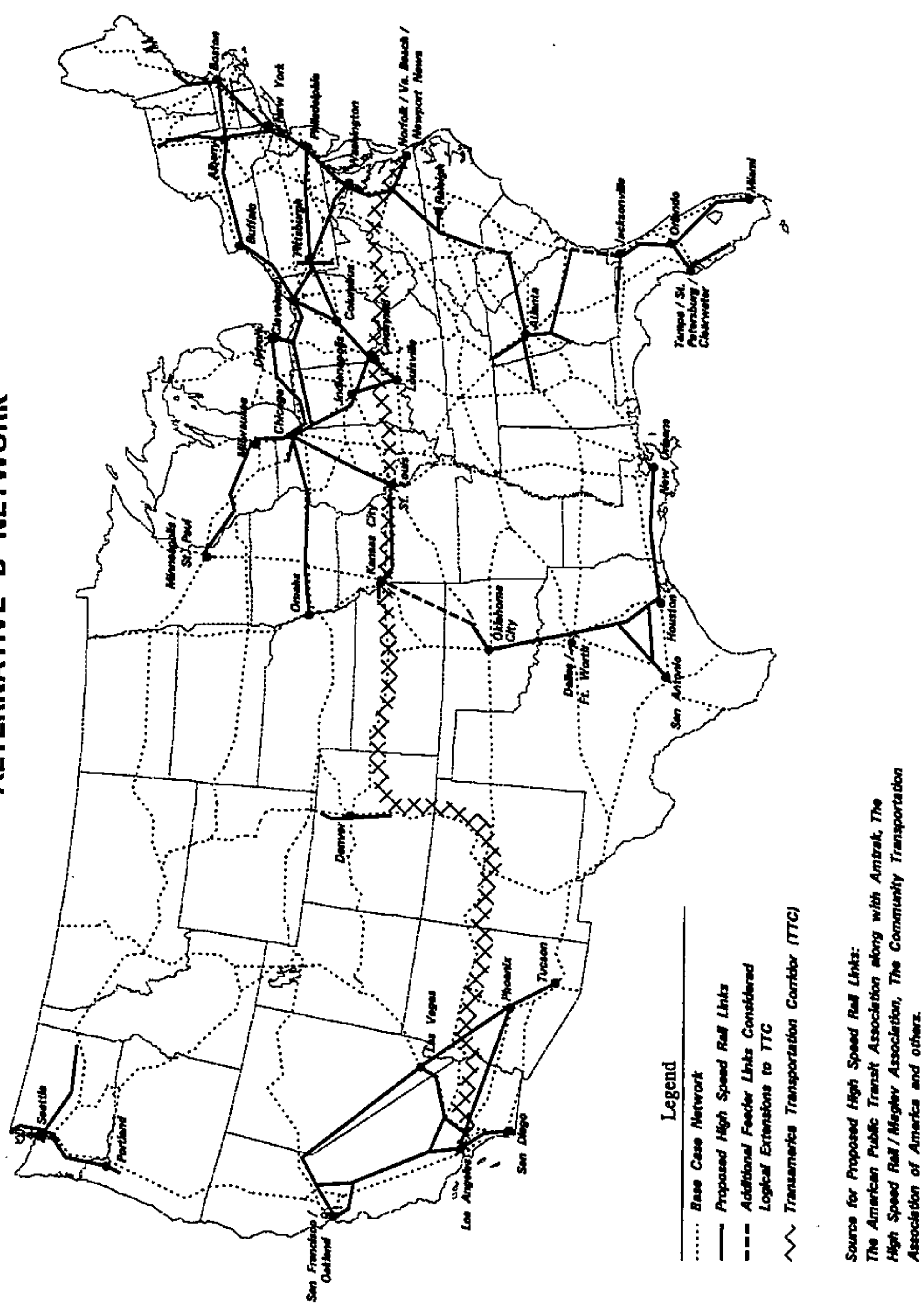
TYPICAL INTER-CITY TOLL RATES

	LENGTH (Kilometers)	TOLL CHARGES (1) Passenger Vehicle	TOLL CHARGES (1) Five-Axle Truck	PER KILOMETER RATE Passenger Vehicle	PER KILOMETER RATE Five-Axle Truck
BARRIER SYSTEMS					
Delaware Turnpike, DE	17.9	$1.00	$4.00	$0.0558	$0.2232
Northwest Tollway, IL	122.1	$2.00	$6.25	$0.0164	$0.0512
Tri-State Tollway, IL	123.4	$2.40	$7.50	$0.0195	$0.0608
East-West Tollway, IL	154.1	$2.70	$8.50	$0.0175	$0.0552
North-South Tollway, IL	27.8	$1.00	$3.00	$0.0359	$0.0178
Central Turnpike, NH	71.5	$1.50	$6.00	$0.0210	$0.0839
Spaulding Tunpike, NH	53.1	$1.00	$5.00	$0.0188	$0.0941
Blue Star Turnpike, NH	25.8	$1.00	$3.50	$0.0388	$0.1359
Atlantic City Expwy, NJ	70.4	$1.25	$5.00	$0.0178	$0.0710
Garden State Pkwy, NY (2)	276.8	$3.85	$10.50	$0.0139	$0.0379
H.E. Bailey Turnpike, OK (3)	138.2	$2.75	$7.75	$0.0199	$0.0561
Cimarron Turnpike, OK (3)	108.3	$1.75	$5.25	$0.0162	$0.0485
Indian Nation Turnpike, OK (3)	168.3	$3.25	$9.00	$0.0193	$0.0535
Muskogee Turnpike, OK (3)	85.0	$1.75	$5.00	$0.0206	$0.0589
West Virginia Turnpike, WV	140.8	$3.75	$12.00	$0.0266	$0.0852
CLOSED TICKET SYSTEMS					
Florida Turnpike, FL	424.0	$9.95	$25.90	$0.0235	$0.0611
Indiana Toll Road, IN (4)	251.0	$4.65	$14.55	$0.0185	$0.0580
Kansas Turnpike, KS	377.6	$7.00	$18.75	$0.0185	$0.0497
Maine Turnpike, ME	169.6	$3.10	$9.30	$0.0183	$0.0548
Massachusetts Turnpike, MA	197.3	$4.70	$15.15	$0.0238	$0.0768
New Jersey Turnpike, NJ	188.8	$4.60	$18.20	$0.0244	$0.0964
New York State Thruway - Mainline, NY	624.0	$12.10	$46.80	$0.0194	$0.0750
New York State Thruway - Eric Section, NY	107.2	$2.10	$8.10	$0.0196	$0.0756
New York State Thruway - Berkshire Section, NY	38.4	$0.75	$2.90	$0.0195	$0.0755
Ohio Turnpike, OH	385.9	$4.90	$19.15	$0.0127	$0.0496
Turner Turnpike, OK (3)	137.6	$2.50	$8.50	$0.0182	$0.0618
Will Rogers Turnpike, OK (3)	141.6	$2.50	$8.50	$0.0177	$0.0600
Pennsylvania Turnpike, East-West, PA	574.2	$14.70	$55.50	$0.0256	$0.0966
Pennsylvania Turnpike, Northeast Ext., PA	177.8	$4.15	$15.75	$0.0233	$0.0886
AVERAGE RATE PER KILOMETER				$0.0202	$0.0679

	LENGTH (Miles)	TOLL CHARGES (1) Passenger Vehicle	TOLL CHARGES (1) Five-Axle Truck	PER MILE RATE Passenger Vehicle	PER MILE RATE Five-Axle Truck
BARRIER SYSTEMS					
Delaware Turnpike, DE	11.2	$1.00	$4.00	$0.0893	$0.3571
Northwest Tollway, IL	76.3	$2.00	$6.25	$0.0262	$0.0819
Tri-State Tollway, IL	77.1	$2.40	$7.50	$0.0311	$0.0973
East-West Tollway, IL	96.3	$2.70	$8.50	$0.0280	$0.0883
North-South Tollway, IL	17.4	$1.00	$3.00	$0.0575	$0.1724
Central Turnpike, NH	44.7	$1.50	$6.00	$0.0336	$0.1342
Spaulding Tunpike, NH	33.2	$1.00	$5.00	$0.0301	$0.1506
Blue Star Turnpike, NH	16.1	$1.00	$3.50	$0.0621	$0.2174
Atlantic City Expwy, NJ	44.0	$1.25	$5.00	$0.0284	$0.1136
Garden State Pkwy, NY (2)	173.0	$3.85	$10.50	$0.0223	$0.1000
H.E. Bailey Turnpike, OK (3)	86.4	$2.75	$7.75	$0.0318	$0.0897
Cimarron Turnpike, OK (3)	67.7	$1.75	$5.25	$0.0258	$0.0775
Indian Nation Turnpike, OK (3)	105.2	$3.25	$9.00	$0.0309	$0.0856
Muskogee Turnpike, OK (3)	53.1	$1.75	$5.00	$0.0330	$0.0942
West Virginia Turnpike, WV	88.0	$3.75	$12.00	$0.0426	$0.1364
CLOSED TICKET SYSTEMS					
Florida Turnpike, FL	265.0	$9.95	$25.90	$0.0375	$0.0977
Indiana Toll Road, IN (4)	156.9	$4.65	$14.55	$0.0296	$0.0927
Kansas Turnpike, KS	236.0	$7.00	$18.75	$0.0297	$0.0794
Maine Turnpike, ME	106.0	$3.10	$9.30	$0.0292	$0.0877
Massachusetts Turnpike, MA	123.3	$4.70	$15.15	$0.0381	$0.1229
New Jersey Turnpike, NJ	118.0	$4.60	$18.20	$0.0390	$0.1542
New York State Thruway - Mainline, NY	390.0	$12.10	$46.80	$0.0310	$0.1200
New York State Thruway - Eric Section, NY	67.0	$2.10	$8.10	$0.0313	$0.1209
New York State Thruway - Berkshire Section, NY	24.0	$0.75	$2.90	$0.0313	$0.1208
Ohio Turnpike, OH	241.2	$4.90	$19.15	$0.0203	$0.0794
Turner Turnpike, OK (3)	86.0	$2.50	$8.50	$0.0291	$0.0988
Will Rogers Turnpike, OK (3)	88.6	$2.50	$8.50	$0.0282	$0.0960
Pennsylvania Turnpike, East-West, PA	358.9	$14.70	$55.50	$0.0410	$0.1546
Pennsylvania Turnpike, Northeast Ext., PA	111.1	$4.15	$15.75	$0.0374	$0.1418
AVERAGE RATE PER MILE				$0.0323	$0.1109

(1) Full-length trip on the facility
(2) Trucks permitted between interchanges 0 and 105 only
(3) Reflects cash toll rate
(4) Includes the Barrier System portion

Exhibit 7-13
ALTERNATIVE B NETWORK



As can be seen from Exhibit 7-6, the Alternative B rail system is highly competitive with air in terms of trip time for distances of up to 320 km (200 miles). It remains competitive through longer distances with a 640 km (400 mile) trip taking 4.9 hours compared to 3.0 hours by air. A typical 640 km (400 mile) air trip may be expected to cost $248 one-way (or $118 discounted with travel restrictions). A similar journey by rail would cost $64 at present Amtrak average rates.

While recognizing the range of uncertainties associated with travel projections of this nature, a single estimate of market share has been developed for use in economic and financial analyses:

4.5 percent - for trips between 160 and 320 km (100 and 200 miles)
3.9 percent - for trips between 320 and 480 km (200 and 300 miles)
3.4 percent - for trips between 480 and 640 km (300 and 400 miles)
2.8 percent - for trips between 640 and 800 km (400 and 500 miles)
2.2 percent - for trips between 800 and 960 km (500 and 600 miles)
1.5 percent - for trips between 960 and 1,600 km (600 and 1000 miles)
0.5 percent - for trips between 1,600 and 3,200 km (1000 and 2000 miles)

Daily passenger flows crossing corridor screenlines on the Upgraded Rail option are shown in Exhibit 7-14 for the year 2040.

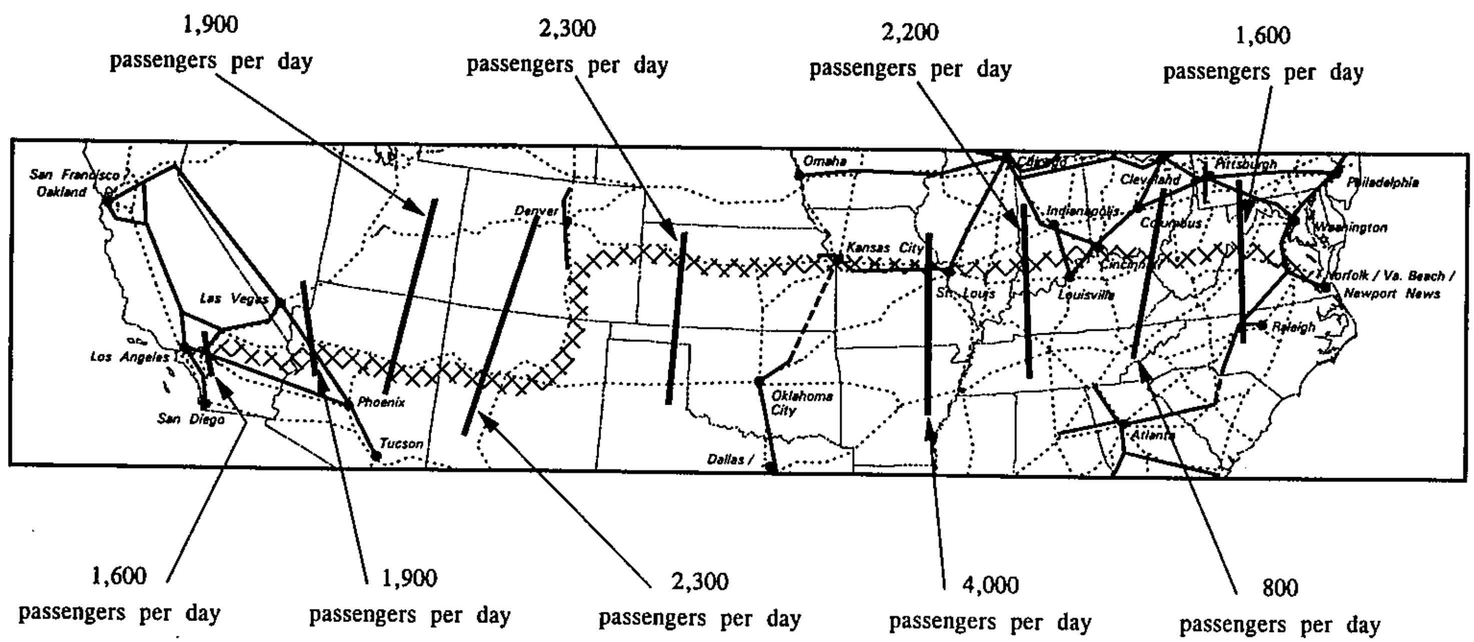
Passenger-km on the TTC under this option are estimated as:

	DAILY PASSENGER KILOMETERS (millions)	
	1990	2040
Passenger-km on the TTC (Passenger-miles on the TTC)	3.31 (2.07)	10.05 (6.28)

Daily passengers using the TTC rail line are estimated at approximately 11,500 by 2040. Based on an assumed line length from Hampton Roads, Virginia to Long Beach, California of 4,720 km (2,950 miles), the number of passengers per route km is 2.4 per day (per route mile is 3.9 per day). On an annual basis passengers per route km may amount to 875 (passengers per route mile may amount to 1,400).

Exhibit 7-14

2040 PASSENGER FLOWS ON ALTERNATIVE B UPGRADED RAIL



Comparison with Other Amtrak Routes

Annual passenger totals on existing Amtrak routes are shown in Exhibit 7-15. Long distance routes currently carry between 32 and 360 annual passengers per route-km (50 and 580 annual passengers per route-mile).

ALTERNATIVE C PASSENGER FORECASTS

Alternative C anticipates substantial deployment of IVHS technologies as part of a new Super Highway and Truckway, including Advanced Vehicle Control Systems (AVCS) to create a fully automated roadway.

It is anticipated that the super highway would include four lanes in each direction. Three types of lane would be used:

- conventional lanes (2) for non-automated vehicles;
- instrumented lane for passenger cars; and
- instrumented lane for trucks.

Instrumented passenger cars are assumed to be capable of travel at the following speeds:

- 240 km/h (150 mph) in flat terrain;
- 192 km/h (120 mph) in rolling terrain;
- 176 km/h (110 mph) in hilly terrain; and
- 160 km/h (100 mph) in mountainous terrain.

The alignment assumed for the Super Highway is the same as that assumed for the Upgraded Highway in Alternative A. This alignment is generally located in the approximate center of the corridor between I-70 and I-40. The mix of the terrain conditions in this corridor results in an estimated average speed for instrumented passenger cars of approximately 192 km/h (120 mph).

Alternative C3

The network used for analysis within this task is shown in Exhibit 7-16. In addition to the TTC corridor, this Exhibit also illustrates a possible feeder network of Super Highways covering a major portion of the United States. This network includes two additional east-west corridors and five north-south corridors. The feeder network is assumed to connect major population centers, but no particular alignments are implied by the lines on the map. The feeder network is assumed to have the same operating characteristics as the TTC Super Highway.

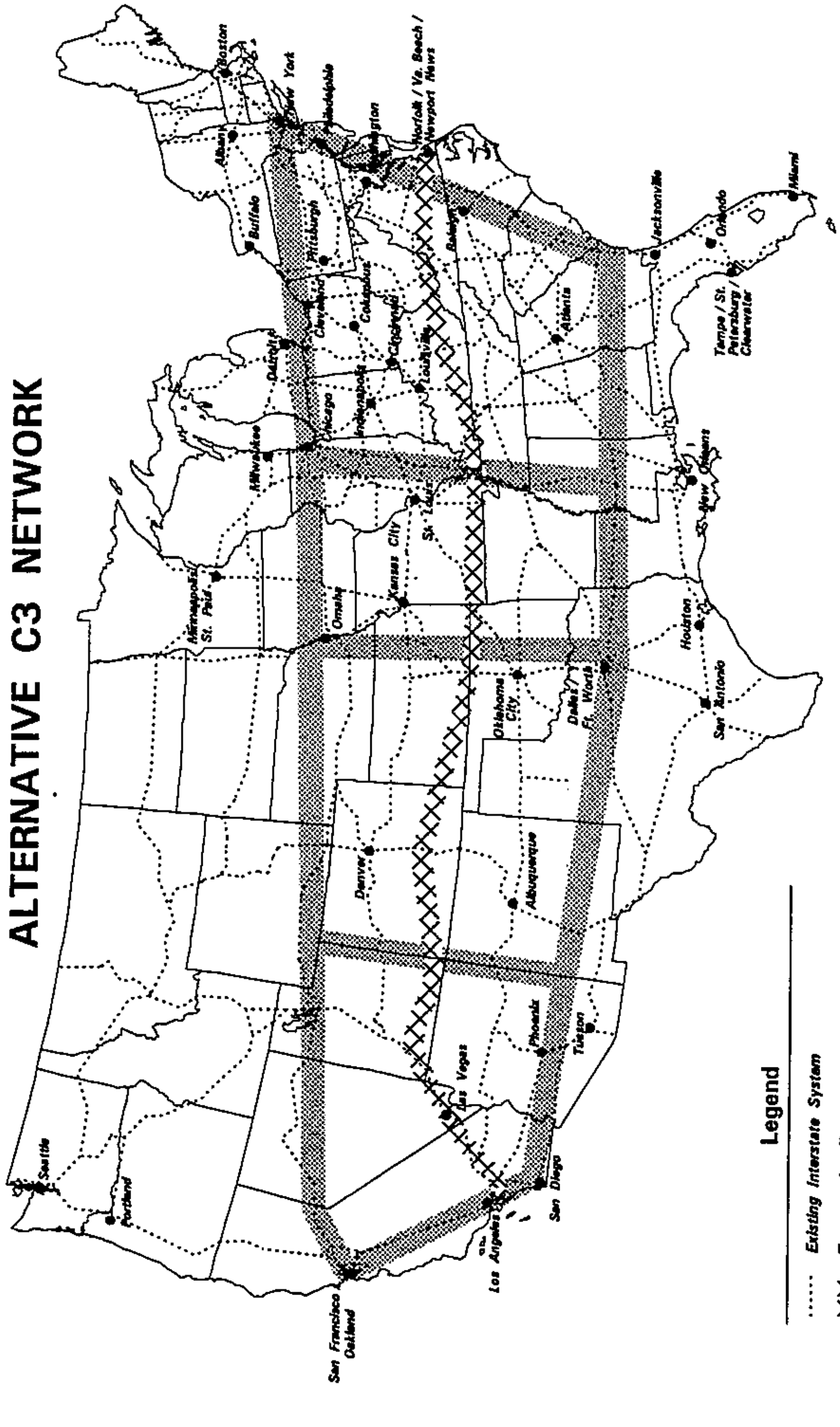
Exhibit 7-15
AMTRAK RIDERSHIP BY ROUTE

	DISTANCE (kilometers)(miles)		1991[1]	ANNUAL PASSENGERS PER ROUTE KILOMETER [MILE]	
NORTHEAST CORRIDOR					
Metroliners	N/A	[N/A]	1,921,642	N/A	[N/A]
Northeast Corridor Conventional	739	[462]	6,345,205	8,584	[13,730]
Atlantic City	N/A	[N/A]	422,338	N/A	[N/A]
New York-Philadelphia	146	[91]	1,861,746	12,787	[20,460]
Philadelphia-Harrisburg	166	[104]	330,619	1,987	[3,180]
Total Northeast Corridor			10,881,550		
SHORT DISTANCE					
New York-Albany-Niagara Falls	736	[460]	1,036,721	1,409	[2,250]
Chicago-St. Louis	451	[282]	264,109	585	[940]
Chicago-Milwaukee	138	[86]	315,440	2,292	[3,670]
Chicago-Detroit-Toledo	536	[335]	390,145	728	[1,160]
Chicago-Carbondale	494	[309]	102,605	208	[330]
Chicago-Quincy	413	[258]	80,458	195	[310]
Los Angeles-San Diego	206	[129]	1,724,321	8,354	[13,370]
Seattle-Portland	298	[186]	87,589	294	[470]
Oakland-Bakersfield	499	[312]	465,423	932	[1,490]
New York-Montreal	610	[381]	72,091	118	[190]
Chicago-Port Huron-(Toronto)	802	[501]	104,178	130	[210]
Chicago-Valparaiso	99	[62]	48,383	488	[780]
Chicago-Indianapolis	312	[195]	109,262	350	[560]
Pittsburgh-Philadelphia-NYC	710	[444]	184,514	260	[420]
Chicago-Grand Rapids	283	[177]	70,241	248	[400]
Total Short Distance			5,055,480		
LONG DISTANCE					
Washington-Montreal	970	[606]	105,153	108	[170]
New York-Florida-Star	2,278	[1,424]	427,413	188	[300]
New York-Florida-Meteor	2,246	[1,404]	486,015	216	[350]
Chicago-Pittsburgh-NYC	1,608	[1,005]	212,450	132	[210]
Chicago-CIN-WAS-New York	1,846	[1,154]	136,680	74	[120]
Chicago-Seattle/Portland	3,832	[2,395]	462,675	121	[190]
Chicago-Pittsburgh-Washington	1,248	[780]	167,460	134	[210]
Chicago-Oakland/LAX/SEA[2]	3,866	[2,416]	725,064	188	[300]
Chicago-Los Angeles	3,595	[2,247]	268,032	75	[120]
Chicago-New Orleans	1,478	[924]	218,170	148	[240]
Chicago-Texas (LAX)	4,427	[2,767]	223,759	51	[80]
New Orleans-Los Angeles	3,253	[2,033]	105,348	32	[50]
Los Angeles-Seattle	2,222	[1,389]	583,642	263	[420]
Chicago-New York/Boston	1,846	[1,154]	360,345	195	[310]
Boston-Newport News	992	[620]	356,858	360	[580]
New York-Savannah-Jacksonville	1,565	[978]	224,457	143	[230]
New York-New Orleans/Mobile	2,208	[1,380]	386,883	175	[280]
Kansas City-Centralia-(NOL)	1,622	[1,014]	189,993	117	[190]
Auto-Train (LOR-SFA)	1,371	[857]	227,193	166	[270]
New York-Charlotte	1,126	[704]	161,910	144	[230]
Total Long Distance			6,029,500		
SPECIAL TRAINS			65,442		
SYSTEM TOTAL			22,031,972		

(1) Fiscal Year, October through September.
(2) Chicago-Oakland distance only

Exhibit 7-16

ALTERNATIVE C3 NETWORK



Within this network the TTC constitutes 24 percent of the approximately 16,960 km (10,600 miles) of super highways. The network assumed is not intended to imply that other areas of the country should not also be served by Super Highways, such as Florida or the north-west region. Rather it was assumed that operation of Super Highway in these areas would not directly impact demand forecasts for the study corridor.

Percentage of Instrumented Vehicles

By the year 2040 it is assumed that 50 percent of passenger vehicles will be instrumented and capable of using instrumented lanes on Super Highways. This level of deployment would take about 20 years to achieve from initial deployment.

Induced Travel on the Super Highway

The Super Highway concept provides a substantial increase in travel speed compared to current interstate standards and permits the driver to relax, read or sleep while safely and smoothly moving towards his destination. This is accomplished within the driver's own vehicle, thus maintaining the driver's freedom of travel and independence at journeys end. This combination of desirable travel characteristics is sufficiently different from existing modes of transport that induced travel may be anticipated. For the purpose of this evaluation induced traffic is assumed to amount to 10 percent of non-induced travel on the Super Highway.

Projected Super Highway Volumes

Based on assumptions described above, projected volumes of passenger vehicles on the TTC are shown in Exhibit 7-17, assuming no tolls are charged on the TTC. Estimates are provided separately for instrumented vehicles capable of speeds of up to 240 km/h (150 mph) under automated control and for uninstrumented vehicles. The latter vehicles are assumed to travel at typical Interstate speeds on non-instrumented lanes.

The majority of passenger vehicles using the Super Highway are projected to be instrumented vehicles. Of the 65.08 million passenger vehicle-km (40.68 million passenger vehicle-miles) estimated on the TTC by 2040, approximately 75 percent are estimated to be instrumented vehicles. Volumes of instrumented vehicles range from 19,500 to 4,800 per day.

Exhibit 7-17

ALTERNATIVE C3: 2040 DAILY PASSENGER VEHICLE SCREENLINE FLOWS

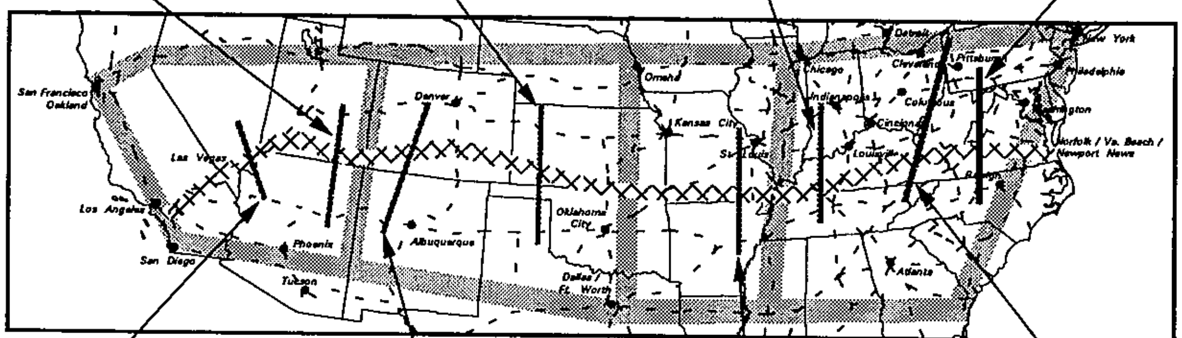
(THREE (3) EAST/WEST ROUTES)

Screenline 7	
I - 70	1,900
TTC - I	6,100
TTC - C	2,500
Other	---
I - 40	1,900
Total	12,400

Screenline 5	
I - 70	4,800
TTC - I	5,900
TTC - C	1,900
Other	---
I - 40	7,500
Total	20,100

Screenline 3	
I - 70	24,300
TTC - I	15,600
TTC - C	1,000
Other	34,000
I - 40	16,100
Total	91,000

Screenline 1	
I - 70	36,500
TTC - I	19,500
TTC - C	6,100
Other	13,500
I - 40	28,200
Total	103,800



Screenline 8	
I - 70	---
TTC - I	9,400
TTC - C	8,400
Other	---
I - 40	4,300
Total	22,100

Screenline 6	
I - 70	2,300
TTC - I	4,800
TTC - C	2,500
Other	---
I - 40	3,100
Total	12,700

Screenline 4	
I - 70	22,800
TTC - I	16,500
TTC - C	3,000
Other	8,500
I - 40	18,200
Total	69,000

Screenline 2	
I - 70	25,800
TTC - I	16,000
TTC - C	3,100
Other	14,600
I - 40	33,800
Total	93,300

Some screenline flows (total crossing the screenline, not just TTC volumes) are lower for the Super Highway than for the Upgraded Highway (Alternative A). It is thought likely that the two parallel east-west super highways outside the TTC corridor may be responsible for this effect, as they are in direct competition with east-west routes in the study corridor.

Total vehicle-km of travel by passenger vehicles on the TTC Super Highway are estimated for the toll-free and with toll scenarios, as follows:

ALTERNATIVE C3	DAILY PASSENGER VEHICLE VKmT (VMT) (millions)			
	1990		2040	
Toll Free				
Instrumented Vehicles	26.77	(16.73)	48.70	(30.44)
Non-instrumented Vehicles	8.83	(5.52)	16.38	(10.24)
TOTAL	35.60	(22.25)	65.08	(40.68)
With Tolls				
Instrumented Vehicles	21.41	(13.38)	38.96	(24.35)
Non-instrumented Vehicles	7.07	(4.42)	13.10	(8.19)
TOTAL	28.48	(17.80)	52.06	(32.54)

"With Toll" travel estimates are based on 80 percent of vehicles on a toll free facility continuing to use the Super Highway if tolls are applied on the TTC. Due to the potential savings in travel time it is assumed toll rates would be higher for the use of instrumented lanes. For the purposes of this analysis rates of 4.04 cents per km (6.46 cents per mile) for instrumented lanes and 2.02 cents per km (3.23 cents per mile) for uninstrumented lanes have been used for passenger vehicles.

Impact of Reduced Feeder Network

Unlike the feeder networks assumed in the analysis of Alternatives A, B and D, the Super Highway feeder network shown previously in Exhibit 7-16 contains two transcontinental east-west routes. Although both lie outside the study corridor, either north of I-70 or south of I-40, both "compete" directly with existing corridor interstates and the proposed TTC Super Highway for east-west inter-city traffic.

To estimate the impact on TTC travel demand forecasts of the assumption that two additional transcontinental

In these runs, the Super Highway feeder network contained only the five north-south feeder routes and TTC was the only transcontinental Super Highway. Projected volumes of passenger vehicles on this network are shown in Exhibit 7-18. In these runs, toll free vehicle-km of passenger vehicle travel on the TTC increases as follows:

DAILY PASSENGER VEHICLE VKmT (VMT) (Millions)				
	3 East/West Routes		1 East/West Route	
	1990	2040	1990	2040
Instrumented Vehicles	26.77 (16.73)	48.70 (30.44)	49.57 (30.98)	89.89 (56.18)
Non-instrumented Vehicles	8.83 (5.52)	16.38 (10.24)	10.48 (6.55)	19.47 (12.17)
TOTAL	35.60 (22.25)	65.08 (40.68)	60.05 (37.53)	109.36 (68.35)

These results indicate that if the TTC is the only transcontinental east-west route, vehicle-km of travel by instrumented passenger vehicles on the TTC may increase by 85 percent in comparison to results for the network shown in Exhibit 7-16. Total vehicle-km (instrumented and uninstrumented cars) would increase 68 percent if the TTC is the only east-west route.

ALTERNATIVE D PASSENGER FORECASTS

Alternative D is based on a Very High Speed Fixed Guideway option. The analysis used to estimate passenger demand forecasts did not attempt to distinguish between possible technologies within this option, such as high speed rail or Maglev.

The network used for this option is shown in Exhibit 7-19. The alignment selected is heavily influenced by the location of major population centers. As a result, the eastern half of the alignment is located along the northern edge of the study corridor.

The terrain through which the alignment passes was identified under four categories. The analysis assumed the following speeds of travel were associated with each terrain category:

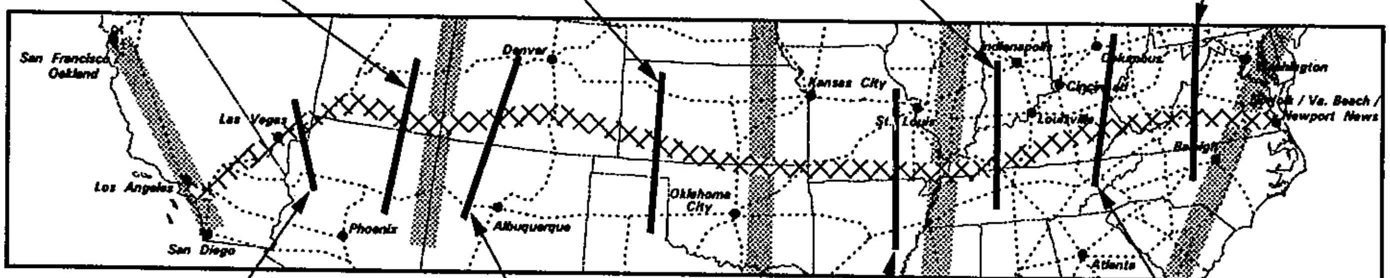
Exhibit 7-18
ALTERNATIVE C1: 2040 DAILY PASSENGER VEHICLE SCREENLINE FLOWS
(One East/West Route)

Screenline 7	
I - 70	2,700
TTC-I	16,400
TTC-C	5,000
Other	---
I - 40	10,600
Total	34,700

Screenline 5	
I - 70	4,800
TTC-I	19,900
TTC-C	2,900
Other	2,400
I - 40	8,800
Total	38,800

Screenline 3	
I - 70	30,000
TTC-I	24,200
TTC-C	300
Other	39,500
I - 40	17,200
Total	111,200

Screenline 1	
I - 70	38,000
TTC-I	29,000
TTC-C	6,800
Other	14,500
I - 40	27,800
Total	116,100



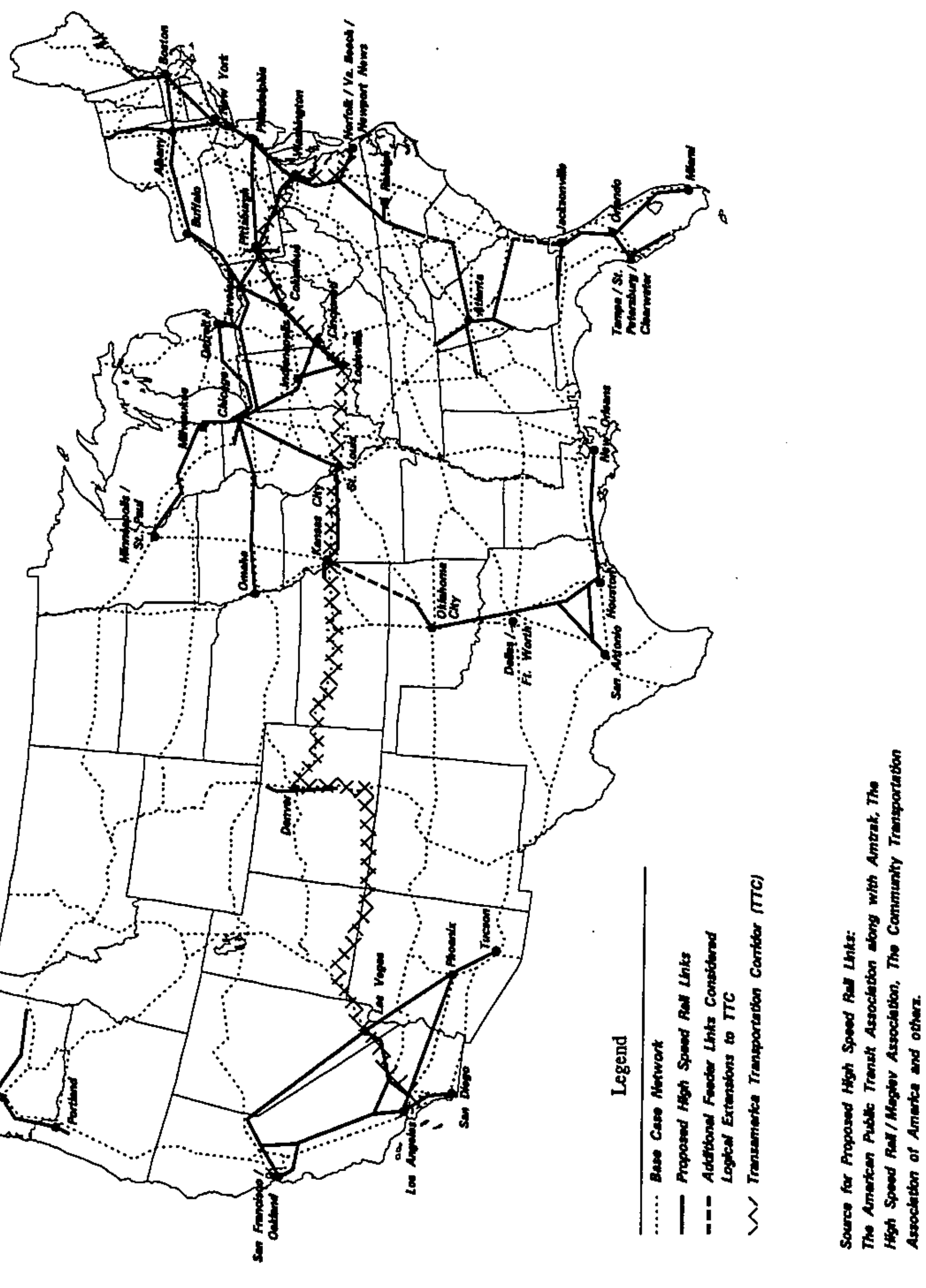
Screenline 8	
I - 70	---
TTC-I	15,700
TTC-C	9,200
Other	---
I - 40	5,100
Total	30,000

Screenline 6	
I - 70	2,500
TTC-I	17,700
TTC-C	4,800
Other	---
I - 40	7,700
Total	32,700

Screenline 4	
I - 70	23,900
TTC-I	30,000
TTC-C	4,000
Other	8,400
I - 40	19,100
Total	85,400

Screenline 2	
I - 70	30,400
TTC-I	27,200
TTC-C	3,000
Other	14,800
I - 40	35,000
Total	110,400

Exhibit 7-19
ALTERNATIVE D NETWORK



- flat terrain — 480 km/h (300 mph)
- rolling terrain — 320 km/h (200 mph)
- hilly terrain — 240 km/h (150 mph)
- mountainous terrain — 200 km/h (125 mph)

The mix of terrain conditions results in an average travel speed of 300 km/h (200 mph).

As with Alternative B, a feeder network of high speed rail lines was assumed as shown in Exhibit 7-19. For this option the feeder network was assumed to operate with similar speed characteristics as the Alternative D TTC. The rail network totals some 21,440 km (13,400 miles) in length, of which the TTC represents approximately 22 percent of the total. The total length is lower and the TTC percentage is higher than is the case with Alternative B, due to the greater degree of overlap in Alternative D between the TTC alignment and the rail feeder network.

Time distance relationships for HSGT and other competing modes are shown in Exhibit 7-6. A comparison between air and HSGT travel times between city pairs directly served by both modes will be dependent upon terrain conditions along the route. Assuming rolling terrain or an equivalent combination of flat, rolling and mountainous terrain permitting an average speed of 320 km/h (200 mph), HSGT is competitive with air travel in terms of total journey time for distances up to 1,280 km (800 miles). Journey times (including station and air access times) by HSGT may exceed those for air travel by 0.3, 1.1 and 1.8 hours for trips of 640, 960 and 1,280 km (400, 600 and 800 miles), respectively. For trips up to 590 km (370 miles) HSGT travel may be expected to be quicker overall than air. HSGT would result in total trip times of one-third of the average trip duration by current Amtrak services.

While recognizing the range of uncertainties associated with travel projections of this nature, a single market share estimate has been developed for use in economic and financial analyses.

6.4 percent — for trips between 160 and 320 km (100 and 200 miles)
6.0 percent — for trips between 320 and 480 km (200 and 300 miles)
5.6 percent — for trips between 480 and 640 km (300 and 400 miles)
4.9 percent — for trips between 640 and 800 km (400 and 500 miles)
4.3 percent — for trips between 800 and 960 km (500 and 600 miles)
2.4 percent — for trips between 960 and 1,440 km (600 and 900 miles)

1.4 percent — for trips between 1,440 and 1,920 km (900 and 1200 miles)
0.7 percent — for trips between 1,920 and 2,400 km (1200 and 1500 miles)
0.5 percent — for trips between 2,400 and 3,200 km (1500 and 2000 miles)

Daily passenger flows crossing corridor screenlines on the Very High Speed Fixed Guideway option are shown in Exhibit 7-20. These flows include adjustments made to reflect the substantial usage of this option between the Los Angeles and Las Vegas regions. Flows at each screenline are within the range shown in the Task D Report, except for screenlines 1 and 2. The flows projected at these screenlines by the current analyses are at, or exceed, the upper end of the range identified previously. This is due to the alignment used in the current analyses passing close to heavily populated urban areas along the northern boundary of the study corridor.

Passenger-km (miles) on the TTC under this option are estimated as:

	DAILY PASSENGER KILOMETERS (MILES) (millions)			
	1990		2040	
Passenger-km (miles) on the TTC	10.46	(6.54)	24.85	(15.53)

Daily passengers using the TTC Very High Speed Fixed Guideway are estimated at approximately 42,000 by 2040. Based on an assumed line length from Norfolk, Virginia to Long Beach, California of 4,800 km (3,000 miles), the number of passengers per route km may amount to 9 (14 passengers per route mile) per day. On an annual basis passengers per route km may amount to 3,200 (5,100 passengers per mile).

Comparison with Other HSGT Projections

In recent years a number of detailed studies have been conducted on the potential ridership of HSGT systems in a variety of locations. In many such studies mode choice assumptions have been based on detailed Stated Preference Surveys. Significant differences exist in corridor conditions, competing modes and operational assumptions among these studies. Different target years for study projections have also been used. None of the studies use a projection year as far into the future as 2040. Despite such differences, it is of interest to review the range of market share anticipated for HSGT. Study results are summarized in Exhibit 7-21.

Exhibit 7-20

2040 PASSENGER FLOWS ON ALTERNATIVE D HSGT

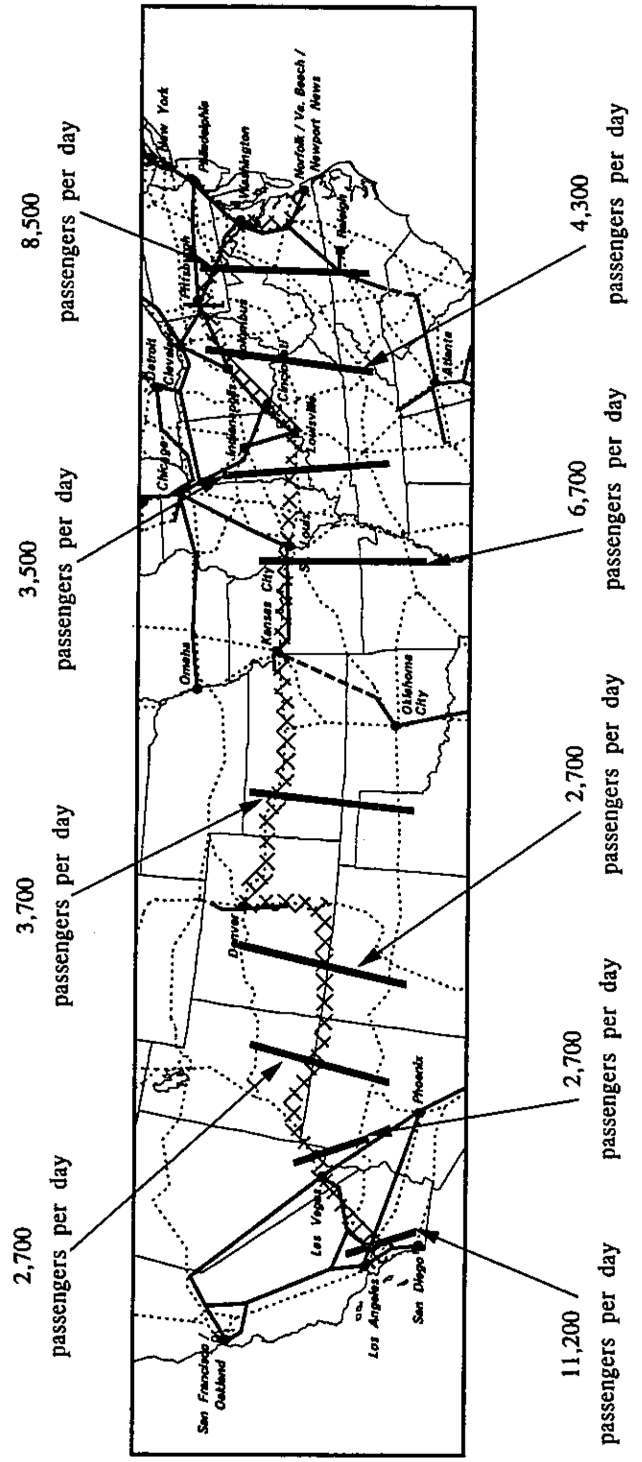


Exhibit 7-21
PROJECTED RIDERSHIP FOR SELECTED HST CORRIDORS

CORRIDOR	LENGTH		POPULATION	DAILY RIDERSHIP	DAILY RIDERS PER ROUTE		TOTAL MARKET SHARE
	km	miles			km	mile	
Detroit - Chicago	446	279	12,864,700	2,060-8,800	4.6-19.7	7.4-31.5	3.2-13.6%
Miami - Orlando - Tampa	502	314	8,810,000	5,180-9,700	10.3-19.3	16.5-30.9	3.8-7.1%
Cleveland - Columbus - Cincinnati	469	293	7,233,756	5,573	11.9	19.0	2-8%
Philadelphia - Harrisburg - Pittsburgh	485	303	11,738,000	7,160-8,200	14.8-16.9	23.6-27.1	1.4-1.6%
Dallas/Ft. Worth - Houston	389	243	11,715,110	9,448	24.3	38.9	15.0%
French TGV - Paris to Lyon	424	265	10,079,000	12,865	30.3	48.5	N/A
Windsor - Quebec City HST	1,186	741	17,416,500	12,953-16,607	10.9-14.0	17.5-22.4	6.8-8.7%
Toronto - Ottawa Montreal HST	560	350	13,838,500	8,685-10,872	15.5-19.4	24.8-31.1	12.1-15.2%
Portland, OR - Vancouver							
N/S Line	507	317	10,788,690	15,890	31.3	50.1	5.4%
E/W Line	459	287	10,788,690	7,095	15.5	24.7	2.5%
Los Angeles - Las Vegas	520	325	16,114,200	11,200	21.5	34.5	

NOTES: The ranges of ridership shown correspond to different maximum speed HST Alternatives.
The French-TGV Paris to Lyon ridership shown includes only trips between these cities. Trips travelling beyond Lyon are not included.

SUMMARY OF FORECASTS

Travel demand forecasts are summarized below for the highway and rail oriented alternatives.

Highway Alternatives

Projected vehicle flows across screenlines are compared for the Base Case and the highway oriented alternatives (A and C) in Exhibit 7-22. Screenline totals are the same for the Base Case and for Alternative A since no induced traffic is assumed to be generated for the Upgraded Highway option.

In Alternative C3, the study corridor contains one of three Super Highways which run east-west across the country from Atlantic to Pacific coasts. The other two lie north and south of the I-40 to I-70 corridor. Interurban travel for vehicles equipped to use instrumented lanes on a Super Highway was assumed to include ten percent induced travel as a result of the substantial increase in travel speed and driver convenience benefits provided by this option.

Despite this induced travel, screenline totals for Alternative C3 do not always exceed those of the Base Case. The reason for this apparent anomaly is that the screenlines only extend over I-40, I-70. In Alternative C3, corridor traffic is affected by the presence of the east-west Super Highways lying north and south of the corridor. Some traffic currently using I-70 or I-40 may be diverted to the northern or southern east-west super highways and so will not be counted in the screenline totals shown in Exhibit 7-21.

In Alternative C1, the study corridor is assumed to contain the only coast-to-coast east-west Super Highway. In this case, screenline totals are always higher than either the Base Case or Alternative C3.

Rail Alternatives

Projected 2040 daily passengers flows for Alternative D, High Speed Guideway, are higher at all screenlines compared to Alternative B, Upgraded Railway. Projected flows are shown in Exhibit 7-23. The higher flows are due primarily to differences in speed of travel and location.

Alternative D assumes speeds in the range of 200 km/h (125 mph) to 480 km/h (300 mph) depending upon terrain conditions. The range of speeds for alternative B is 200 km/h (125 mph) to 220 km/h (135 mph). Alternative D connects major population centers, particularly in the eastern half of the country. In comparison, the Alternative B location lies closer to the center of the I-40 to I-70 corridor, in the east, and serves fewer population centers.

Exhibit 7-22

PROJECTED 2040 PASSENGER VEHICLE FLOWS AT SCREENLINES FOR HIGHWAY ALTERNATIVES

SCREENLINE	BASE CASE	ALT "A"	ALT "C3" 3 E/W Rte	ALT "C1" 1 E/W Rte
1. Through NC, VA, WV, PA				
West of Richmond, VA				
I-70	39,100	37,600	36,500	38,000
TTC	---	6,700	25,600	35,800
Other	26,700	22,800	13,500	14,500
I-40	34,600	33,300	28,200	27,800
Total	100,400	100,400	103,800	116,100
2. Through TN, KY				
East of Knoxville, TN				
I-70	34,000	30,300	25,800	30,400
TTC	---	7,000	19,100	30,200
Other	19,700	30,600	14,600	14,800
I-40	44,200	30,000	33,800	35,000
Total	97,900	97,900	93,300	110,400
3. Through TN, KY, IN				
East of Nashville, TN				
I-70	23,600	24,600	24,300	30,000
TTC	---	11,700	16,600	24,500
Other	34,400	35,700	34,000	39,500
I-40	29,000	15,000	16,100	17,200
Total	87,000	87,000	91,000	111,200
4. Through MO, AK				
West of St. Louis, MO				
I-70	29,700	25,500	22,800	23,900
TTC	---	10,600	19,500	34,000
Other	20,600	20,700	8,500	84,000
I-40	24,000	17,500	18,200	19,100
Total	74,300	74,300	69,000	85,400

SCREENLINE	BASE CASE	ALT "A"	ALT "C3" 3 E/W Rte	ALT "C1" 1 E/W Rte
5. Through TX, OK, KS				
East of Amarillo, TX				
I-70	7,400	5,800	4,800	4,800
TTC	---	9,000	7,800	22,800
Other	5,800	---	---	2,400
I-40	13,100	11,500	7,500	8,800
Total	26,300	26,300	20,100	38,800
6. Through CO, NM				
West of Denver, CO				
I-70	7,100	4,900	2,300	2,500
TTC	---	7,000	7,300	22,500
Other	---	---	---	---
I-40	12,200	7,400	3,100	7,700
Total	19,300	19,300	12,700	32,700
7. Through AZ, UT				
East of Phoenix, AZ				
I-70	7,300	5,200	1,900	2,700
TTC	---	7,000	8,600	21,400
Other	---	---	---	---
I-40	12,200	7,300	1,900	10,600
Total	19,500	19,500	12,400	34,700
8. Through NV, AZ				
East of Las Vegas, NV				
I-70	---	---	---	---
TTC/I-15	13900	16,200	17,800	24,900
Other	---	---	---	---
I-40	10,400	8,100	4,300	5,100
Total	24,300	24,300	22,100	30,000

NOTE: Flows shown are daily two-way auto volumes.

Exhibit 7-23
PROJECTED 2040 DAILY PASSENGER FLOWS AT SCREENLINES FOR RAIL ALTERNATIVES

SCREENLINE	ALT "B" UPGRADED RAIL	ALT "D" HSGT
1. Through NC, VA, WV, PA West of Richmond, VA	1,600	8,500
2. Through TN, KY East of Knoxville, TN	800	4,300
3. Through TN, KY, IN East of Nashville, TN	2,200	3,500
4. Through MO, AR West of St. Louis, MO	4,000	6,700
5. Through TX, OK, KS East of Amarillo, TX	2,300	3,700
6. Through CO, NM West of Denver, CO	2,300	2,700
7. Through AZ, UT East of Phoenix, AZ	1,900	2,700
8. Through NV, AZ East of Las Vegas, NV	1,900	2,700
9. Through CA East of San Bernardino	1,600	11,200

FREIGHT DEMAND FORECASTS

Although 50-year forecasts can not be expected to be made with a significant degree of accuracy, a review of past actions, current trends and what is known about the future can provide insights.

THE PAST

The future forecast period of 50 years coincides with the historical period which saw the development of the freight transportation system we know today.

Railroads

The diesel locomotive entered revenue service in 1941. Although it has undergone a series of improvements since then, it is still the mainstay of motive power for American railroads over 50 years later. The 1950s saw the beginning of the modern merger movement and the rationalization of the U.S. rail system as well as the beginning of intermodal (trailer on flat car) service.

The '80s and '90s have seen the growth of double-stack container service which were first tested in 1977. In 1992, the number of containers exceeded the number of trailers transported in railroad intermodal service for the first time.

The composition of the rail system has continued to dwindle since the '40s and is now approximately one-half the size it was in 1944 (192,691 route km vs. 346,728). The system continues to shrink to high-density traffic routes which justify their existence financially in this private-sector freight transportation mode.

Highways and Trucks

Freight transportation by truck was limited by the lack of adequate roads until the 1920s and 1930s and did not really take off until the early '40s. An increase in revenue ton-miles of 190 percent between 1940 and 1950 began a continued growth period which was virtually guaranteed with authorization of the Interstate System in 1956. Truck sizes and payloads also grew, a trend which continues today.

Waterways

The corridor is concerned with two types of water-borne commerce -- domestic and international. Domestic transportation is largely attributed to the inland waterway system with the Mississippi River System providing the largest impact on the corridor. These impacts are largely limited to areas adjacent to the rivers.

International trade, however, is a different story. As the move toward a "global economy" continues, increases in international trade are also expected to continue. For purposes of corridor transportation demands, the focus of growth in this field is on intermodal traffic. Steamship containerization began in 1956, less than 40 years ago, and has grown to the point today that approximately 10 percent of U.S. international trade (60 percent of general cargo) now moves in containers.

INTERCITY TRANSPORTATION TRENDS

Intercity transport trends by mode have also varied over the past. Exhibit 7-24 displays this trend by three different measures.

Tonnage

The first columns of this Exhibit reveal intercity freight tonnage by truck and rail since 1947. In terms of absolute tonnage, rail traffic in 1990 was back up to 1947 levels after fluctuating up and down in the intervening years. Truck tonnage, on the other hand, has experienced a five-fold increase over the same time period with current levels substantially in excess of rail tonnage (2.4 billion vs. 1.5 billion metric tons [2.6 billion vs. 1.7 billion tons]).

Ton-Miles

Ton-miles by both modes have grown although truck ton-miles have grown faster than rail. Rail ton-km are still larger (1,563 billion to 1,072 billion [1,071 billion to 735 billion ton-miles]), however, due to the typically longer rail haul.

Revenues

The biggest disparity between the two modes is evident in the revenue columns. The two-to-one difference in 1960 has grown to a five-to-one difference in 1990 with trucking on top. Therefore, railroads not only provide more transportation (ton-km) but also do it for much less revenue.

Conclusions

Trucks haul fewer tons than railroads but railroads haul them further. Trucks, however, receive the most revenue by far and therefore must provide a more valuable service. Railroads have attempted to break into this trucking market through the provision of expedited intermodal service.

Exhibit 7-24
HISTORIC INTERCITY FREIGHT MODAL SHARE

	METRIC TONS		METRIC TON-KM		REVENUES	
YEAR	Truck	Rail	Truck	Rail	Truck	Rail
1947	504[1]	1,463[1]				
1950	720	1,289	252[2]	871[2]		
1960	1,071	1,180	416	845	$17,958[3]	$9,028[3]
1970	1,658	1,426	601	1,125	$33,553	$11,869
1980	1,820	1,441	810	1,360	$94,551	$27,858
1990	2,356	1,503	1,072	1,563	$162,300	$30,403
	TONS		TON-MILES		REVENUES	
YEAR	Truck	Rail	Truck	Rail	Truck	Rail
1947	556[1]	1,613[1]				
1950	794	1,421	173[2]	597[2]		
1960	1,181	1,301	285	579	$17,958[3]	$9,028[3]
1970	1,828	1,572	412	771	$33,553	$11,869
1980	2,007	1,589	555	932	$94,551	$27,858
1990	2,598	1,657	735	1,071	$162,300	$30,403

SOURCE: Transportation in America, 1992 Edition, Eno Transportation Foundation, Inc., pp. 40, 44 and 46.

(1) Millions
(2) Billions
(3) Millions of Dollars

THE FUTURE

Basic technological changes in transportation over the last 50 years have been comprised of dieselization of the railways, construction of the Interstate highway system and containerization of international trade. While other improvements in equipment, operations and facilities have occurred, and are currently continuing, revolutionary changes of these magnitudes are not currently foreseen.

Railroads

There is no replacement for the diesel-electric locomotive on the horizon although alternative fuels and mechanical/electronic improvements are being tested. Other forms of motive power have been and are being used, e.g., straight electric and turbines, but they have found only limited application due principally to costs, either capital, operation or maintenance.

Freight cars are becoming bigger and many railroads are considering increasing the nominal 90.7-ton payload capacity limit. Automatic train control systems are also being developed which will increase railroad capacities and safety.

The trunk line rail system continues to shrink through abandonments and spin-offs. While some operators of spin-offs are increasing traffic and creating viable operations, others are only postponements of the inevitable. As the system shrinks to a core system of high density main lines, direct rail service will be available to less and less of the shipping public which will result in increased use of trucks and/or intermodal transportation.

Highways-Trucks

The Interstate system has just been completed, its creation taking almost 35 years. A major future development in highway systems is expected to be automation in terms of vehicle control.

Freight vehicles, i.e., trucks, are becoming more fuel efficient, alternative fuels are being tested and more stringent air quality goals are being assessed. The pressure is mounting for larger vehicles in terms of cube and number of trailers permitted behind a single tractor.

A trend is also developing for long-distance highway movements to be converted to rail. This development, which started with trailers, now is being converted to containers moving in double-stack trains. The basic economics directing this conversion are evident from examination of Exhibit 7-25.

Currently the search is on for the design/construction of a 16.1-meter (defined legally as 53-foot) domestic container (to match the largest highway semi-trailer) capable of withstanding the rigors of handling and stacking. This, in turn, will require the railroads to develop a 16.1-meter (53-foot) well car. Currently, 16.1-meter (53-foot) containers are limited to riding on top of other containers in double-stack service.

This trend does have limitations, however, as the majority of the truck market is not long haul. Also, as shown

Exhibit 7-25
COST STRUCTURE COMPARISON BY MODE

MODE	TOFC/ COFC		OWNER-OPERATOR		TRUCKLOAD SUPERCARRIER		DOUBLE-STACK	
	Per KM	Per Mile	Per KM	Per Mile	Per KM	Per Mile	Per KM	Per Mile
DIRECT COSTS:								
Labor Cost	$0.04	($0.07)	$0.15	($0.25)	$0.13	($0.21)	$0.02	($0.03)
Fuel Cost	$0.04	(0.07)	$0.11	(0.17)	$0.07	(0.11)	$0.04	(0.06)
Pick-Up and Delivery Cost	$0.16	(0.25)	$0.00	(0.00)	$0.00	(0.00)	$0.16	(0.25)
Equipment Ownership Cost	$0.07	(0.10)	$0.13	(0.21)	$0.11	(0.17)	$0.02	(0.04)
Fixed Running Cost[1]	$0.06	(0.09)	$0.09	(0.14)	$0.07	(0.12)	$0.03	(0.05)
TOTAL DIRECT COST	$0.37	($0.58)	$0.48	($0.77)	$0.38	($0.61)	$0.27	($0.43)
INDIRECT COSTS:								
Circuitry Factor		(x 1.15)		(x 1.00)		(x 1.00)		(x 1.15)
Adjusted Cost	$0.42	($0.67)	$0.48	($0.77)	$0.38	($0.61)	$0.31	($0.50)
Admin., Sales & Marketing, Etc. Cost	$0.12	(0.20)	$0.15	(0.24)	$0.11	(0.18)	$0.10	(0.16)
SUBTOTAL	**$0.54**	**($0.87)**	**$0.63**	**($1.01)**	**$0.49**	**($0.79)**	**$0.41**	**($0.66)**
Deadhead Factor (Empty Backhaul)		+ 0.65		(+ 0.85)		(+0.92)		(+ 0.80)
TYPICAL COST PER LOADED KM	**$0.83**	**($1.33)**	**$0.74**	**($1.19)**	**$0.51**	**(0.86)**	**$0.51**	**($0.82)**

SOURCE: *A Look Ahead - Year 2020*, Transportation Research Board, National Research Council, 1988, p. 348.
NOTE: All costs per trailer/container kilometer (mile).
(1) Includes equipment maintenance, insurance, licensing, etc.

in Exhibit 7-25, the cost difference between the truckload supercarrier and double-stack operations are not really significant. Swings in costs or other factors such as environmental pressure, would have a large influence in favor of one over the other.

Environmental Considerations

It appears that the basic freight transportation system we have today will be with us for the foreseeable future, with some refinements of course. The most pressure for change at this time would appear to be attributable to environmental and energy concerns, namely fuel consumption and emissions. This could result in the increase in the use of modes which consume relatively little fuel, namely railroads and waterways, or increased efforts to make the more fuel-hungry modes more efficient and less polluting. Of the current efforts, the use of alternative fuels and legalization of LCVs appear to be the most likely. The use of "truck-trains" even larger than LCVs, operating on roadways separate from conventional traffic, is certainly not inconceivable.

Competitive Considerations

The railroads and the trucking industry have been the fiercest of competitors with trucks having siphoned off many of the railroad's highest revenue commodities over the years. The development of intermodal networks was an attempt to get this traffic back which had mixed success until the long-distance truckload trucking companies and the railroads developed what has become known as "strategic alliances." In such arrangements truckers provide local pick-up and delivery and the railroads the long haul. The long haul typically is over 805 km [500 miles] (could be up to 1,448 km [900 miles]). This alliance has resulted from economics, driver shortages and other reasons. The railroads are also trying different concepts for short-haul markets which minimize transfer costs, such as RoadRailer and the Iron Highway, but it is a difficult undertaking.

Corridor Implications

As stated earlier, it is anticipated that railway bulk cargo will remain on the existing conventional rail system and that the corridor would only attract trucks and intermodal rail freight traffic. Further, it is assumed that only long-haul traffic would be attracted. Short-haul traffic is not attracted to rail for intermodal movements (except in special circumstances) and short-haul truck traffic is most likely to remain on the existing highway system to avoid introducing circuitry.

Really effective use of the corridor by the highway mode will require introduction of LCVs. Their use to date has been limited principally by safety concerns. The separation of this traffic from other vehicular use will mollify this concern.

BASE CASE FREIGHT FLOWS

National freight traffic flows were examined[3] to determine movements which might logically make use of the corridor. In order to aggregate the traffic data into manageable form, the country was divided into 15 zones. The 15 zones used in the traffic analysis are the subject of Exhibit 7-26.

Zone-to-Zone Transport

Tonnage was determined for traffic that originated in each zone and forwarded to other zones and for that which terminated in each zone received from the other zones. Intrazone traffic was not considered.

[3] Using 1990 data obtained from Transearch by Reebie Associates.

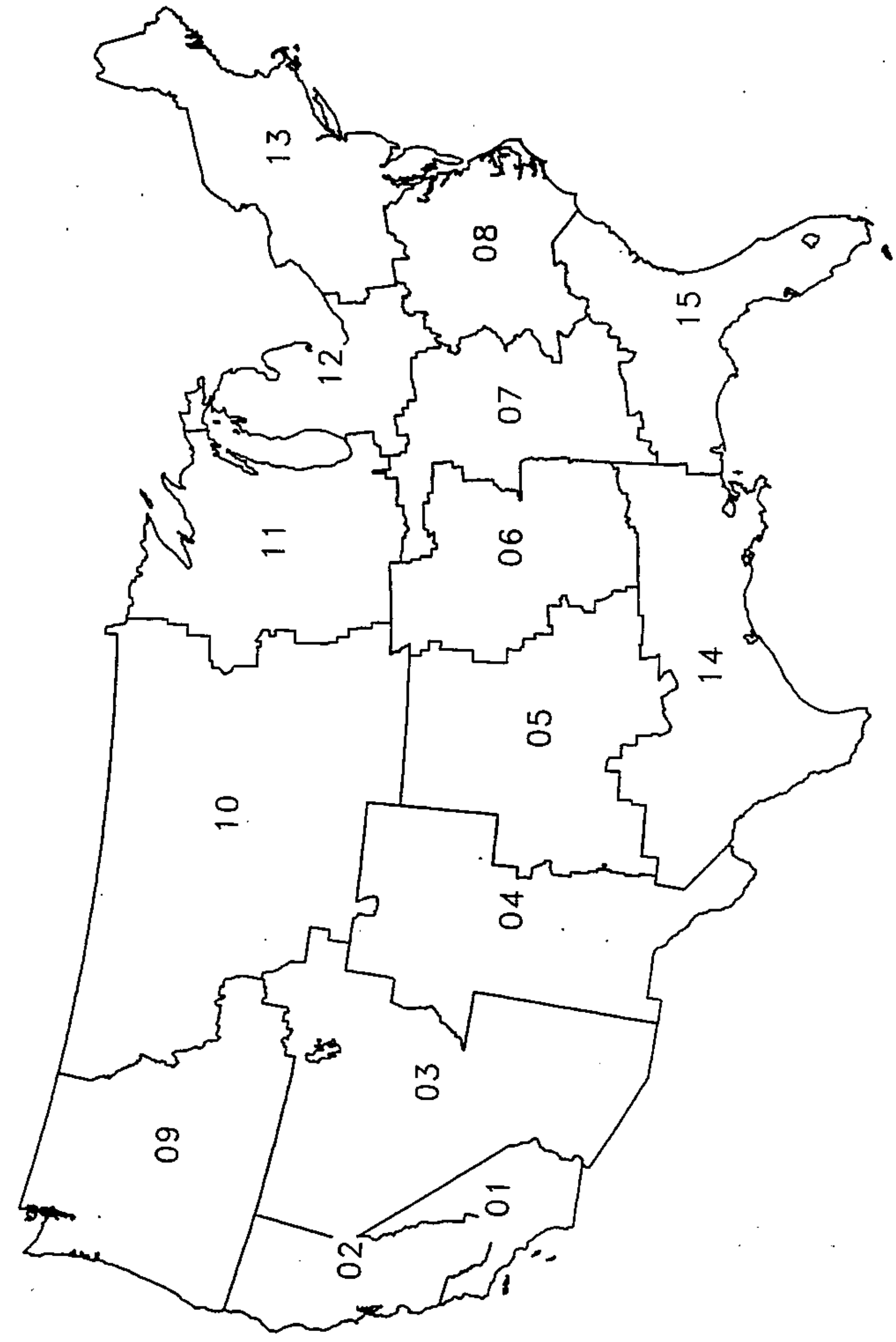


Exhibit 7-26
ORIGINAL AND DESTINATION ZONES

The totals shown in the Exhibits and discussed in the text may be somewhat misleading as the totals used in this analysis are not the total traffic generated by each zone but rather the traffic attributable to each zone, which might move through the corridor. For example, freight might move between Zone 9 and Zone 7 using the corridor, but freight moving between Zone 9 and Zone 10 would not and this volume is not included in the analysis nor in the totals.

Exhibit 7-27 reveals the 1990 truck tonnage moving between origin-designation zone pairs. Exhibit 7-28 reveals rail intermodal movements. The blanks in each matrix represent movements between zones which were felt would not make use of the corridor.

Truck Movements

Examination of Exhibit 7-27 reveals that, of the east-west freight movements in and out of zones within the corridor, over one-half (55 percent) is associated with adjacent zones (shaded in the Exhibit). The percentage of adjacent zonal movement by zone is also shown in the Exhibit. Note these short movements are less for Zones 1 and 2 than any of the others.

Rail Intermodal Movements

Exhibit 7-28, displaying rail intermodal movements, reveals a somewhat different pattern. Only 15 percent of the corridor's east-west movements are associated with adjacent zones. Although there is a high percentage between some zones, they are small in terms of absolute numbers. The largest activity is between Zones 1 and 2 and Zones 6, 11 and 14. These activities do not benefit significantly from the TTC corridor due to their north-south orientation.

FREIGHT FORECASTS

Growth and decline in the transportation sector has traditionally been subject to economic changes. Assuming that this trend continues in the future, a methodology has been established to predict the changes in both intermodal rail and truck transportation based on a 50-year projection in economic activity.

BEA Economic Projections

Preliminary economic projections were developed in October of 1990 by the Department of Commerce (*Regional Projections to 2040, Volume 3: BEA Economic Areas*, USDOC). These projections were based on dampened extensions of relevant historical growth rates. For each major commodity, a series of steps was undertaken. First, historical values were obtained for each commodity between

Exhibit 7-27

ORIGIN & DESTINATION MATRIX
1990 TRUCK MOVEMENTS

(Thousands of Tons)

DESTINATION ZONES

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total	% Adj Zonal ovement
	1			2,634	1,646	777	718	730	410		383	1,194	857	1,862	1,161	459	12,831	21%
O	2			1,521	733	613	508	615	403		284	963	730	1,703	950	396	9,419	16%
R	3	3,602	2,779		4,199	638	232	182	115			572	154	1,003	586	136	14,198	75%
I	4	354	212	1,330		2,545	661	482	138			625	1,100	1,581		124	9,152	42%
G	5	1,188	718	563	4,232		#####	2,118	839	732			1,284	1,969		863	30,454	66%
I	6	999	633	341	1,204	#####		#####	2,759	489			5,654	5,035			45,369	62%
N	7	1,569	941	2,069	4,240	3,145	#####		#####	1,957	2,366				4,463		46,626	55%
	8	836	443	135	206	1,070	3,099	#####		178	170	3,722			2,675		25,528	51%
	9					420	369	538	285				855	1,257	515	191	4,430	
Z	10	431	287					3,842	298						355	276	5,489	
O	11	1,690	1,097	2,270	4,566				2,510								12,133	
N	12	2,661	1,697	640	1,363	2,662	5,263			879							15,165	
E	13	2,836	1,735	568	502	2,627	5,163			848					4,731		19,010	
S	14	1,276	847	298				6,921	1,456	393	533			3,380		4,880	19,984	
	15	429	258	107	156	1,156				155	622				4,747		7,630	
	Tot	#####	#####	#####	#####	#####	#####	#####	#####	5,631	4,358	7,076	#####	#####	#####	7,325	######	55%

Thousands of Metric Tons)

INATION ZONES

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total	% Adj Zonal ovement
	1			2,389	1,493	705	651	662	372		347	1,083	777	1,689	1,053	416	11,638	21%
O	2			1,380	665	556	461	558	366		258	873	662	1,545	862	359	8,543	16%
R	3	3,267	2,521		3,808	579	210	165	104			519	140	910	532	123	12,878	75%
I	4	321	192	1,206		2,308	600	437	125			567	998	1,434		112	8,301	42%
G	5	1,078	651	511	3,838		#####	1,921	761	664			1,165	1,786		783	27,622	66%
I	6	906	574	309	1,092	#####		#####	2,502	444			5,128	4,567			41,150	62%
N	7	1,423	853	1,877	3,846	2,853	#####		#####	1,775	2,146				4,048		42,290	55%
	8	758	402	122	187	970	2,811	#####		161	154	3,376			2,426		23,154	51%
	9					381	335	488	258				775	1,140	467	173	4,018	
Z	10	391	260					3,485	270						322	250	4,979	
O	11	1,533	995	2,059	4,141				2,277								11,005	
N	12	2,414	1,539	580	1,236	2,414	4,774			797							13,755	
E	13	2,572	1,574	515	455	2,383	4,683			769					4,291		17,242	
S	14	1,157	768	270				6,277	1,321	356	483			3,066		4,426	18,125	
	15	389	234	97	141	1,048				141	564				4,306		6,920	
	Tot	#####	#####	#####	#####	#####	#####	#####	#####	5,107	3,953	6,418	9,645	#####	#####	6,644	######	55%

Note : Blank cells indicate traffic movements not investigated
Source : Reebie Associates, compiled by Wilbur Smith Associates

Exhibit 7-28

ORIGIN & DESTINATION MATRIX
1990 RAIL INTERMODAL MOVEMENTS

(Thousands of Tons)

		DESTINATION ZONES																% Adj Zonal ovement
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total	
	1			148	235	666	1,968	427	101		131	4,075	120	228	1,912	292	10,303	1%
O	2			152	110	274	502	170	146		10	1,363	20	50	514	125	3,436	4%
R	3	144	214		148	15	184	59	29			298	6	20	37	22	1,176	43%
I	4	206	88	250		42	178	29	3			355	3	16		20	1,190	25%
G	5	852	343	39	234		401	49	61	272			29	71		80	2,431	26%
I	6	2,580	778	414	366	692		555	278	461			203	913			7,240	17%
N	7	287	173	21	23	148	394		435	86	2				473		2,042	41%
	8	72	65	9	18	22	97	367		20		213			49		932	40%
	9					125	444	147	101				76	95	158	179	1,325	
Z	10	87	13					16	32						24	10	182	
O	11	4,218	1,833	542	536				214								7,343	
N	12	24	44	5	6	36	219			58							392	
E	13	241	156	15	4	180	374			1					26		997	
S	14	2,934	534	69				150	131	259	21			117		754	4,969	
	15	75	30	6	8	31				32	1				458		641	
	Tot	#####	4,271	1,670	1,688	2,231	4,761	1,969	1,531	1,189	165	6,304	457	1,510	3,651	1,482	44,599	15%

(Thousands of Metric Tons)

		DESTINATION ZONES																% Adj Zonal ovement
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total	
	1			134	213	604	1,785	387	92		119	3,696	109	207	1,734	265	9,345	1%
O	2			138	100	249	455	154	132		9	1,236	18	45	466	113	3,116	4%
R	3	131	194		134	14	167	54	26			270	5	18	34	20	1,067	43%
I	4	187	80	227		38	161	26	3			322	3	15		18	1,079	25%
G	5	773	311	35	212		364	44	55	247			26	64		73	2,205	26%
I	6	2,340	706	375	332	628		503	252	418			184	828			6,567	17%
N	7	260	157	19	21	134	357		395	78	2				429		1,852	41%
	8	65	59	8	16	20	88	333		18		193			44		845	40%
	9					113	403	133	92				69	86	143	162	1,202	
Z	10	79	12					15	29						22	9	165	
O	11	3,826	1,663	492	486				194								6,660	
N	12	22	40	5	5	33	199			53							356	
E	13	219	141	14	4	163	339			1					24		904	
S	14	2,661	484	63				136	119	235	19			106		684	4,507	
	15	68	27	5	7	28				29	1				415		581	
	Tot	#####	3,874	1,515	1,531	2,024	4,318	1,786	1,389	1,078	150	5,718	414	1,370	3,311	1,344	40,451	15%

Note : Blank cells indicate traffic movements not investigated
Source : Reebie Associates, compiled by Wilbur Smith Associates

1972 and 1988. Next, a long-term growth average was developed by averaging the first three years (1972-1974) and a short-term growth average was developed by averaging the last three years (1986-1988). These two growth rates were then used to determine an average growth rate. Finally, the growth rate was dampened according to a schedule depending on the year. In other words, the growth rate for 1990 to 1995 was equal to 80 percent of this historical growth rate, while five-year internals after 1995 use a rate approximately 70 percent of the previous five-year period's rate. Also, smoothing was used to account for major swings in certain commodities, occasioned by actions such as plant closings, that could distort future projections.

Preliminary Transportation Projections

Based on the economic projections developed by the Department of Commerce, transportation projections were made for intermodal rail and truck movements. Data obtained from Reebie Associates were used as baseline transportation volumes for 1990.

The first step was to develop a ratio between Year 2040 total employment and 1990 total employment to obtain a growth adjustment factor. This was accomplished using the Department of Commerce projections referenced earlier. This ratio was then applied to the 1990 freight movements to estimate 2040 freight movements. Finally, adjustments were made to the freight movements to account for changes within the transportation industry and the likely effects of building the TTC. For example, adjustments were made for likely transfers of truck movements to intermodal rail or from intermodal rail to LCV truck movements on a super highway.

FREIGHT FORECASTS BY OPTION

As applicable for freight transportation, there are three corridor configurations to be considered -- a new conventional highway (interstate standards), an upgraded conventional railroad, and a super highway and truckway. The fourth alternative (D), has no impact on freight forecasts, as it is anticipated that no conventional freight of any significance would be transported on the Very High Speed Fixed Guideway system. This system undoubtedly would have some provision for mail/express and perhaps small packages, however.

Alternative A - Freight Forecasts

For freight transport, the main attraction of the Alternative A highway would be the avoidance of congestion around major cities on the existing Interstates. This attraction would be limited to long-haul transport and, as there are no major improvements otherwise, it is assumed that only that portion of the existing truck traffic which would travel through at least two intervening zones between origin and destination would be attracted to the TTC. It was also assumed that portions of the long-distance truck traffic would be captured by the existing rail system as the trend toward domestic containerization continues.

Rail intermodal is projected to capture 20 percent of the long-haul (over 805 km) truckload market by 1995. This represents an 8 percent increase since 1989.[4] Truckload diversions are due in large part to conversion by carriers of trailer fleets to container fleets which is expected to be completed in five years or so.[5] Projecting market share once this conversion has occurred results in a 25 percent share, plus or minus, which represents a 12 percent diversion of long-haul truck traffic as defined for the corridor analysis.

Alternative B - Freight Forecasts

The rail share for Alternative B is based on expected economic growth plus continued diversions from long-haul trucks. Given the relative attractiveness in the rail vs. truck service under this alternative, expected diversions from long-haul truck are increased by 50 percent to a total of 18 percent. Exhibit 7-29 displays the composition of the tonnage in the year 2040.

Alternative C - Freight Forecasts

This alternative is almost the reverse of the previous one in that the truck alternative, Longer Combination Vehicles (LCVs) operating on an exclusive truckway, is most attractive compared with the conventional rail system. Therefore, in this case, it is assumed that rail traffic is diverted to truck. Analyses performed by the Association of American Railroads (AAR) indicated that rail intermodal would lose 17 percent of its ton-km with the advent of twin 14.6.[6] An increase of half

4 "1993 Index: Good Service Equals Greater Traffic Management," Traffic Management, February, 1993, p. 19.

5 Burke, Jack; "TTX and Congressional Watchdog Offer Divergent Views on Intermodal," Traffic World, January 4, 1993, p. 13.

6 Lee, Lane; Intermodal Trends, Volume III, Number 4, p. 4.

Exhibit 7-29
ALTERNATIVE B: FREIGHT COMPOSITION
(2040)

MEASURE	DIVERTED FROM		TOTALS
	Highway	Rail	
Metric Tons (millions)	7.68	19.79	27.47
Metric Ton-km (billions)	24.41	56.67	81.08
Tons (millions)	8.47	21.82	30.29
Ton-miles (billions)	16.73	38.84	55.57

again the diversion would not appear to be unreasonable given the prospects of even greater truck size combinations on an exclusive roadway.

In addition, it is assumed the LCVs would operate much like rail intermodal in that the trailers would have to be combined/split-up in terminals adjacent to the truckway for local pick-up/delivery. However, the operation would not be as complex nor as costly as rail intermodal terminals.

The anticipated diversions to the super highway are the subject of Exhibit 7-30. The large diversions from rail, as opposed to truck, are a function of the typically longer rail hauls which would be attracted to the corridor.

Total TTC Freight Forecasts

A summary of anticipated corridor transport demand for each TTC alternative is the subject of Exhibit 7-31. In all cases it was anticipated that approximately two-thirds (65 percent) of the total tonnage which could be attracted to the corridor would actually use it. A range of ±20 percent, equating to 50 to 80 percent of the totals, was also established for sensitivity tests.

For illustrative purposes, Alternatives B and C are shown in flow chart form in Exhibits 7-32 and 7-33, respectively. In Alternative B, midwest origins/destinations are favored for rail movement. Significant rail intermodal move-

Exhibit 7-30
ALTERNATIVE C: FREIGHT COMPOSITION
(2040)

MEASURE	DIVERTED FROM		TOTALS
	Highway	Rail	
Metric Tons (millions)	7.69	90.17	97.86
Metric Ton-km (billions)	18.76	194.46	213.22
Tons (millions)	8.48	99.42	107.90
Ton-Miles (billions)	12.86	133.28	146.13

Exhibit 7-31
PROJECTED YEAR 2040 TTC FREIGHT TONNAGE
(50 to 80 percent range)

ALT.	MODE		TOTALS
	Truck	Rail	
	(millions of metric tons)		
A	28.8 - 46.2	n.a.	28.8 - 46.2
B	n.a.	21.1 - 33.8	21.1 - 33.8
C	75.3 - 120.4	n.a.	75.3 - 120.4
D	n.a.	Negligible	Negligible
	(millions of tons)		
A	31.8 - 50.9	n.a.	31.8 - 50.9
B	n.a.	23.3 - 37.3	23.3 - 37.3
C	83.0 - 132.8	n.a.	83.0 - 132.8
D	n.a.	Negligible	Negligible

n.a. - not applicable

ments are drayed from one rail terminal to another in Chicago and thus the records do not reflect the through movement; significant traffic also is drayed direct to the northeast.

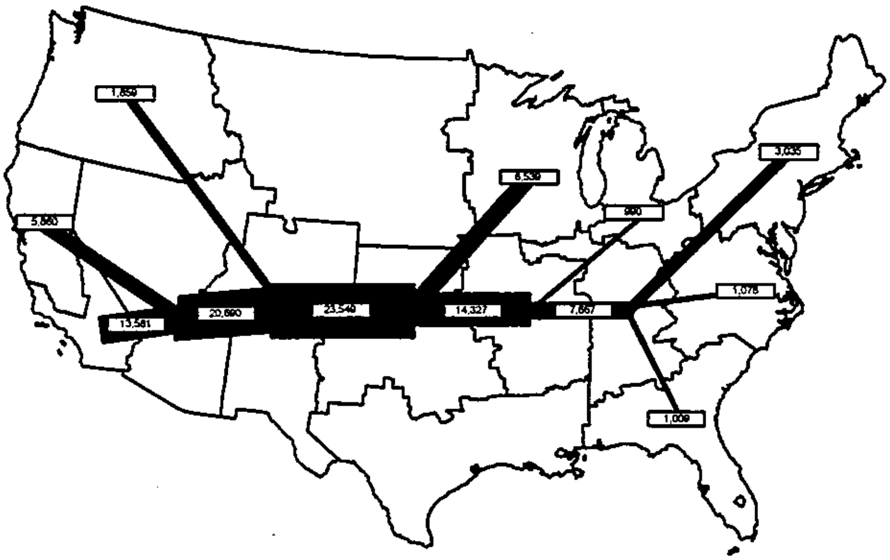
Exhibit 7-33, which displays truck movements for the super highway, reveals much the same pattern as the conventional highway, but larger volumes.

Exhibit 7-32

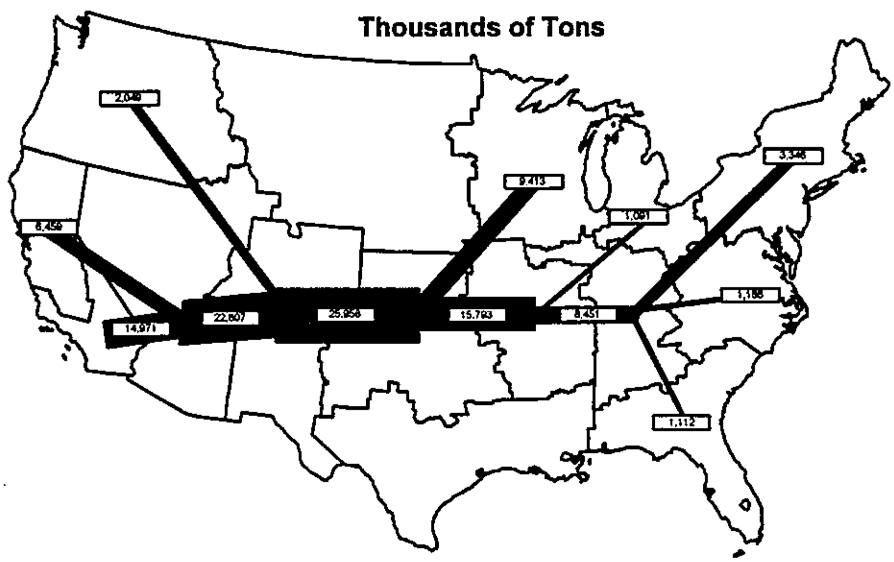
ALTERNATIVE B: EXPANDED RAIL SYSTEM

MOVEMENT OF FREIGHT BY INTERMODAL RAIL

Thousands of Metric Tons



Thousands of Tons

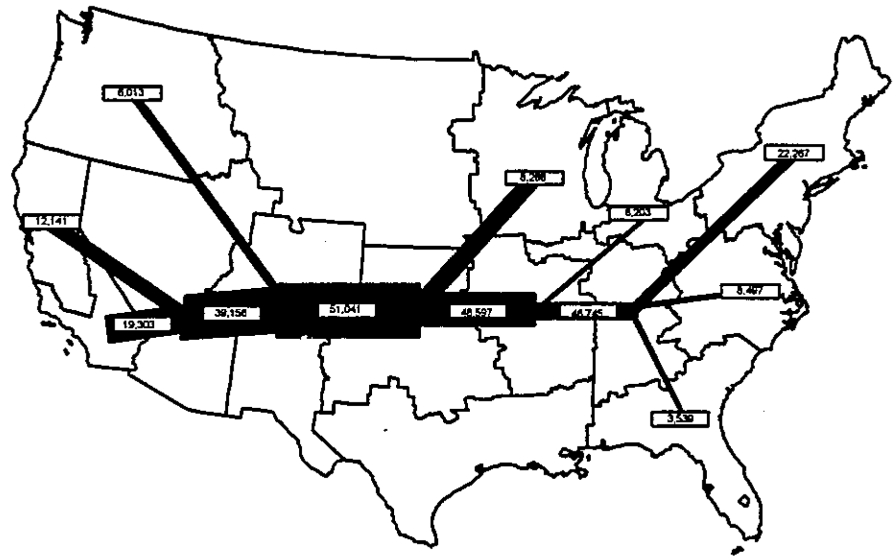


NOTE: Band widths include tonnage generated in respective zones plus through movements.

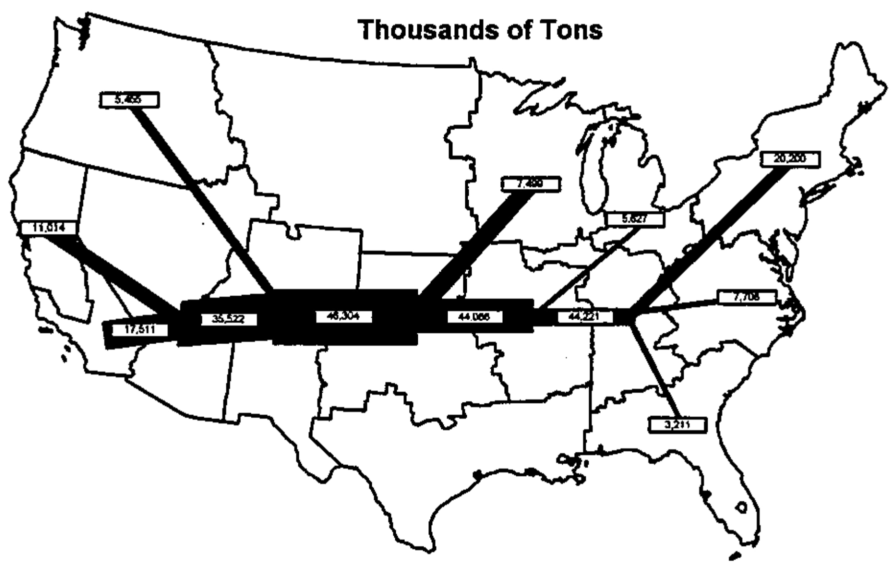
SOURCE: Reebie Associates, compiled by Wilbur Smith Associates, GIS Department

Exhibit 7-33
ALTERNATIVE C
MOVEMENT OF FREIGHT BY TRUCK

Thousands of Metric Tons



Thousands of Tons



NOTE: Band widths include tonnage generated in respective zones plus through movements.
SOURCE: Reebie Associates, compiled by Wilbur Smith Associates, GIS Department

Chapter 8
APPROACH TO THE ECONOMIC FEASIBILITY ANALYSIS

A major public investment such as a new Transamerica Transportation Corridor (TTC) is "economically feasible" if the economy is better off with the TTC than without it. Without question, a well planned TTC investment will be a significant economic asset to the corridor areas through which it passes, and it could be of help to the economic future of communities and activities located in proximity to the facility.

Government is often asked to make investments, particularly highway investments, for "economic development" purposes. The rationale, from the corridor perspective, is that the corridor area will be better off due to greater transport efficiency, the possible attraction of new businesses, and the overall improved ability of the corridor region to compete for economic activity. If the improved corridor economy is sufficient to cause the overall U.S. economy to be better off, and if that economic improvement is greater than the cost of the transportation facility, then the TTC facility is an economically feasible investment.

ECONOMIC ASSESSMENT OVERVIEW

For purposes of the TTC Study, economic benefit is defined as "an increase in the prosperity and incomes of people and institutions." Economic gains of this nature occur when the incomes and product generated in the area are caused to increase. Such increases occur in either of two ways:

Types of Economic Effects

1. <u>Efficiency</u> - Transportation cost savings that result from improvements to a corridor are true benefits to the Nation. When travellers experience time savings, greater safety, or reduced vehicle operating costs, their gain is not offset by losses to other people. Cost reductions act exactly the same as income increases by making resources available for other purposes. If the effective increase in income brought about by the project exceeds its cost, the project is said to be efficient. It makes the Nation better off.

2. <u>Attraction of Resources (referred to as corridor economic development)</u> - Reduced transportation costs in the corridor, relative to costs at other

locations, can encourage economic activity to shift to the corridor. If output increases in the area, the increased output will require more resources (land, labor, materials, capital) which can mean that more people are employed and net income within the area increases. If the TTC investment enables the attraction of additional business in the corridor (new firms, or expanded firms), then the transportation investment can aid the economic development process, to the benefit of the corridor area.

It is important to distinguish between these two economic effects of transportation improvements. Efficiency improvements benefit users of the transportation facility and others with no corresponding losses to others. They are, therefore, net gains to the nation. Resources attracted to the improved corridor are, in essence, transferred from other locations in the U.S. These transfers are not net gains to the Nation; increases in income and property values along the corridor occur at the expense of other people elsewhere.

Throughout the analysis of potential TTC investments, a clear distinction is drawn between these two types of economic impacts. How the transfer of economic activity is viewed depends greatly on the geographic perspective one takes.

Economic Basis for an Efficient Transportation Project

Transportation facilities (highways, railroads, airports) are essentially "tools" used in transporting goods and people from one place to another. Investments in transportation facilities contribute to economic development in that they lower transportation and/or logistics costs and/or improve people's perceptions of the corridor or nation, thereby causing people or firms to want to settle or invest there. Such transportation-caused changes may be due to faster travel speeds, more reliable travel, improved safety, decreases in fuel and other vehicle operations costs, revised logistics or agricultural patterns, reductions in noise or air pollution, or for other reasons. But in the final analysis, all of the direct benefits of a transcontinental transportation facility, and therefore the justification for investing in it, flow from using it for transportation.

Benefits from the TTC may accrue to persons and businesses other than those who use the facility. Lower transportation costs may be passed on to consumers as lower prices for consumer goods, to workers as higher wages, or to owners of businesses as higher net income. Persons may thus benefit from the TTC investment without actually traveling on the facility.

It is important to keep in mind that, for any of these benefits to occur, the TTC investment must either enable significant reductions in transportation costs or cause revised perceptions of the area. If the amount of these savings is small for each trip, if the number of travellers or amount of freight using the TTC is not sufficiently large, or if peoples' perceptions do not change dramatically, the investment will not produce benefits that exceed its cost. Therefore economic feasibility conclusions must be based on reasonable estimates of the travel volumes that will use the TTC, the cost savings travelers and freight will experience, and a realistic assessment of how the TTC investment might influence industrial location decisions, logistics patterns, other investment decisions, and peoples' perceptions of the corridor and the transportation investment.

Investing in a major transportation improvement that produces benefits which are less than the associated costs of the improvement operates counter to economic development. The costs will be paid by users and other taxpayers in the form of higher taxes than otherwise would be the case, or would be paid in a lost opportunity (an alternative transport facility or other facility would not get built). These higher taxes work against economic growth within the taxing jurisdictions because they reduce post-tax return to businesses and households, and investment in the "wrong" transport project or corridor similarly retards economic growth. Therefore, if the TTC investment is not economically feasible, it is economically counterproductive.

Impact Area and Transfer Effects

By reducing the costs of transporting people and goods along a corridor, a TTC investment can make locations along the corridor more attractive to businesses. Two general types of economic development effects can result from improvements that lower transportation costs along the corridor relative to other places: improved competitive position and growth in businesses serving travelers.

- Improved Competitive Position - The TTC transportation improvements could remove one impediment to the attraction and growth of economic activity. Reduced transportation costs should enable the corridor area to better compete for economic activities, meaning that business activity will be expanded in, or otherwise attracted to, the local economies. The primary impact area receives these benefits, the states receive some of them, but the U.S. as a Nation does not benefit in this way unless it allows the U.S. to improve its competitive position vis-à-vis other Nations.

- Growth in Businesses that Serve Travelers - The two candidate highway improvements will divert highway traffic to the corridor, and this additional traffic will increase the local economy revenues of such businesses as service stations, motels, restaurants and others. All of these are beneficial at the local level, some are impacts at the state level, none are valuable at the national level since traffic is merely diverted from one transportation facility to another.

Both of these effects transfer income and property value to owners of land and businesses along the improved corridor. Corresponding losses will occur at other places where this economic activity otherwise would have been located. Transfers resulting from improving a corridor might include:

- New businesses being formed along the corridor.

- Expansion of existing businesses along the corridor.

- Existing businesses along the corridor remaining there that otherwise would have departed.

- Businesses from other locations moving to the corridor.

A final type of transfer effect is economic activity related to the act of transportation facility construction. This effect is, of course, temporary in that when construction is complete, any economic activity it stimulated along the corridor will gradually subside. During the period of construction, state, Federal or private money spent in the corridor region (the primary impact area) to build the TTC is of economic value to this region. Wages are paid, gravel and other materials are purchased. From the perspective of the corridor, the effect of construction-related expenditures is positive. At the national level there is no net effect from these expenditures, per se, because they are transfer payments at that level.

How one values these transfer effects is very much a function of geographic perspective. If one's perspective is that of a rather narrow belt along the improved transportation facility, an increase in economic activity is almost certain. Stated differently, the corridor will be the recipient of economic activity that transfers to it as a result of reductions in relative transportation costs.

If instead the impact area of interest is the entire multi-state region, the overall amount of economic development resulting from the highway or rail investment might be less. A certain number of businesses within the region, especially those that are relatively mobile, will relocate to higher access sites along the TTC. While an increase in economic activity may be evident near the highway or rail line, it may not be a net gain to a state if it is only a relocation from elsewhere within the state. From a single state perspective, the TTC investment contributes to economic growth if travel costs within the state are reduced or if it creates economic activity within the state. Lower travel costs help improve productivity which, in turn, increases income to firms and individuals. Productivity gains also help enable one state's produced goods to be more competitive in other states and even in international markets. The key point here is that for a highway or rail line investment to contribute to state economic growth, it must significantly reduce transportation costs, or draw economic activity to the state from other states. Transfers from one location in a state to another location in the same state are of little or no net gain to the statewide economy.

Similarly, if the TTC investment is to help the U.S. economy, it must either create travel efficiencies or enable U.S. goods and services to be more competitive internationally, or both. The fact that the investment might allow the corridor or corridor states to better compete with non-corridor states is of little or no net benefit to the nation as a whole.

In this study, economic implications are examined for two impact areas: 1) the TTC corridor area, referred to herein as the corridor area's "primary impact area," and 2) the U.S. as a whole. The primary impact area is shown on Exhibit 8-1 and comprises those counties within approximately 80 km (50 miles) of each alignment option.

Overview of the Economic Evaluation Process

The economic approach used to analyze the TTC investment options, while being tailored to the study, is one which has been used on other corridor studies, and one which has evolved over the years. Exhibit 8-2 summarizes the approach.

The economic approach includes:

- A definition of the types of transportation facilities considered in the corridor (the TTC options).
- Development of a "base case" against which all TTC options can be compared.
- A generalized estimate of each option's life cycle cost.
- Estimated use (passenger and freight) that will be made of each option (existing and future use).
- Quantification of estimated travel efficiency economic benefits believed to be attributable to the TTC investment.
- Quantification of estimated corridor area economic development impacts believed attributable to the TTC investment.
- A comparison of the economic costs and economic benefits attributable to the TTC.

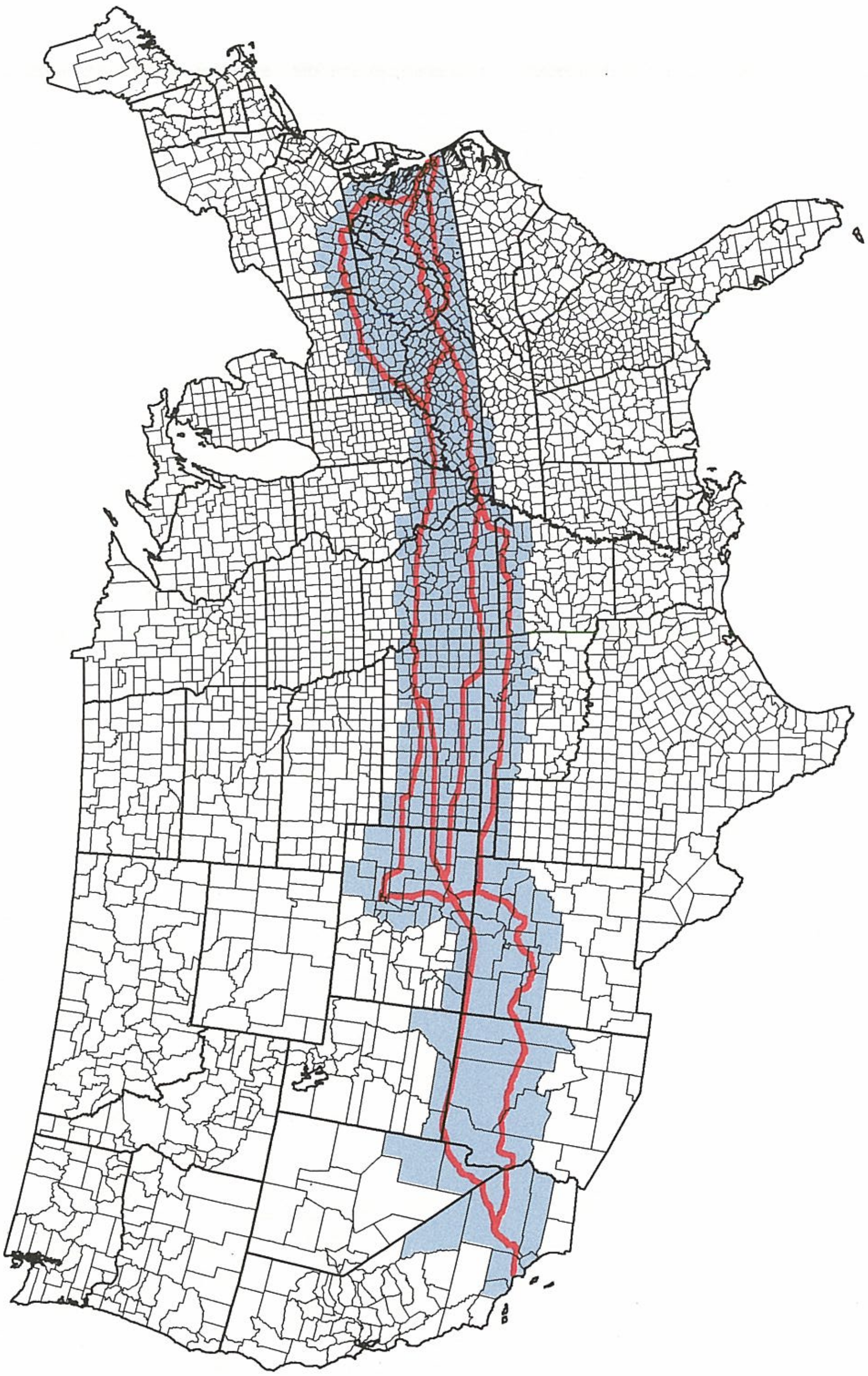
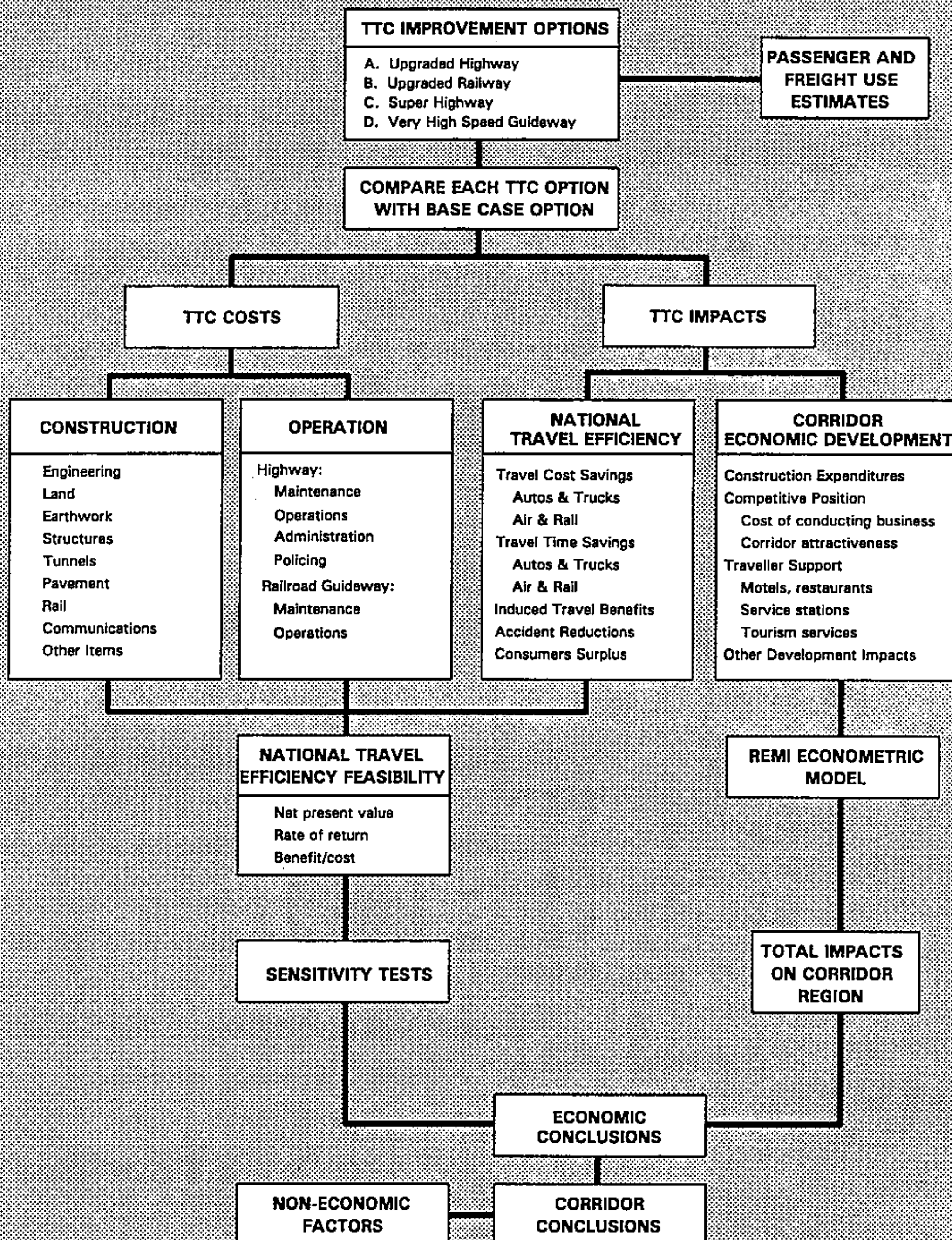


Exhibit 8-1
TTC PRIMARY IMPACT AREA

Exhibit 8-2
TTC ECONOMIC EVALUATION PROCESS



- Sensitivity tests of key parameter values.
- Conclusions concerning the economic impact and feasibility of investing in the TTC.

ECONOMIC EVALUATION PRINCIPLES

The economic analysis of each of the candidate TTC options follows a consistent set of evaluation principles.

Comparisons With "Do-Nothing" Base Case

To calculate each TTC option's costs and benefits, each of the candidate technologies is compared with the "base case." The economic benefits and other impacts for each TTC option are calculated by comparing each TTC "improved case" transportation situation with the "base case" transportation situation. In this manner each TTC option's "feasibility" is determined and, implicitly, the TTC options can be compared one with the other.

Treatment of "Transfer" Impacts

Only "net" changes and impacts are recognized. Transfers of economic value from one part of the corridor to another part of the corridor (from one group of people or firms to another), or from one part of the U.S. to another part of the U.S., are excluded from the national efficiency calculations.

Underinvestment vs. Overinvestment

One objective of this study is to determine if a huge transcontinental capital investment in the corridor is warranted from an economic perspective. There are economic consequences of either underinvesting or overinvesting in U.S. transportation infrastructure and in the corridor. If the U.S. underinvests in transportation, economic development will be inhibited because real and perceived travel costs will be greater, competitive position will be retarded, etc. There is therefore an economic cost associated with underinvestment in transportation. However, if the Nation overinvests in transportation, overall efficiency will suffer because those funds could have been put to better use elsewhere (put to more efficient use) in the U.S. There is, therefore, an economic cost associated with overinvestment in transportation in the corridor.

Recognizing these facts, this study seeks to determine whether or not any of the investments make economic sense, and whether any of those levels of investment are efficient (neither underinvested nor overinvested). This implies efficient and feasible use of tax dollars. The proper level of investment is calculated in terms of national travel efficiency feasibility and corridor economic development impact.

Indicators of "Economic Feasibility"

To determine whether any of the envisaged investments are economically feasible, the costs of building and operating the TTC options are compared with the economic benefits estimated to be attributable to the candidate technologies. This cost and benefit comparison yields three indicators of "economic feasibility" for each TTC option.

- <u>Net Present Value</u> - All costs and benefits in future years are discounted back to the base year using a seven percent real (constant dollar) discount rate. The future stream of discounted costs is subtracted from the future stream of discounted benefits. When the sum of the discounted benefits is greater than the sum of the discounted costs, the "net present value" is positive and the TTC option is deemed to be "economically feasible." The net present value is the best indicator of whether or not the TTC is economically feasible.

- <u>Discounted Benefit/Cost Ratio</u> - After the future streams of costs and benefits are discounted, the sum of the discounted benefits are divided by the sum of the discounted costs. When the result is 1.0 or greater, the TTC is considered to be "economically feasible."

- <u>Internal Rate of Return</u> - This calculation determines that discount rate at which the net present value difference between costs and benefits is zero. If the rate of return, expressed as a percentage, is equal to or greater than seven percent, then the investment option is deemed to be "economically feasible."

Included in the above economic feasibility calculations are all quantifiable direct economic costs attributable to the transportation investment project (cost of planning, designing, building, maintaining and operating each TTC option) and all national quantifiable user benefits (operating cost savings, value of time savings, accident cost savings). Excluded from the economic cost-benefit calculations are the corridor economic development effects and those implications that cannot reasonably be tabulated in monetary terms (environmental or social implications, impacts on other modes of transportation, etc.). As a result, the economic feasibility calculation should be important to the TTC investment decision, but should not be viewed as the only criterion.

Discount Rate

Benefits and costs (present and future) are tabulated in constant dollars (inflation is not factored in). At the same time, it is important to recognize that future benefits and costs do not have the same value in the future as they do today. Therefore, all future costs and benefits are "discounted back" to a base year (1993). Because future inflation is not included, the selected discount rate should also exclude future price level changes (inflation). A constant dollar discount rate of seven percent is used in this study, as recommended by the U.S. Office of Management and Budget (OMB).

Residual Value

A 47-year study analysis period is used (1994-2040). However, some components of the candidate technologies can be expected to last longer than 47 years. To recognize this, the cost portions of each TTC option that will last beyond the year 2040 are added as economic benefits in the year 2040. For example, a bridge might be expected to have a life of 75 years, and therefore a residual value equal to 28/75ths of its original price in the year 2040. Similarly, earthworks and other cost components have considerable remaining life for residual purposes, while pavement has little or no residual value after 47 years.

ECONOMIC EFFICIENCY EVALUATION

Economic efficiency is a legitimate local corridor, regional, state and even national goal. If a TTC improvement creates transportation cost savings that, over time, exceed the cost of the investment needed to generate the efficiencies, then that transportation investment is warranted. Therefore, economic efficiency is relevant to the funding decisions by the federal government, the state departments of transportation, and local agencies.

Transportation Investment Costs

The cost side of the cost-benefit calculation includes two costs: 1) the net "capital costs" of constructing the TTC, and 2) the annual net change in administration, operation, and maintenance costs. Only the net costs attributable to the new TTC are included, e.g., there are no costs associated with the Base Case.

- <u>Capital Costs</u> - Capital costs comprise the cost of implementing the TTC options, including right-of-way acquisition, planning, design, and construction.

- <u>Annual Maintenance and Operations Cost</u> - Once the TTC is in place, it must be operated and maintained. The resulting net change in maintenance and operations cost is estimated.

Economic Efficiency Benefits Attributable to the TTC

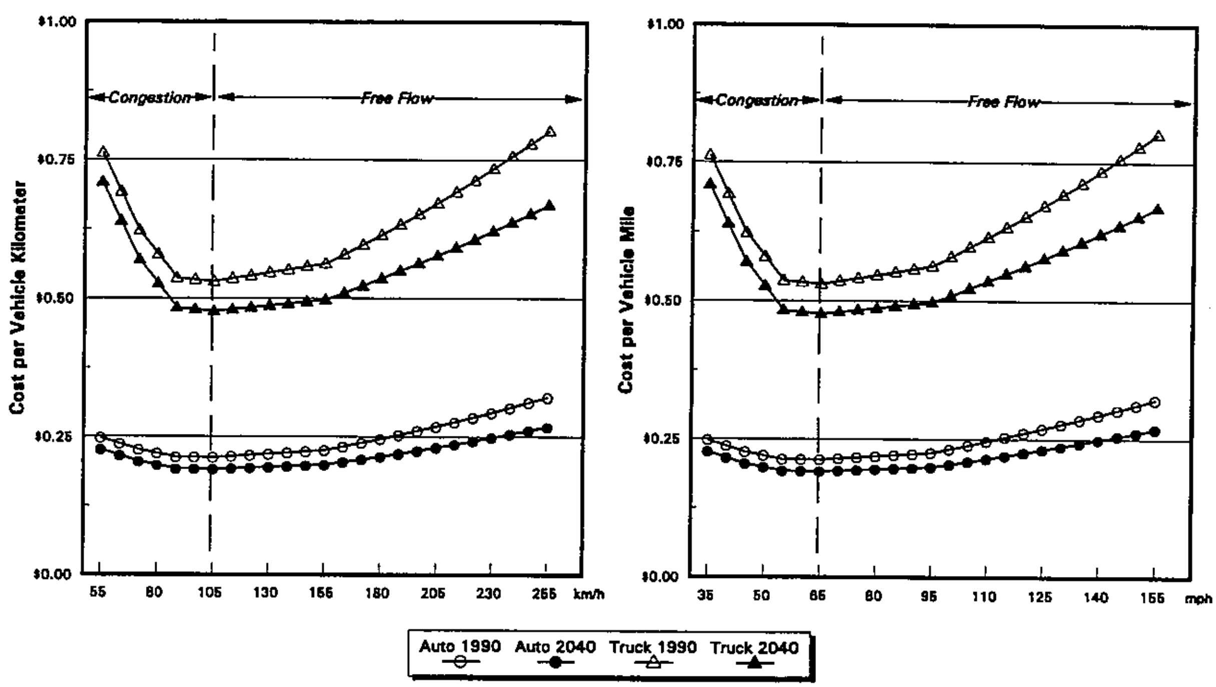
The travel efficiency benefits of the highway and railroad improvement options are of six types: user out-of pocket cost savings, accident cost savings, value of travel time savings, cost of transportation services provision savings, the value of induced trip making, and the economic value attributable to the new attributes offered by the TTC technologies. Such benefits are calculated for two highway vehicle types (cars and trucks), for the air mode, and for the railroad mode. All benefits are expressed by forecast year of occurrence. Benefits are estimated for two analysis years (1990 and 2040); intermediate year benefits are interpolated between the two analysis years in straight line fashion.

- <u>Automobile Cost Savings</u> - The TTC will divert some people from other highways to the TTC. This will reduce vehicle-km of travel on these highways, and should reduce some congestion. Resultant operating cost savings estimates are made using standard procedures recommended by the American Association of State Highway and Transportation Officials (AASHTO) and the Federal Highway Administration (FHWA). The vehicle operating cost changes reflect differences in vehicle-km of travel, travel speed changes, and other changes that affect vehicle operations.

  Autos travelling at less than 100 km/h (60 mph) on an Interstate highway are assumed to be travelling in increasingly expensive congested conditions; vehicles travelling at over 100 km/h (60 mph) are travelling at free flow conditions, but at an increasing per km cost due to fuel inefficiencies. In the future, it is assumed that vehicle efficiencies will occur. The vehicle operating cost curves are shown in Exhibit 8-3.

Exhibit 8-3

VEHICLE OPERATING COST 1990 and 2040



- **Other Mode Cost Savings** - Similarly the TTC will attract travellers from other modes, e.g., from aviation and Amtrak. Analyses were conducted to determine the extent of such diversion. Costs of using air service and Amtrak service were reduced by $0.087 per passenger-km diverted.

- **Auto Travel Time Savings** - Any of the TTC options will save auto hours travelled, by diverting their passengers to the TTC, by reducing congestion on the existing Interstate highway system, and, in the case of the two rail options, by reducing auto VMT. Such time savings were calculated using the nationwide traffic model. Monetary costs of $5.92 per passenger hour were utilized in 1993. This was increased by one percent per year in the future to reflect real increases in per capita income. This value is based on FHWA values per auto hour, updated to 1993 and adjusted to reflect 2.238 persons per auto.

- <u>Other Passenger Mode Time Savings</u> - By diverting passengers from other modes (principally air), their travel time is affected. According to the study's calculations, net travel time is greater on the TTC, even for the Super Highway 160-210 km/h (100-130 mph), indicating an economic disbenefit.

- <u>Treatment of Travel Benefits</u> - Everyone that uses the TTC will gain benefit from it; otherwise, they would not use it. Those that divert to it benefit by its cost savings compared with the cost of using its next best alternative. The highest speed TTC options, involving the new technologies, will also induce some trips to be made that would not be made without the TTC (see Chapter 7). Such diverted and induced trips have value and cost savings, otherwise they would not be made. Their economic value is estimated by means of the "Consumers Surplus" formula:

  Benefits = $\frac{1}{2}(p_1 - p_2)(v_1 + v_2)$

  Where: p_1 = trip cost (cost plus time) without the TTC

  p_2 = trip cost (cost plus time) with the TTC

  v_1 = trip volume (zero, with no induced trips)

v_2 = trip volume with the TTC (the induced portion)

- <u>Additional Consumers Surplus Benefits</u> - The two highest speed TTC options have attributes not available with conventional surface transportation systems. These include a nearly accident free operating environment, the ability to sleep or work while travelling, on-time arrival reliability, improved ability to make single day trips, etc. These types of benefits are included in the evaluation, as described starting on page 17.

- <u>Truck Cost Savings</u> - Truck cost savings are calculated just like car cost savings, and for the same reasons (reduced trip distance, reduced congestion, changed travel speeds, etc.). The average truck operating cost is $0.53 per km at 105 km/h (65 mph) in 1990, as shown in Exhibit 8-3.

- <u>Rail Cost Savings</u> - Those TTC options that will divert freight from other conventional railroads to the TTC will cause cost reductions (and revenue reductions) for the railroads. The cost reductions are taken as a benefit. This is countered by the higher TTC rail operating cost, which is taken as a cost increase on the cost side of the benefit/cost calculation.

- <u>Truck Time Savings</u> - The TTC could reduce truck travel hours, due to shorter distances, increased speeds, reduced congestion, and diversion of freight to the rail options. Such time savings are estimated, and valued at $18.53 per truck hour. This value is predominantly the driver's total cost to the driver's firm, and is based on FHWA statistics.

- <u>Freight Time Savings</u> - The higher speed TTC options will enable the faster movement of freight. While for most freight, vehicle speed is somewhat unimportant, for some freight significant time savings do have economic value. To gauge this, commodities were valued at $1,729 per ton, a 7 percent interest rate was used, and inventory cost savings were estimated based on the estimated freight time saved.

- <u>Accident Cost Savings</u> - Accident costs are based on accident rates per hundred million passenger km by mode. The Super Highway is assumed to be nearly accident free, and the Very High Speed Guideway to be fatality free (per Japanese and French experience with HSR). The accident rates, per hundred million passenger-km travelled, are:

Intercity Highway	0.347
Air	0.208
Rail	0.185
Super Highway	0.047
Guideway	0.0

  Monetary values per accident and per fatality, per recent FHWA statistics, are as follows in 1993 dollars:

Per Fatality	$2,904,000
Per Injury Accident	$58,000
Per Property Damage Accident	$5,000

- <u>Residual Value</u> - The portion of the TTC facilities that will still have useful remaining life after the year 2040 is taken as a benefit in the year 2040.

Value of Travel Time

Perhaps the most significant direct user benefit of the TTC, especially the highest speed TTC options, is the ability to save travel time for travellers. The national transportation model was used to estimate such travel time savings. These passenger hours saved annually are net hours saved, and reflect:

- Savings per trip when the passenger diverts from cars or rail to the TTC.
- Losses per trip (sometimes) when the passenger diverts from air to the TTC.
- Total trip time, including access and egress to/from the TTC or the other modes.

- Reduced congestion on the Interstate highways.

In order to include these time savings in the economic evaluations, it is necessary that a time value be assigned.

When a person makes a trip, he or she is consuming time, and time is valuable. However, time, unlike other marketplace products, has no standard price. In addition, time cannot be transferred, recalled, saved or stored up. Every person is allotted 24 hours in a day. With that, each person gets to decide how to allocate that time. Time has value only based on what can be accomplished with the time. When a trip is made over the TTC, time is not "saved," rather, only the ability to use time differently is changed, e.g., less time spent travelling can be used for some other purpose. Sometimes time is extremely important, e.g., if one is late for work. At other times, travel time may have little value, e.g., a leisure drive with the family. The value of time actually varies from person to person, and situation to situation. What is certain is that everyone, at one time or another, is willing to pay something to reduce the amount of time spent on travel.

The per hour values of time utilized herein are based on AASHTO statistics, as supported by FHWA which, in 1989, were $8.00 per car hour and $15.00 per truck hour. These car values are based on 1.56 persons per car. In 1993, the TTC is estimated to have 2.238 persons per vehicle based on statistics from the National Personal Transportation Survey; in addition, the TTC values are at 1993 price levels. In addition, average wage rates in the U.S. have, over time, increased in real terms (exclusive of inflation). This means that, over time, people are willing to pay more to save time. To account for this, the per hour time values are increased by one percent per year, in real terms. The per passenger hour time values used in this study are listed in Exhibit 8-4.

ADDITIONAL CONSUMERS SURPLUS BENEFITS

The above described benefit types are based on traditional methods used to evaluate traditional highway systems. But a new TTC using new fast technologies (Alternative C: Super Highway and Alternative D: Very High Speed Guideway) offer much more than merely speed. In essence, these two technologies offer:

Exhibit 8-4
PER HOUR TIME VALUES
1993 Price Levels

	1993	2040
Per Car Hour	$13.25	$21.15
Per Passenger Hour[a]	5.92	9.45

(a) At 2.238 persons per auto.

- A much safer trip than is the case with the conventional Interstate highway;
- The ability to read, sleep, work or relax while travelling, rather than driving one's automobile;
- Uncongested travel reliability, thereby reducing stress and improving arrival time reliability; and
- The ability to make day-return trips that, without the high TTC speeds, might require an overnight stay.

Travellers, especially business travellers, will be "willing to pay" for many of these new TTC features. If people are willing to pay more, that indicates that they are deriving benefits which exceed what they are willing to pay (otherwise they would not have made the trip). The issue is, what would they be willing to pay to use these new systems?

There is no empirical evidence concerning what people are willing to pay to utilize either the Super Highway or the Very High Speed Guideway. Several recent studies have attempted to derive such willingness to pay statistics. These studies used "stated preference surveys" of several thousand trip makers.

In 1992, the Transport Directorate of the European Commission conducted an *"Economic Evaluation of the European High Speed Rail Network."* That study examined the feasibility of developing a high speed network, from Spain to Italy to Germany to Denmark to the United Kingdom. That study surveyed several thousand Europeans, and found that business travel time, for evaluation purposes, should be valued at U.S. $39.70 per hour and non-business travel at U.S. $9.90 per hour (these values compare to the TTC study value of only $5.92 in the base year of 1993). Further study by Halcow Fox and Associates in 1993 suggested that the European time values should actually be 30.4 percent higher, due to willingness to pay for other amenities associated with high speed rail.

A second series of high speed rail studies in the U.S. has been conducted by various consultants. These studies used stated preference surveys to define a value of time that reflected people's perceptions of high speed rail speeds, amenities, and other perceived attributes. These studies depict high time value results similar to the European studies, as shown in Exhibit 8-5.

Exhibit 8-5
HSR STUDY VALUES OF TIME

HIGH SPEED RAIL STUDY	VALUE OF TRAVEL TIME PER PERSON		PRICE LEVEL
	Business	Non-Business	
Chicago-Milwaukee -St. Louis	$49	$16	1992 dollars
Windsor-Quebec	$58	$4.80	1991 dollars
Chicago-Detroit	$30	$10	1988 dollars
Cleveland-Cincinnati	$50	$30	1988 dollars
Tri-State	$43	$26	1990 dollars
New York	$26	$26	1990 dollars

SOURCE: Various high speed rail studies, various consultants.

Both the U.S. HSR and European surveys suggest that travellers derive additional benefit (consumers surplus) and are, therefore, willing to pay much more per hour to utilize advanced systems than the $5.92 used in this study. How much they are willing to pay is open to debate. For TTC benefit/cost purposes, the following comparatively conservative values were adopted, which are additive to the $5.92 utilized earlier:

- Business Travel: $15 per hour saved
- Non-Business Travel: $5 per hour saved

For analysis purposes, it is assumed that 30 percent of the TTC users will be on some type of business travel. This means that a weighted average additional savings of $8.00 per hour saved is included as a proxy for the willingness of people to pay for the amenities offered by the two advanced TTC technologies.

Another way of explaining this "additional consumers surplus" benefit is to assign monetary values to the attributes offered by the TTC options. This is done in Exhibit 8-6.

Exhibit 8-6
ADDITIONAL CONSUMERS SURPLUS
TTC ATTRIBUTES

TTC ATTRIBUTE	RELATED TO:	VALUE
Comfort	Person-Hours of Travel	$1.00
Reliability	Person Trips	$2.00
Safety Perception	Person Trips	$2.00
Sleep/Read/Work	Driver-Hours of Travel	$5.00
One-day Turnaround	Person Trips 320-563 km (200-350 miles)	$20.00
1-Way in Single Day	Person Trips 324-1,529 km (450-950 miles)	$20.00
Use Car at Trip End	Vehicle Trips	($5.00)

This Exhibit indicates that, if the TTC technology is perceived to be considerably more comfortable than the existing technology, trip makers might derive a consumers surplus benefit of $1.00 per person hour spent travelling on the TTC. If the TTC is perceived to be more reliable in terms of arrival time, the trip makers would benefit by $2.00 per person trip. Similarly, TTC users could perceive the accident free nature of the TTC, and could be willing to pay an amount even greater than the calculated accident savings. The ability to not have to drive one's car also has value, since the driver would be able to sleep, read, work or have other activities. Also, the faster TTC options will also enable travellers to reduce the need to stay overnight away from home. In the case of the rail modes, the traveller will not have his or her auto available at the trip end; this is taken as an economic disbenefit.

The per unit dollar value of the various TTC options shown in Exhibit 8-6 are likely to be conservative. They result in the same $8.00 per hour willingness to pay estimated in the previous page.

CORRIDOR IMPACT EVALUATION

A major transportation investment of the type envisaged for the TTC will make travel faster, easier and more efficient. In the process it will divert people and freight from other highways and modes to the TTC, and it could also generate traffic. All of these events would be most welcome to the corridor, not only because of the travel efficiencies and the improved perception of the corridor area, but also because of what these travel efficiencies and perceptions could mean to the economies along the highway or rail corridor.

It is believed by some corridor residents and by portions of the business community that the corridor area, and the states through which the corridor passes, will be better off economically with the TTC than without it. Most certainly this is true; the issues are: 1) what magnitude of economic impact can be expected? 2) what is the nature of that economic impact? and 3) which of the economic impacts are true economic benefits to be used in the analysis, and which are merely transfer payments?

REMI Econometric Model

The economic impact portion of the economic feasibility study relies on an interregional model of the U.S. and of the counties located within the defined primary economic impact area. The "REMI" set of models are private sector models owned by Regional Economic Models, Inc. of Amherst, Massachusetts. This model package has previously been applied to a number of corridor evaluations, and this model package has the advantage that it is dynamic in nature.

The REMI model is a comprehensive forecasting and simulation system useful for policy and investment analysis in a wide array of issues. The REMI model does have some similarities to Input-Output models. The model is structured to incorporate inter-industry transactions along with feedback from final demand activities. The proportion of intermediate and final demand that is fulfilled by producers in the corridor primary impact area is determined by the model. Demand not fulfilled by local production leads to imports. The REMI model differs from regular Input-Output models in its ability to allow substitution among factors of production in response to changes in relative factor costs over time; that is, it is dynamic. Within the model, wages are responsive to changes in labor market conditions, migration is responsive to changes in expected income, and the share of local and export markets responds to changes in regional profitability and export costs.

Simulations with the model can be used to estimate the economic and demographic effects of policy and investment interventions in the TTC such as economic development programs, infrastructure investments such as new highway or rail system construction, energy and natural resource conservation programs, state and local tax changes, and other policies. The policy simulation compares the performance of the corridor region after a policy intervention with the projected performance of the region based on national forecasts of industry growth, changing technology and estimates of the shifting competitive position of each industry in the corridor region compared to that industry elsewhere in the country and elsewhere in the primary impact area.

Corridor Impact Terms and Definitions

Any of the candidate transportation systems will yield many different forms of impact on local economies within the corridor region. In order to recognize these diverse impacts in a consistent fashion, a single set of "indicators of impact" is used throughout the economic impact calculations. The economic impacts are expressed in terms of three "indicators of economic impact:"

- <u>Value Added</u> - The value of each firms' output minus the value of the inputs they purchase from other firms.
- <u>Wages</u> - Total increases in payroll costs (wages and salaries and benefits) paid by local industries due to the new TTC highway or rail line.
- <u>Jobs</u> - Job impacts are expressed as "full-time equivalents" (FTE's) and include the number of person job years due to TTC construction and use, plus the share of those that are employed in sectors that directly or indirectly support the construction process, the highway or rail line users, and the firms that might expand in or locate to the

corridor region due to the productivity improvements attributable to the TTC.

Corridor Impact Types

The TTC investment and associated travel efficiencies could cause a number of events to occur, all of which will be beneficial to local economies along the corridor. These events are categorized into four types.

- Act of TTC Construction
- Corridor Competitive Position
- Other Efficiencies and Expenditures
- Additional Consumers Surplus

Economic Impacts of TTC Construction

Any of the investment options would cost billions of dollars to build. The very act of spending large sums of externally generated construction money in an area is of economic value to that area, since contractors and construction workers are hired, construction materials are purchased, etc. Economic value that is created in the corridor due to the act of spending such construction funds in the primary impact area is estimated.

The TTC capital costs are estimated and the construction costs are treated as increases in final demand and input into the REMI model. The construction costs are assumed to be spent, initially, within the corridor's defined primary impact area. The economic impacts due to the act of construction comprise the monies spent in the corridor and the flow of those monies in terms of respending. The impacts include the labor and expenses associated with planning, design and construction, plus the respending of those funds to the extent that such respending occurs within the corridor.

Impact on the Corridor Region's Competitive Position

There is a desire for the corridor's communities to expand existing businesses, to attract new businesses, and to diversify the area's economic base. To attract business, the corridor must be competitive with other areas in the U.S.

The question arises as to whether and to what extent a highway or rail investment in the corridor would benefit the businesses already in the corridor. A related question is what the TTC could do to help foster growth of other, emerging industries. It is clear that competition will be great among regions to maintain as high a level of economic activity as possible and to attract activities demonstrating growth potential nationally and internationally. Keeping transportation costs as low as possible is one action government can take to make any corridor region more competitive.

Stated differently, the major economic transition that is taking place internationally creates unique opportunities because previous centers of economic activity will not necessarily continue to dominate. By reducing the cost of doing business, a nation or state or region strengthens its business climate. Facilitating faster, safer travel along the corridor represents a logical means for increasing the competitive advantage of communities along it.

The ability to attain such economic growth is a function of many things, one of which is the ability of the corridor region to compete for such diversification and growth. The ability to compete is also a function of many things, one of which is the cost of doing business in the corridor, and the cost of doing business is a function of many things, one of which is the cost of transportation. By tracing this relationship, it is apparent that transportation does have a role in achieving the corridor region's economic development goals.

Exhibit 8-7 presents a sequential flow of activities involved in moving from the TTC highway or rail improvement itself to the economic impact of that improvement in terms of what it does for competitive position. The activities themselves are described as follows:

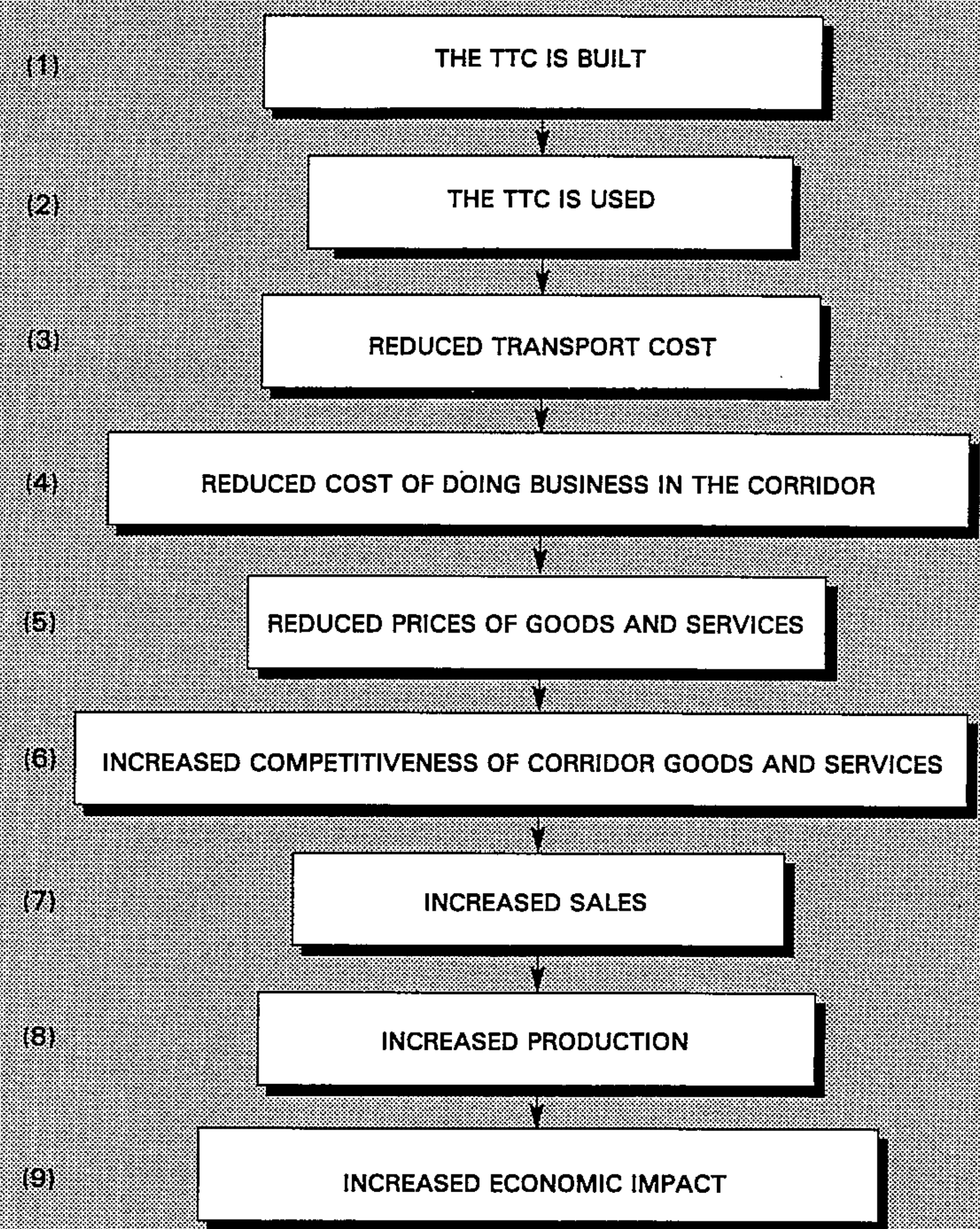
1. <u>The TTC is Built</u> - The act of building the highway or rail facility has a short-term economic impact; that impact is assessed.

2. <u>The TTC is Used</u> - The new transportation facility will be used by existing and diverted and possibly induced users. Passenger and freight transport estimates with and without the TTC are developed.

3. <u>Reduced Transportation Cost</u> - The TTC leads to increased travel efficiency in the form of reduced travel time, increased travel reliability, reduced accidents and revised vehicle operating costs. The efficiencies themselves are quanti-

Exhibit 8-7

COMPETITIVE POSITION PRINCIPLES



fied in the "user analyses" for cars, trucks, trains and aircraft.

4. <u>Reduced Costs of Doing Business in the Corridor</u> - Transportation cost is one factor in the cost of doing business in the corridor. If transportation costs decline in the corridor, this means that the total costs of doing business in the corridor will also decline.

5. <u>Reduced Prices of Goods and Services</u> - If costs of production decline due to transportation cost reductions, the result will be reduced prices of goods and services, or increased profits, or both. Such reductions apply to goods produced in the corridor as well as goods shipped into the area.

6. <u>Increased Competitiveness of the Corridor's Goods and Services</u> - With slightly reduced costs and therefore prices, the goods and services produced in the corridor should be slightly more competitive with the TTC in place than without it.

7. <u>Increased Sales</u> - If the region's goods and services become more competitive due to price decreases, the region's businesses should be able to make additional sales of those goods and services.

8. <u>Increased Production</u> - If sales increase, production of goods and services will increase by a like amount (by either expanding existing firms or by attracting new firms to the corridor region).

9. <u>Increased Economic Impact</u> - Increased production generally implies increased payroll, additional jobs, increased tax revenue and increased final demand, value added and output.

Other Efficiencies and Expenditures

In addition to development caused by improved competitive position, the TTC will require goods and services that cater to the users of the new transportation system.

This is especially true for either of the highway options, in that the new highway would increase sales for businesses along the highways that cater to traffic. For highway economic evaluation purposes, "roadside services" are defined as businesses that serve the cars and trucks and their drivers/passengers such as gasoline stations, hotels/motels, restaurants, tourist visitation places, gift shops, etc. There is a general relationship between traffic density (volume), trip characteristics, and the number of roadside service establishments that exist, e.g., the higher the traffic volume, the greater the number of motels, etc. Construction of either of the highway improvements will cause greater traffic density and consequently the attraction of additional roadside services to serve those increased traffic volumes.

The issue to consider is, what increase might be expected due to new/diverted traffic associated with the new TTC, and whether that development represents a net increase suitable for use in the economic impact calculations.

Transportation service increases will be due to traffic increases. Over the next 50 years there will be normal traffic change, even if the TTC is not built. In addition, there will be increased traffic due to the TTC, which will principally be diverted from other highways, rail lines, and airports. The change in corridor use is calculated. These changes will bring with them comparable percent increases in roadside business in the form of increased roadside gas station, motel and restaurant activities. This increase could involve the attraction of new businesses, or could accrue in the form of increased sales by existing businesses, or both. In either event, however, the business increases are drawn from other U.S. highways and other modes and therefore from other U.S. businesses.

The direct impacts caused by increased traveler expenditures are run through the REMI model, to gauge the value of those expenditures to the corridor (primary impact area) economy. Such impacts at the corridor area level, however, do not represent net gains to the U.S. economy because they are transfer effects (gains in the corridor are offset by losses elsewhere in the U.S).

In addition to the above effects on the corridor region, the TTC will also offer travel cost savings, personal travel time savings and reduced numbers of accidents. These also have economic value to the corridor region and are, therefore, added to the impact total. These savings were not included in the other impact types and can, therefore, be added as corridor regional impacts, without double counting the impacts.

Additional Consumers Surplus

Similarly, the corridor region travellers also benefit by the "additional consumers surplus" amounts, as described in the Chapter 9: National Travel Efficiency analysis.

Impact on Employment

The retention of existing jobs and the attraction of new job opportunities is an important goal of all jurisdictions in the corridor. A TTC will aid in the achievement of this jobs goal. Jobs will be created in the corridor impact area in four ways.

- Construction Jobs - The firms engaged to construct the TTC will spend large sums of money in the area. These expenditures will be used to pay contractors and suppliers of goods and services. These construction caused jobs will exist only during the construction process itself.

- Competitive Position Jobs - By making the corridor area more competitive, output will increase and with it existing firms might be expanded and new firms attracted. Both forms of business activity expansion will employ additional people.

- Traveler Expenditure Jobs - Increased travel in the corridor will lead to increased business along the route for businesses that cater to those using the new facility. These businesses will therefore employ increasing numbers of people.

- Consumer Respending Jobs - In each of the above cases, the people in the new jobs will spend much of their income within the corridor region. This respending will in turn create additional jobs.

TWO ECONOMIC CHAPTERS

In order to distinguish between the travel efficiency benefits evaluation and the corridor region impact assessment, each is presented in a separate report chapter.

Chapter 9 deals with the travel efficiency benefit/cost evaluation from the national perspective.

Chapter 10 deals with economic development from the TTC corridor's perspective.

Chapter 9
ECONOMIC FEASIBILITY: NATIONAL PERSPECTIVE

Economic efficiency is a legitimate local, state and national goal. If a new Transamerica Transcontinental Corridor (TTC) creates passenger and/or freight user cost savings and operations cost savings that, over time, exceed the cost of the transportation facility, then implementation of the TTC may be warranted. Therefore, transportation efficiency is relevant to the funding decision for the federal government, each state, and all local jurisdictions. However, efficiency is only one of a number of factors to consider when making the investment decision. Other factors include system continuity, equity, energy and the environment, and corridor - specific economic impacts.

In this report chapter, each of the TTC technology/route options is subjected to the travel efficiency economic feasibility tests. Conventional benefit/cost indicators (Benefit/Cost Ratio, Net Present Value and Internal Rate of Return) are used to gauge economic feasibility from the National perspective.

In this assessment of travel efficiency feasibility, a life cycle cost approach is used. The costs of planning, building, and maintaining the TTC over a 48 year period (1993-2040) are estimated. Then, the travel efficiency gains over that period are estimated, and the efficiency gains are compared with the costs to determine whether or not the TTC is economically "feasible," from the travel efficiency perspective. This chapter presents the results of the travel efficiency economic evaluation, from the National perspective. It does not include the potential economic development impacts on the corridor area created by the TTC. (See Chapter 10 for the development evaluation from the Corridor's perspective).

FIVE OPTIONS STUDIED

The economic evaluation examines the feasibility of each of the four principal TTC options:

- A: Upgraded Highway
- B: Upgraded Railway
- C: Super Highway
- D: Very High Speed Guideway

In analyzing the Super Highway option, the feeder route assumptions approved by the Committee implied that not only would there be north-south feeders; there also would be two other transcontinental super highways, one to the north of the TTC and one to the south. This, because of the way the analysis was conducted, indicated that the study was evaluating the feasibility of constructing a third super highway across the country. This analysis is contained herein. An additional analysis has been performed which assumes that the other two transcontinental highways are eliminated, to determine whether or not a single super speed highway, in the TTC, is feasible. Therefore, the economic analysis included a second super highway option:

- C-1: A single transcontinental Super Highway - This option has the same costs, but different use and therefore benefits, as the other Super Highway option (C-3, with three transcontinental super highways).

ECONOMIC COSTS

The cost side of the benefit/cost calculation comprises the costs of constructing, operating and maintaining the TTC. The costs include the life cycle construction, operations and maintenance costs, regardless of funding source.

Construction Costs

The total construction cost for the different TTC options include right-of-way acquisition, planning, design, and construction, as described in Chapter 6. Exhibit 9-1 summarizes the total construction costs for the four options, as presented initially in Chapter 6. For those options which have more than one alignment suboption, the costs for the various suboptions are averaged. For the Very High Speed Guideway option, the high speed rail costs are used rather than the maglev costs.

For benefit/cost purposes only, the capital costs are assumed to be spent in the study's initial analysis year (1993). This allows for an equitable treatment of the different route options and technology options.

Residual Value

The period of time following TTC construction, as used in this study, is 47 years (1994 to 2040). By 2040 some of the TTC improvements will be depreciated (used some or all of their useful life) while other elements have longer lifespans. To account for these differences, a residual

Exhibit 9-1
CAPITAL COST SUMMARY
($ Million)

TTC OPTION	COST[a]
Upgraded Highway	$17,855.8
Upgraded Railway	33,105.0
Super Highway	53,365.2
High Speed Rail	51,385.6

(a) Alignment options averaged
SOURCE: HNTB

value is assigned in the year 2040 as a benefit. The residual value is the value of the useful life of each cost item following the year 2040.

To estimate the residual values, composite residual factors were developed based on the useful lives of the various construction cost items for each corridor option. The 1994-2040 time period was used, and the resultant residual values for each TTC option are listed in Exhibit 9-2. These are based on the capital costs, exclusive of engineering, administration, and contingencies costs.

Exhibit 9-2
TTC RESIDUAL VALUE

	USEFUL LIFE (years)	RESIDUAL VALUE ($ Million)			
		A	B	C	D
Construction:					
Earthworks	100	$2,212.8	$2,243.3	$6,894.5	$4,932.4
Structures	75	674.3	2,396.5	2,055.1	3,311.6
Pavement	47	0	0	0	0
Trackwork	47	0	0	0	0
Signals & Comm.	47	0	0	0	0
Right-of-Way	Infinite	203.9	294.2	844.4	301.9
Engineering & Admin.	---	0	0	0	0
Vehicles	47	0	0	0	0
Contingencies	---	0	0	0	0
		$3,091.0	$4,934.0	$9,794.0	$8,545.9

Annual Operating and Maintenance Costs

The annual costs of operating and maintaining each TTC option were estimated in Chapter 6. These annual costs are summarized in Exhibit 9-3.

Exhibit 9-3
ANNUAL OPERATING AND MAINTENANCE COSTS SUMMARY
($ Million)

TTC OPTION	ANNUAL COST
A: Upgraded Highway	$ 66.89
B: Upgraded Railway	2,838.47
C: Super Highway	91.94
D: Very High Speed Guideway	654.17

The Upgraded Railway annual costs are much higher than the highway options because they include not only the costs of maintaining the railway but also include the costs of operating the trains. The highway costs include highway maintenance costs but do not include the cost of operating the autos and trucks. This seemingly unequal treatment is corrected by including total reductions in truck and train costs in the benefit totals (in Exhibit 9-4), while on the highway side only net changes in car and truck costs are included. Therefore, the Alternative B Upgraded Railway costs of Exhibit 9-3 are high, but so are the benefits in Exhibit 9-4.

TOTAL ECONOMIC EFFICIENCY BENEFITS

This study's estimated National perspective travel efficiency benefits in the years 1990 and 2040 are listed in Exhibit 9-4. The year 2040 benefits are greater than the 1990 benefits, not because of any future price level changes but rather because of travel volume increases. This summary Exhibit depicts a number of things:

- All five TTC options create very large travel efficiencies per year, due to the magnitude of the envisaged TTC project.

Exhibit 9-4
NATIONAL PERSPECTIVE ANNUAL TRAVEL EFFICIENCY BENEFITS
($ Million)

	A: UPGRADED HIGHWAY	B: UPGRADED RAIL	SUPER HIGHWAY C-3	SUPER HIGHWAY C-1	D: HIGH SPEED RAIL
YEAR 1990					
PASSENGER BENEFITS					
Auto Cost Savings	$175.662	$51.173	($402.567)	($676.313)	$173.468
Other Mode Cost Savings	—	62.531	11.258	18.913	119.888
Auto Time Savings	195.010	41.769	720.000	1,209.600	116.111
Other Mode Time Savings	—	(0.188)	(9.540)	(16.027)	(0.139)
Induced Travel Benefits	—	—	34.499	57.958	19.304
Additional Consumers Surplus	6.000	43.000	999.000	1,679.000	140.000
TOTAL PASSENGER BENEFITS	376.672	198.285	1,352.650	2,273.132	568.632
FREIGHT BENEFITS					
Truck Cost Savings	89.193	553.270	(200.065)	(336.109)	69.952
Rail Cost Savings	—	1,620.480	—	—	—
Truck Time Savings	54.543	178.750	201.378	338.315	38.893
Freight Time Savings	10.045	9.808	37.089	62.310	7.163
TOTAL FREIGHT BENEFITS	153.781	2,362.308	38.402	64.516	116.008
ACCIDENT SAVINGS	48.289	15.526	423.594	711.638	53.813
RESIDUAL VALUE	0	0	0	0	0
TOTAL 1990 BENEFITS	578.742	2,576.119	1,814.646	3,049.286	738.453
YEAR 2040					
PASSENGER BENEFITS					
Auto Cost Savings	$348.659	$88.184	($489.852)	($822.951)	$288.162
Other Mode Cost Savings	–	208.689	51.371	86.303	389.657
Auto Time Savings	953.701	153.823	2,381.201	4,000.418	379.635
Other Mode Time Savings	–	(1.084)	(47.516)	(79.827)	(0.999)
Induced Travel Benefits	–	–	72.227	121.341	57.726
Additional Consumers Surplus	8.000	106.000	1,776.000	2,985.000	294.000
TOTAL PASSENGER BENEFITS	1,310.360	555.612	3,743.431	6,290.284	1,408.181
FREIGHT BENEFITS					
Truck Cost Savings	194.197	647.453	(223.959)	(393.051)	119.515
Rail Cost Savings	–	1,895.760	–	–	–
Truck Time Savings	167.108	208.967	417.236	700.956	78.528
Freight Time Savings	17.081	11.480	42.649	71.650	8.027
TOTAL FREIGHT BENEFITS	378.387	2,763.660	225.926	379.556	206.070
ACCIDENT SAVINGS	92.722	25.443	747.800	1,256.304	104.911
RESIDUAL VALUE	3,091.000	4,934.000	9,794.000	9,794.000	8,545.900
TOTAL 2040 BENEFITS	4,872.469	8,278.715	14,511.157	17,720.144	10,265.062

- The year 2040 benefits are dramatically greater than in 1990, due in part to the residual value which is taken in 2040 (when discounted this is not significant), and due in part to the TTC travel volume increases.

- The Alternative B: Upgraded Railway benefits appear large. This is due to the way the costs and benefits are handled for this option.

PASSENGER TRAVEL EFFICIENCY BENEFITS

The passenger efficiency benefits comprise the travel cost and travel time savings expected to be attributable to the TTC. They also include the additional consumers surplus benefits attributable to the new technology options' features, plus economic benefits attributable to induced (generated) traffic carried by the new TTC.

Auto Cost Savings

For most TTC options, the TTC will save some auto costs (less fuel consumption, etc.). More specifically:

- Alt A: Upgraded Highway - This option will save auto costs because fewer vehicle-km will be travelled (shorter trip distance) and because some congestion will decline on other existing highways.

- Alt B: Upgraded Railway - This option will reduce auto user costs because of traffic diversion from auto to rail (fewer car-km driven). The savings are small, however, due to the comparatively few numbers of riders expected on the upgraded rail option. The Alt. D: Guideway savings are greater because more people are diverted from auto to guideway than from auto to conventional rail.

- Alt C: Super Highway - With this option, auto costs increase by over $400 million annually because people will drive out of their way to get to the TTC (more auto-km driven) and because it costs more to drive at 120 mph than at 65 mph (see Exhibit 8-3).

Other Mode Cost Savings

The savings from other modes are principally caused by diverting passengers from the air mode to the TTC. No air passengers are diverted to the Alt A: Upgraded Highway, while a great many are diverted to Alt D: Guideway.

Auto Time Savings

Auto time savings represent the net hours saved in moving from the existing Interstate highways to the TTC. The Alt C: Super Highway dominates, because of the large numbers of autos diverted, and the high speed advantages of the TTC. There is also auto time saved by non-TTC users due to reduced congestion on the existing Interstates. Total annual time savings are summarized in Exhibit 9-5.

Exhibit 9-5
ESTIMATED PASSENGER TRAVEL TIME SAVINGS

	Annual Travel Time (Millions of Person Hrs/Yr)	
	1990	2040
Total Annual Travel Hours		
Base Case	5,138.835	9,378.310
A: Upgrade Highway	5,105.839	9,277.424
B: Upgrade Railway	5,131.785	9,362.146
C-3: Super Highway	5,003.790	9,131.313
C-1: Super Highway	4,937.234	8,963.450
D: High Speed Guideway	5,119.221	9,338.065
Annual Hours Saved		
A: Upgraded Highway	32.996	100.886
B: Upgraded Railway	7.050	16.164
C-3: Super Highway	120.065	246.997
C-1: Super Highway	201.601	414.860
D: Highway Speed Guideway	19.614	40.245

SOURCE: Wilbur Smith Associates

Other Mode Time Savings

There is a disbenefit in time savings in this category of benefit because each TTC option will take slightly longer for some trips than by the air mode. The TTC will save some travellers time, while taking others longer. The result is a net increase in travel time compared with the air mode.

Induced Travel Benefits

As explained in Chapter 7, the two high speed technologies (Alt C: Super Highway, and Alt D: Very High Speed Guideway) are expected to induce additional trip making. Such additional trips have value, otherwise the trips would not be made. The economic value is derived based on the cost and time changes by applying consumer surplus principles (see Chapter 8).

Additional Consumers Surplus Benefits

As discussed in Chapter 8, these benefits are awarded to the passenger users of the TTC due to the special attributes of the TTC. They comprise value which is over and above what the users pay to use the TTC.

Exhibit 9-6 lists these TTC attributes, the monetary values assigned to each, and the calculated additional consumers surplus. The Exhibit indicates that Alternative C: Super Highway generates by far the most consumers surplus benefit. This is because the passengers retain the benefit of having their private car, but add to that the attributes usually associated with the air mode (safety, reliability, the ability to sleep/read/work, etc.).

FREIGHT EFFICIENCY BENEFITS

The economic benefits attributable to freight includes benefits accruing to users of the TTC as well as more limited benefits due to less congested parallel highways. No induced freight traffic is included in the calculations, so there are no induced travel benefits. Similarly, there are no consumers surplus benefits associated with freight because the freight efficiencies are cost based rather than willingness to pay based.

Truck Cost Savings

Truck cost savings follow similar trends to auto cost savings for the same reasons, e.g., shorter trip distances, reduced congestion, etc. For Alt B: Upgraded Railway the significant savings are due to the diverted cargo from truck to rail (the rail cost side of the benefit/cost calculation increased dramatically, the benefit side similarly increased dramatically). The Alt C: Super Highway truck cost savings are negative because of the high cost of operating trucks at very high speeds (See Exhibit 8-3).

Rail Cost Savings

The rail cost savings are due to freight diversions from existing railroads to the TTC. Only Alternative B: Upgraded Railway has significant diversions of rail freight. The large rail cost savings ($1.6 billion in 1990) are countered by the large rail freight operations cost of the Alternative B: Upgraded Rail TTC ($2.3 billion in 1990). In other words, it will cost more to carry the freight on the new TTC rail line than it does on the existing U.S. slower speed rail lines.

Exhibit 9-6
ADDITIONAL CONSUMERS SURPLUS BENEFITS

ALTERNATIVE A: UPGRADED HIGHWAY

CHARACTERISTIC	RELATED TO:	RATE	YEAR 1990 Quantity (Millions/Yr)	YEAR 1990 Value ($ Mill/Yr)	YEAR 2040 Quantity (Millions/Yr)	YEAR 2040 Value ($Mill/Yr)
Comfort	Same as Base Case	--	--	$0	--	$0
Reliability	Same as Base Case	--	--	$0	--	$0
Safety Perception	Same as Base Case	--	--	$0	--	$0
Sleep/Read/Work	Same as Base Case	--	--	$0	--	$0
One-day Turnaround	Person Trips (relevant O/D)	$20.00	0.1	$2	0.1	$2
1-Way in Single Day	Person Trips (relevant O/D)	$20.00	0.2	$4	0.3	$6
Use Car at Trip End	Same as Base Case	--	--	$0	--	$0
Total Additional Consumers Surplus				$6		$8

ALTERNATIVE B: UPGRADED RAILWAY

CHARACTERISTIC	RELATED TO:	RATE	YEAR 1990 Quantity (Millions/Yr)	YEAR 1990 Value ($ Mill/Yr)	YEAR 2040 Quantity (Millions/Yr)	YEAR 2040 Value ($Mill/Yr)
Comfort	Person-Hours of Travel	$1.00	6.2	$6	18.6	$19
Reliability	Person Trips	$2.00	3.1	$6	6.6	$13
Safety Perception	Person Trips	$2.00	3.1	$6	6.6	$13
Sleep/Read/Work	Driver-Hours of Travel	$5.00	2.2	$11	6.5	$32
One-day Turnaround	Person Trips - 320-563 km (200-350 miles)	$20.00	0.6	$11	1.2	$24
1-Way in Single Day	Person Trips - 724-1,529 km (450-950 miles)	$20.00	0.5	$9	1.0	$19
Use Car at Trip End	Vehicles Trips	($5.00)	1.4	($7)	2.9	($15)
Total Additional Consumers Surplus				$43		$106

ALTERNATIVE C: SUPER HIGHWAY (3 TTC)

CHARACTERISTIC	RELATED TO:	RATE	YEAR 1990 Quantity (Millions/Yr)	YEAR 1990 Value ($ Mill/Yr)	YEAR 2040 Quantity (Millions/Yr)	YEAR 2040 Value ($Mill/Yr)
Comfort	Same as Base Case	--	--	$0	--	$0
Reliability	Instrumented Person Trips	$2.00	62.2	$124	109.6	$219
Safety Perception	Instrumented Person Trips	$2.00	62.2	$124	109.6	$219
Sleep/Read/Work	Instrumented Driver-Hrs of Travel	$5.00	50.6	$253	92.3	$461
One-day Turnaround	Person Trips - 320-563 km (200-350 miles)	$20.00	14.3	$286	25.2	$504
1-Way in Single Day	Person Trips - 724-1,529 km (450-950 miles)	$20.00	10.6	$211	18.6	$373
Use Car at Trip End	Same as Base Case	--	--	$0	--	$0
Total Additional Consumers Surplus				$999		$1,776

ALTERNATIVE C: SUPER HIGHWAY (1 TTC)

CHARACTERISTIC	RELATED TO:	RATE	YEAR 1990 Quantity (Millions/Yr)	YEAR 1990 Value ($ Mill/Yr)	YEAR 2040 Quantity (Millions/Yr)	YEAR 2040 Value ($Mill/Yr)
Comfort	Same as Base Case	--	--	$0	--	$0
Reliability	Instrumented Person Trips	$2.00	104.4	$209	184.1	$368
Safety Perception	Instrumented Person Trips	$2.00	104.4	$209	184.1	$368
Sleep/Read/Work	Instrumented Driver-Hrs of Travel	$5.00	85.1	$425	155.0	$775
One-day Turnaround	Person Trips - 320-563 km (200-350 miles)	$20.00	24.0	$480	42.4	$847
1-Way in Single Day	Person Trips - 724-1,529 km (450-950 miles)	$20.00	17.8	$355	31.3	$626
Use Car at Trip End	Same as Base Case	--	--	$0	--	$0
Total Additional Consumers Surplus				$1,679		$2,985

ALTERNATIVE D: VERY HIGH SPEED GUIDEWAY

CHARACTERISTIC	RELATED TO:	RATE	YEAR 1990 Quantity (Millions/Yr)	YEAR 1990 Value ($ Mill/Yr)	YEAR 2040 Quantity (Millions/Yr)	YEAR 2040 Value ($Mill/Yr)
Comfort	Person-Hours of Travel	$1.00	12.8	$13	30.2	$30
Reliability	Person Trips	$2.00	8.8	$18	17.7	$35
Safety Perception	Person Trips	$2.00	8.8	$18	17.7	$35
Sleep/Read/Work	Driver-Hours of Travel	$5.00	4.6	$23	10.8	$54
One-day Turnaround	Person Trips - 322-965 km (200-600 miles)	$20.00	3.6	$72	7.2	$144
1-Way in Single Day	Person Trips - 965-2,574 km (600-1,600 miles)	$20.00	0.8	$17	1.7	$34
Use Car at Trip End	Vehicles Trips	($5.00)	3.9	($20)	7.9	($40)
Total Additional Consumers Surplus				$140		$294

Truck Time Savings

The truck time savings are due to reduced truck vehicle-km, reduced congestion on existing highways, and the faster speeds of the various TTC options. Alternative C: Super Highway saves the most truck time because of its very fast truck speeds; Alternative B: Upgraded Railway saves considerable truck time due to the diversion of freight from truck to TTC rail.

Freight Time Savings

In addition to saving truck and rail time and cost, the faster TTC options will also save time in transit for the cargo that is carried. Available evidence, however, suggests that time in transit for cargo has little economic value, at least for most cargo types. Therefore, a nominal value is used, calculated as an inventory cost. Alt C: Super Highway is shown to save the most freight in transit time.

OTHER TRAVEL EFFICIENCY BENEFITS

The remaining benefit types are accident savings and residual value, neither of which can easily be attributable to either passenger or freight transportation.

Accident Savings

The accident savings are assigned monetary values as described in Chapter 8. The Alt A: Upgraded Highway has low savings because traffic is merely shifted between Interstate Highways. The Alt B: Rail and Alt D: Guideway options have low savings due to their comparatively low estimated ridership. The Alt C: Super Highway has high accident savings because of the significant traffic diversion and the low accident rate assumed for an automated highway.

Residual Value

These values are based on the capital costs of each option. Consequently, the highest cost TTC options have the greatest residual value in the year 2040.

TRAVEL EFFICIENCY ECONOMIC FEASIBILITY

To calculate the economic feasibility in travel efficiency terms, all costs and benefits in constant (1993) dollars are determined by year 1993 through 2040, and then discounted back to 1993 using a discount rate of 7%. The benefits are then compared with the costs using the conventional feasibility indicators.

Time Lag Before Benefits Occur

A coast-to-coast TTC would take many years to build, due to funding availability, engineering, and construction realities. While the TTC could be opened in sections, it will still take several years to even open single segments. As a result, funds expended in one year will typically yield benefits several years later. In between the expenditures of funds and the initiation of traffic use (when benefits are produced), zero (or little) benefit is derived. This is referred to as a "time lag," that is, the time period between the years of investment and the generation of economic benefit.

A conventional highway can be opened sooner (less time lag), than can a railway or a super highway. The latter TTC options will likely involve a longer construction period and the opening of longer TTC segments. Therefore, the time lag for conventional highways is less than for the higher technology options.

After considerable debate, the study's Steering Committee opted for the following time lags:

TTC Option	Time Lag (years)
A: Upgraded Highway	2
B: Upgrade Railway	3
C-3: Super Highway	5
C-1: Super Highway	5
D: High Speed Guideway	8

These time lags were used in the study as representative of the average time lag for the average capital investment dollar to generate benefits. This means that no benefits are taken during the time lag period. For example, the Super Highway has a time lag of 5 years, the investment funds are assumed to be spent in year 1, and no benefits are assumed to occur until year 6 (five years later).

Travel Efficiency Results

Exhibit 9-7 presents the National perspective travel efficiency economic feasibility indicators for each TTC option. These indicators are interpreted as follows:

- An economically feasible project is one which has a positive Net Present Value, an Internal Rate of Return equal to or exceeding the discount rate (7%), and a Discounted Benefit/Cost ratio of 1.0 or higher.

- The higher the NPV, IRR and B/C, the more feasible the project.
- A negative rate of return is indicative of a project whose benefits, not discounted, are not as great as its costs.

Exhibit 9-7
NATIONAL PERSPECTIVE TRAVEL EFFICIENCY FEASIBILITY FINDINGS

TTC OPTION	Net Present Value[a] $ Billion	Internal Rate of Return	Discounted Benefit/Cost Ratio[a]
A: Upgraded Highway	($5.9)	4.8%	.68
B: Upgraded Railway	($34.9)	–4.5%	.49
C3: Super Highways	($23.4)	4.1%	.57
C1: Super Highway	($3.3)	6.7%	.94
D: High Speed Guideway	($47.1)	–1.2%	.18

NOTES:
(a) Discounted at 7%
(b) See Appendix exhibits A for the calculation of these statistics.
SOURCE: Wilbur Smith Associates

The feasibility of each TTC option, from the national efficiency perspective, is depicted on Exhibit 9-8. Only one option (a single transcontinental super speed highway) is shown to be anywhere near feasible, and its benefit/cost ratio is less than 1.0.

Travel Efficiency Feasibility Findings

Travel efficiency is the conventional and traditional method of defining whether or not a surface transportation improvement is economically feasible. It is also the proper method from the national perspective. According to this test, a highway or rail improvement needs to be quite successful in reducing travel costs, travel time, and accident risk; and, it needs to have sufficient traffic or use volumes to attain the necessary level of user economic benefits. Similarly, a new technology needs to have attributes such that people perceive their importance and are willing to pay for them.

Exhibit 9-8
TRAVEL EFFICIENCY BENEFIT/COST RATIOS

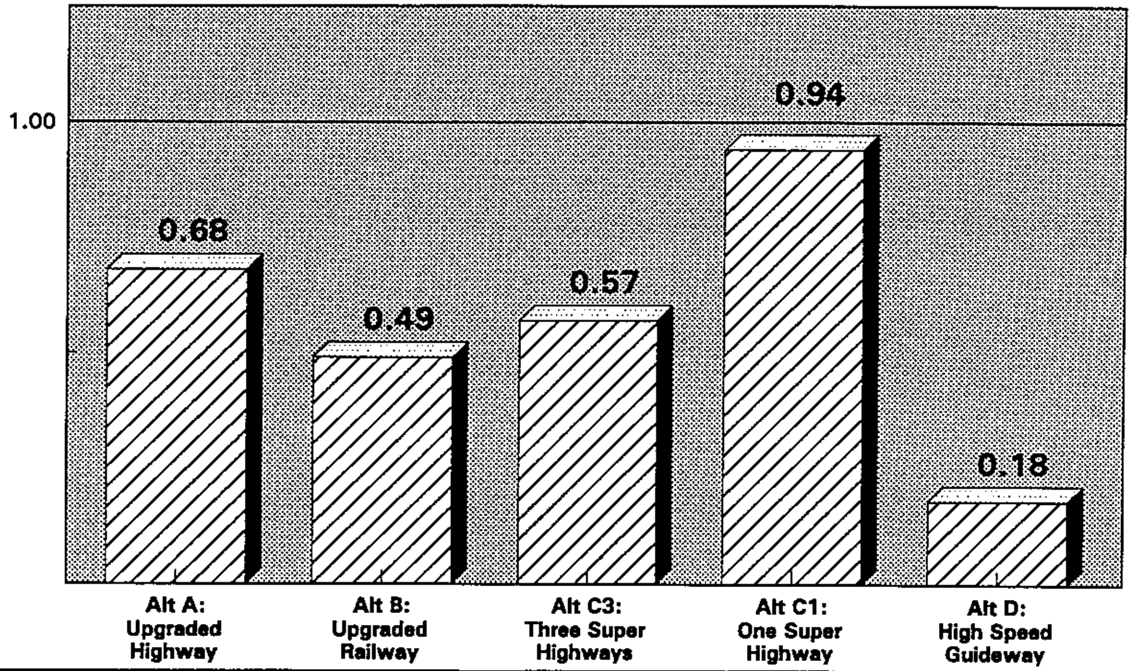


Exhibit 9-7 suggests the following conclusions, from the travel efficiency perspective (exclusive of corridor economic development impacts):

1. <u>Alternative A: Upgraded Highway</u> - This TTC option is not economically feasible as an investment from the National point of view.

    - A benefit/cost ratio of only .68 is a very low ratio, indicating that the project falls far short of economic feasibility.

    - According to these calculations, the U.S. economy will be worse off by $5.9 billion if the Upgraded Highway is built.

    - This option suffers because of its cost ($17.9 billion) combined with its low estimated usage (only 28.8 million daily vehicle kilometers of travel, for an average AADT of 6,400 vehicles).

- While this new 4,529 km (2,815 mile) Upgraded Highway is not economically feasible coast to coast, some segments of the highway might be feasible.

2. Alternative B: Upgraded Railway - This new combination freight and passenger cross country railway also is not economically feasible. In fact, it is less feasible than the upgraded highway.

    - This TTC railway option has a negative rate of return, indicating that the annual benefits are insufficient to even cover the annual operating and maintenance costs, with nothing left to cover the capital costs.

    - This option suffers because its estimated utilization is low. It would, in the year 2040, need to handle only 6.8 passenger trains daily and 21.7 freight trains daily to carry the forecasted traffic.

    - It also suffers because the cost of carrying freight on this new TTC railway greatly exceeds the costs of carrying the same freight on the existing transcontinental railroad lines.

    - And, it suffers because the estimated passenger use on the rail line is low compared with the estimated $33.1 billion cost of building this railway.

3. Alternative C-3: Super Highway - This option assumes that there are already two 200 km/h (120 mph) Super Highways crossing the U.S., and evaluates whether a third such super highway should be built in the TTC. From the National economic perspective, this third Super Highway is believed to be economically infeasible.

- This third Super Highway yields a 4.1 percent rate of return, and a benefit/cost ratio of 0.57.

- While a third Super Highway might be feasible sometime in the future (as traffic builds) there is insufficient travel demand estimated at this time to warrant three transcontinental super highways.

- This third Super Highway suffers because its 1990 daily traffic averages only 9,500 AADT which would grow to 17,300 by the year 2040. These volumes are well below the Super Highway's expected capacity (eight lanes) and do not justify the $53.4 billion initial investment.

4. <u>Alternative C-1: Super Highway</u> - The economic calculations suggest that, from the Nation's perspective, construction of one transcontinental super highway is the best of the TTC options but, even so, has a benefit/cost ratio of less than 1.0 and therefore is not quite economically feasible.

   - The rate of return is 6.7%, the benefit/cost is .94, and the NPV is a negative $3.3 billion. This TTC option is not quite feasible.

   - This Super Highway option is better than the three TTC's because it assumes that it is the only operating transcontinental super highway in the U.S. Its AADT is an estimated 68 percent higher than if it must compete with two other transcontinental Super Highways. Its high travel speed and greater rate of utilization of 16,000 AADT in 1990 and 29,000 in 2040 are the reasons for its better ranking.

5. <u>Alternative D: High Speed Guideway</u> - The travel efficiency calculations suggest that the transcontinental high speed guideway is not an economically feasible investment at this time.

- The guideway benefit/cost ratio is a very low 0.18, and the rate of return is negative, indicating the annual benefits, undiscounted, do not exceed its costs.

- The transcontinental guideway suffers because the distances (up to 4,500 km or 2,800 miles) are too great to enable the guideway to competitively compete with the faster airplane. The guideway also suffers because this TTC has a very low population density, and because of the TTC capital cost of $51.4 billion.

SENSITIVITY TESTS

The National perspective feasibility test is based on a number of calculations and estimates, many of which are approximations. Ten sensitivity tests were conducted, to determine the extent to which study findings are dependent on these approximations. These tests are as follows:

1. 25 percent reduction in capital costs,
2. 25 percent increase in capital costs,
3. Determination of that capital cost at which the investment is economically feasible,
4. Use of a four percent discount rate,
5. Use of a 10 percent discount rate,
6. Exclusion of the "Additional Consumers Surplus" benefit type.
7. Exclusion of the 1% per year increase in per hour value of time.
8. One year benefit time lag.
9. 25 percent increase in benefits.
10. 25 percent increase in benefits and 25 percent reduction in capital cost.

Exhibit 9-9 summarizes the benefit/cost results of the ten sensitivity tests.

1. 25% Less Capital Cost Sensitivity Test

If the capital costs were 25 percent less than estimated, all TTC options would be better but, only Alternative C-1: single Super Highway, would be economically feasible. All of the others remain economically infeasible. If the 8-lane Super Highway could be reduced to 6 or even 4 lanes, it could possibly be economically feasible.

Exhibit 9-9
TRAVEL EFFICIENCY SENSITIVITY RESULTS
(Benefit/Cost Ratios)

	A: UPGRADED HIGHWAY	B: UPGRADED RAILWAY	C: SUPER HIGHWAY		D: HIGH SPEED GUIDEWAY
			C-3	C-1	
Study's Benefit/Cost	0.68	0.49	0.57	0.94	0.18
1. 25% Less Capital Cost	0.89	0.56	0.75	1.24	0.23
2. 25% More Capital Cost	0.55	0.44	0.46	0.76	0.15
3. Capital Cost for a B/C of 1.0 ($ billion)	$11.9	$0.00	$30.0	$50.1	$4.3
4. 4% Discount Rate	1.16	0.62	1.03	1.68	0.32
5. 10% Discount Rate	0.45	0.40	0.35	0.59	0.11
6. No Additional Consumers Surplus	0.68	0.48	0.32	0.53	0.15
7. Constant Time Value	0.56	0.49	0.50	0.83	0.17
8. 1 year Benefit Lag	0.71	0.52	0.70	1.16	0.26
9. 25% More Benefits	0.85	0.62	0.71	1.17	0.22
10. 25% More Benefits and 25% Less Capital Cost	1.12	0.70	0.94	1.55	0.28

SOURCE: Wilbur Smith Associates.

2. 25% More Capital Cost Sensitivity Test

If the capital cost were 25 percent greater than estimated, no TTC option is feasible (the best would be the single Super Highway, with a benefit/cost ratio of .76).

3. Capital Cost for a B/C of 1.0 Sensitivity Test

The third test asked at what capital cost would each TTC option be feasible (B/C 1.0, an IRR of 7.0 percent, and a discounted net present value of $0.0). To be feasible in this sense, Alternative A: Upgraded Highway would need to cost $11.9 billion, which is 33 percent less than the actual cost estimate. Alternative B: Upgraded Railway would not be feasible even if its cost is zero, due to the high costs of operation. If a third Super Highway were built, it would be feasible only if it cost $30.0 billion (44 percent less than estimated), and the single Super Highway would be feasible if it cost $50.1 billion (6 percent less than estimated). The High Speed Guideway would be feasible only if it cost $4.3 billion (92 percent less than estimated).

4. 4% Discount Rate Sensitivity Test

The feasibility analysis used a constant price level discount rate of 7 percent. For sensitivity purposes, rates of 4 percent and 10 percent were also used. At 4 percent, all of the highway options are economically feasible, with the single Super Highway remaining the most feasible.

5. 10% Discount Rate Sensitivity Test

At a 10 percent discount rate, none of the TTC options is feasible.

6. Without Additional Consumers Surplus Sensitivity Test

If the additional consumers surplus benefit type is not included as an economic benefit, none of the TTC options is feasible, and the conventional Interstate Highway (Option A) is slightly the superior option with a benefit/cost ratio of 0.68.

7. Constant Time Value Sensitivity Test

In this study the value that travelers place on their time was increased by one percent per year in constant dollars. This sensitivity test excluded that one percent per year increase. It reduced the feasibility results for those options that entail significant time savings benefits.

8. 1 Year Time Lag Sensitivity Test

In this study zero benefits were taken for the period of time in which the TTC would be built. The time lags were 2, 3, 5, and 8 years for options A, B, C and D, respectively. In the sensitivity test, one year time lags were used, e.g., the TTC is built one year, and benefits start the next year. Under this assumption, the single Super Highway is economically feasible.

9. 25% More Benefits Sensitivity Test

It is possible that a TTC will create more (or less) economic benefits than estimated in this study. If the TTC attracted 25 percent more traffic than forecast, the benefits would increase by about that amount. Or, other benefits or benefits of a greater magnitude might occur that are not included in this study. If the benefits are 25 percent more than estimated, the sensitivity analysis shows that the single Super Highway would be economically feasible. The other TTC options would remain infeasible.

10. 25% More Benefits, and 25% Less Capital Cost Sensitivity Test

In this sensitivity test the costs of building the TTC are reduced by 25 percent and the benefits are increased by 25 percent. If this were to occur, the Alt. A Upgraded Highway and the Alt. C-1 single Super Highway would be economically feasible.

ECONOMIC FEASIBILITY CONCLUSIONS

In this chapter the economic wisdom of building a transcontinental surface transportation artery in this corridor was examined from the travel efficiency perspective. The chapter takes the "National perspective" since it does not include any redistributional effects attributable to the facility, e.g., it does not include any corridor impacts associated with the corridor region being better able to attract new industries and business from elsewhere in the U.S.

Based on these analyses, the chapter determines the following:

1. From this perspective, none of the coast-to-coast TTC options are economically feasible.

2. Of the alternatives studied, the single Super Highway is the closest to feasible (benefit/cost ratio of 0.94). The other TTC options are significantly less feasible.

3. As demonstrated in the sensitivity tests, there are scenarios under which one or more of the TTC options could be demonstrated to be economically feasible from the national perspective. Of these, the lesser capital cost, reduced time lag, or greater benefits scenarios would be the most likely.

4. This study explored new technologies and compared various technologies in a very long and wide corridor region. It is difficult to judge the rate and nature of technology development; it is therefore difficult to precisely predict their costs and economic implications. The economic calculations should therefore be viewed as indicative of feasibility, but within an indeterminate range of potential error.

5. The economic analyses explored only a coast-to-coast TTC. Shorter segments might be found to be feasible based on further analysis. A segmental analysis was not conducted as part of this study. The data for this study was developed based on the overall coast-to-coast route and should not be construed as reflecting on the economic feasibility of any segment.

SPECIAL NOTE

The economic efficiency calculations of Chapter 9 comprise the estimated travel efficiency benefits. From the national funding perspective, these are the only benefits. From the corridor perspective, the benefits exclude any economic development impacts that might accrue in the TTC corridor. These are addressed in Chapter 10.

Chapter 10
ECONOMIC DEVELOPMENT EFFECTS

The efficiency analysis of Chapter 9 examined the feasibility of each TTC option from the perspective of the entire Nation, and calculated the economic feasibility of each TTC option in terms of travel efficiency (productivity). From that perspective, the economic analysis found that none of the coast-to-coast TTC options are economically feasible.

However, a new transportation facility built in this corridor could accomplish more than improving the Nation's productivity. A new transportation facility built in this corridor could also help the communities in the corridor to develop economically, by attracting firms and economic activity to the corridor area and by generally helping the corridor's communities to better compete with other communities in the U.S. However, this increase in economic activity would largely occur at the expense of other areas of the country. By creating a new transportation facility, and by reducing transportation costs in the region, the area could become more economically attractive and competitive vis-a-vis other regions in the U.S.

Two improvement questions related to TTC corridor-specific impacts are relevant:

1) How substantial would be the economic development along the corridor that is stimulated by reduced transportation costs?

2) Are there significant redistributive (social equity) arguments for a TTC, to the extent that the region it serves is comparatively disadvantaged economically?

Together, these two questions are important because they enable an evaluation to be made as to whether the economic gains to a "primary impact area" from a TTC would be sizable enough and the relative need would be great enough to warrant the required investment.

This chapter examines these two separate but interrelated questions. The questions are interrelated because only if economic development would be significantly facilitated by a TTC is there a social equity argument for investing in transportation improvements.

TTC PRIMARY IMPACT AREA

To gauge the economic development and redistributive effects of the TTC on its region, the TTC effects or impacts are estimated for a defined "TTC Primary Impact Area." That area is shown on Exhibit 10-1, and comprises counties in proximity to the defined corridor routes. The economic development impacts of this chapter refer to the economic gains estimated to occur within this defined primary impact area if any of the TTC options are built.

NET GAINS VS. TRANSFER EFFECTS

This chapter estimates the economic impacts on the defined primary impact area as a result of the TTC. Most of these economic gains within the corridor area are, however, due to helping the corridor to develop economically at the expense of other places in the U.S. For example, the calculations suggest that if the TTC is built, this corridor will be better able to compete with other places in the U.S. for economic activity. This means that firms may choose to locate in the TTC region, because of the new TTC, rather than to relocate elsewhere in the U.S. Such an impact will benefit the TTC primary impact area, but at a loss to other U.S. locations external to the primary impact area.

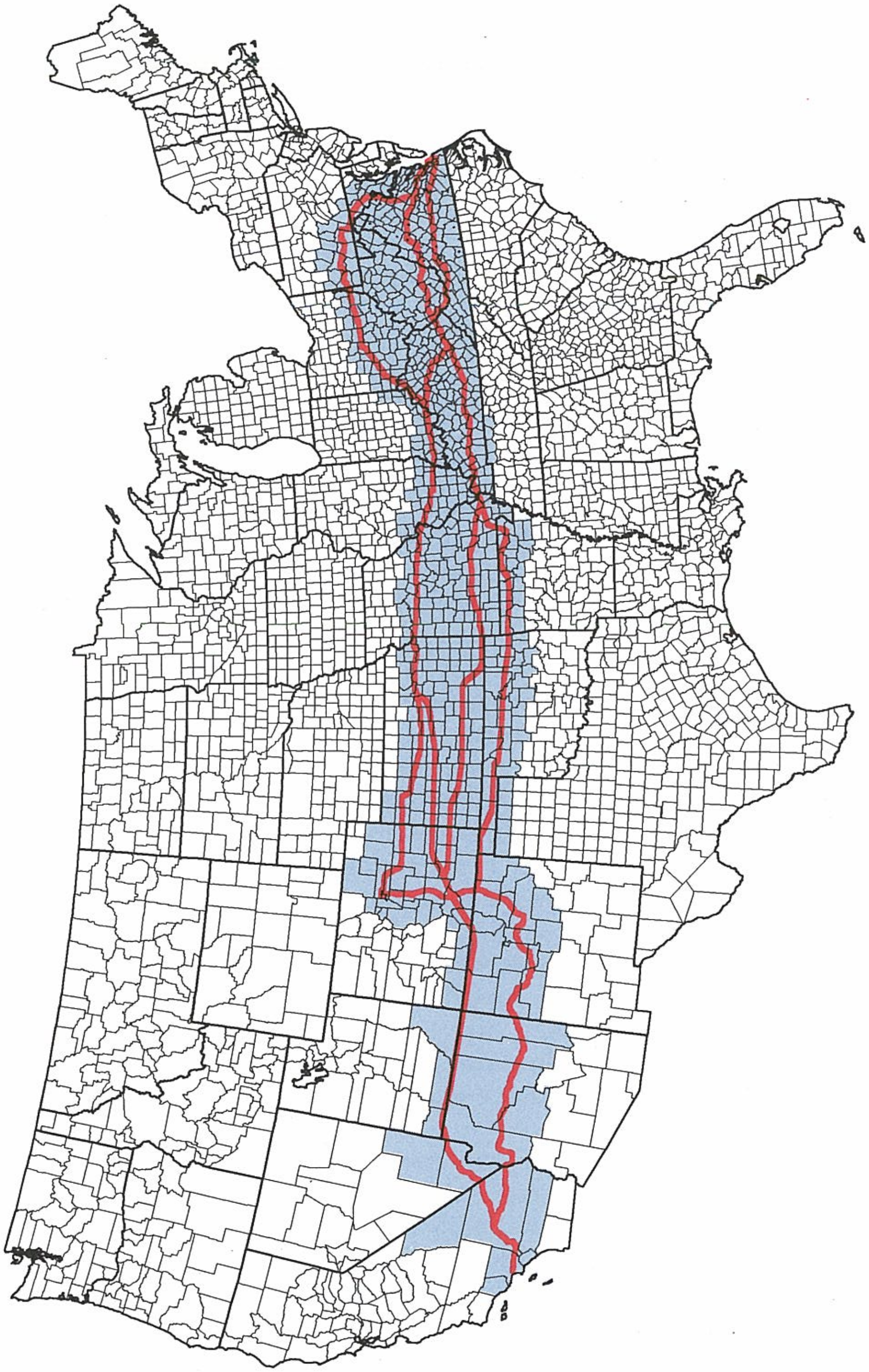
THREE INDICATORS OF ECONOMIC DEVELOPMENT IMPACT

The TTC could yield many different forms of impact to the corridor area. In order to recognize these diverse impacts in a consistent fashion, a single set of "indicators of impact" and a single set of definitions are used throughout the economic impact calculations. The economic impacts are expressed in terms of three "indicators of economic development impact." These three impact measures are estimated for each TTC option.

Value Added

"Value added" is the value of the corridor firms' output minus the value of the inputs they purchase from other firms. In the corridor study, it is the value added by firms located in the defined corridor impact area, including employee compensation, proprietary income, indirect business taxes, and other property income. The value added component is the most comprehensive and accurate measure of economic development impact.

Exhibit 10-1
TTC PRIMARY IMPACT AREA



Wages

This measure of economic impact includes increases in payroll costs (wages and salaries) plus income from self-employment.

Employment

Employment comprises "new" jobs attributable to the TTC including the number of person job years due to TTC construction and use, plus the share of those that are employed in sectors that directly or indirectly support the construction process, the TTC users, and the firms that might expand in or locate to the region.

These indicators are all produced by the REMI Model; they should not be added together because they are alternative measures of the same thing: economic growth.

FOUR ECONOMIC DEVELOPMENT CAUSES

An upgraded transportation facility could help to create additional economic development for the residents and businesses of the primary impact area. These effects were categorized into four types, and economic development impacts were estimated for each.

Act of TTC Construction

The act of spending money in the corridor region to build the transportation facility will increase economic activity in the corridor area. The construction impacts are temporary in nature, since they exist only during the construction period and end when the construction is complete. However, the increased maintenance spent on TTC operations and maintenance will occur annually and will continue to be of benefit to the primary impact area throughout the life of the TTC. Such construction expenditures, however, are net gains to the corridor only if they represent "new" monies, from elsewhere (federal funds) spent in the region. For economic impact purposes, the costs of TTC construction are assumed to occur in equal annual amounts over a 10-year period. As a result, these impacts cease after year ten.

Corridor Competitive Position Impacts

A new transportation facility will make this corridor region more attractive to business. The TTC will cause reductions in the cost and time of transportation, which could lead to reduced costs of production, which in turn could lead to reduced prices and/or increased profits, which could lead to increased production (expansion of existing firm production and/or attraction of new firms), which in turn generates economic impact value. These lower transportation costs could help the region to compete against other areas of the country for economic development opportunities. These "competitive position" impacts are created by the reduced travel cost from using the TTC and are of economic benefit value to the primary impact area.

Other Efficiencies

In addition to the above described economic development effects, the TTC will also create an assortment of productivity changes. These include travel efficiencies for people on non-business travel. The personal business efficiency (time saved, accidents avoided, etc.) are not included elsewhere; hence, they are included here as "other efficiencies."

Additional Consumers Surplus

The "additional consumers surplus" described in Chapters 8 and 9 are also not included above. Therefore, they too are added to the primary impact area effects as a benefit to the region.

REMI ECONOMETRIC MODEL

To gauge the impact of the TTC on the primary impact area economy, the REMI econometric model (Regional Economic Models, Inc.) was used. The REMI model is a multi-regional dynamic economic and demographic forecasting model that estimates regional and national effects from various governmental or private policy changes or investments. The REMI model simulates a regional economy that predicts demand and supply conditions across 53 sectors, 94 occupations, 25 final demand sectors, and 202 age/sex cohorts.

The TTC would create freight transportation cost savings, business cost savings, TTC use expenditures, tourism expenditures, and others. These direct changes, in monetary terms, serve as inputs into the REMI economic model. For example, the model estimates the regional economic effect from increased profits for businesses and firms in the region created by more efficient truck travel on the highway. The REMI model requires separate regional inputs into the model. The model utilized price levels and output levels for the year 1987; all results are then increased to 1993 price levels utilizing appropriate producer price inflators.

The direct monetary impacts of each of the four categories of impact (construction expenditures, competitive position, other efficiencies, and additional consumers surplus) were estimated external to the REMI model. Then the construction expenditures, competitive position impacts, and a portion of the other efficiencies were input into the REMI model. Some components of TTC economic development effects such as willingness to pay for non-business time savings, are not increases in final demand. Therefore, these effects are added to the REMI results. All of the impact categories are net impacts within the primary impact area; they should not be construed as net impacts for the U.S. as a nation.

ESTIMATED ECONOMIC DEVELOPMENT IMPACT ON THE PRIMARY IMPACT AREA

The people and businesses near the TTC stand to gain economically if the TTC is constructed. In some cases, the communities in the region will be better able to compete for industrial and commercial businesses, more money may be spent in the area, and overall the regional economy should benefit.

Economic Impact of TTC Construction and Maintenance

The total construction cost for the TTC varies significantly by route option and TTC technology. The spending of construction money in the area is of economic value to the primary impact area, since construction contractors and workers will be hired, construction materials will be purchased, etc. To assess the construction impacts, the estimated cost for each TTC option was input into the REMI model. The model was then used to estimate the economic development impacts that might occur in the primary impact area associated with the construction process itself.

The capital cost for each TTC option was treated as an increase in final demand and was input into the REMI model. This is proper since the REMI model determines which construction purchases can be spent in the area and which involve expenditures outside the primary impact area. The REMI model determines the amount of materials, labor, etc. that could be supplied locally and estimates the total economic development impacts to the corridor area created by the TTC construction outlays. For economic development analysis purposes it was assumed that construction would take 10 years to complete, and that construction expenditures would be spent in equal amounts over the 10-year period. Increased maintenance costs were estimated by year and the net maintenance cost change was input into the REMI model annually through the year 2040.

The economic impacts due to construction comprise the expenditures spent in the primary impact area, the extent to which those funds employ local people and buy local goods and services, and the flow of those expenditures in terms of respending. The REMI model determines what is needed in TTC construction and determines how many local contractors can be hired, what materials can be purchased locally, etc. The impacts include labor and expenses associated with planning, design and construction of the TTC, plus the respending of those funds to the extent that such respending occurs within the primary impact area.

The estimated economic impacts in the corridor attributable to TTC construction are listed in Exhibit 10-2.

Exhibit 10-2
TTC CONSTRUCTION ECONOMIC IMPACTS
TTC Primary Impact Area

TTC OPTION	IMPACT PER YEAR FOR TEN YEARS		
	Value Added ($ million)	Wages ($ million)	Employment (Jobs)
A: Upgraded Highway	$2,478	$1,635	57,840
B: Upgraded Railway	5,796	3,825	118,368
C3: Three Super Highways	9,330	6,158	190,644
C1: One Super Highway	9,330	6,158	190,644
D: High Speed Guideway	8,985	5,930	183,570

NOTE: This Exhibit depicts the primary impact area annual average impacts due to the act of constructing the TTC. These impacts occur every year for ten years, and then cease.

SOURCE: Wilbur Smith Associates, REMI Model.

According to the Exhibit 10-2 calculations, the residents and businesses of the TTC corridor will benefit significantly if "outside" funds are used to construct the TTC. The value added impacts over the 10-year assumed construction period total to an impact value which is greater than the TTC capital cost. This is due to the respending of monies (the "multiplier effect"). As such, these jobs and impacts include not only those engaged in construction of the TTC, but also include jobs that serve the construction process plus those created by the respending of money.

It is important to keep in mind that these impacts would occur over the 4,500 kilometer length of the corridor. Depending on the TTC option, construction activity shown in Exhibit 10-2 will constitute between a 0.1 and 0.6 percent increase in employment during the ten-year period.

Because these construction effects result from the expenditure of capital investment funds, the greater the project cost, the greater the impact on the corridor region. Construction expenditures are transfers from those paying user fees or taxes to those deriving income from construction activity. Therefore, these impacts cannot be thought of as justification for the investment.

Competitive Position Impacts

The improved competitive position impacts are directly related to increased productivity. To quantify the anticipated competitive position impacts attributable to the TTC, the reduced costs of doing business were estimated and input into the REMI model. These lower costs may be passed on to consumers as lower prices for consumer goods, to workers as higher wages, or to owners of businesses and firms as higher net income. Persons may thus benefit from the TTC without personally traveling on it.

To the extent that it lowers transportation costs along the corridor, the TTC also increases the probability that the corridor will be able to attract new industry to the region. How great this effect will be depends on four factors:

1) The importance of transportation costs to an industry. If the industry is transportation intensive, reductions in such costs constitute a significant savings.

2) The magnitude of the transportation cost savings. If average flow speeds along the corridor are increased substantially, or if the certainty of arrival time is greatly improved (i.e., the time enroute becomes less variable), more sizable cost savings are possible.

3) How "footloose" are various industries for which the region could be competitive. Industries with major and immobile capital assets (e.g., factories) are less able to relocate to lower cost sites

than are industries whose resources tend to be mobile (e.g., workers in rented office space).

4) The extent to which other required resources are available. Industries vary in their needs for factors such as skilled labor, natural resources, and a favorable climate. Good transportation often is a necessary but not sufficient condition for regional growth and development.

Exhibit 10-3 summarizes the estimated economic impacts in the corridor area of each TTC option due to the increased competitive position of that region if the TTC is built.

The competitive position effects of Exhibit 10-3 suggest a number of things:

- Any of the TTC options, if built, could have a beneficial economic impact on the TTC corridor region and its communities. Over the analysis period, value added of $12 to $25 billion and jobs added to the region of 36 to 84 thousand represent growth for the TTC region.

- The effects of the corridor region being better able to compete will occur gradually, over time. The impacts are low in the early years, but as businesses are attracted to the region, the impact values are more sizable later.

- For all practical purposes, all of these competitive position impacts are drawn from elsewhere in the U.S. The TTC corridor communities gain, but at a loss to the rest of the U.S.

Other Efficiencies Impacts

The "other efficiency impacts" comprise transportation cost savings that accrue to impact area residents that were not input into the REMI model in the other impact categories. The actual cost savings were input into REMI as income increases (greater disposable income), while the accident savings and non-business time savings were not input through REMI but instead are added as value added (without accompanying wage or jobs impacts). The results are presented in Exhibit 10-4.

Exhibit 10-3
TTC COMPETITIVE POSITION ECONOMIC IMPACTS
TTC Primary Impact Area

TTC OPTION	ANNUAL IMPACT: Value Added ($ million)	ANNUAL IMPACT: Wages ($ million)	EMPLOYMENT IMPACT (Jobs)
YEAR 2001 (Not Discounted)			*YEAR 2001*
A: Upgraded Highway	$1,144	$693	19,805
B: Upgraded Railway	812	493	14,056
C3: Three Super Highways	895	544	15,495
C1: One Super Highway	1,498	909	25,923
D: High Speed Guideway	970	587	16,797
YEAR 2040 (Not Discounted)			*YEAR 2040*
A: Upgraded Highway	$3,553	$1,981	48,778
B: Upgraded Railway	3,123	1,729	42,708
C3: Three Super Highways	3,673	2,030	50,168
C1: One Super Highway	6,134	3,392	83,796
D: High Speed Guideway	2,618	1,472	36,028
TOTAL 1993-2040 (Discounted at 7 Percent)			
A: Upgraded Highway	$18,596	$10,496	
B: Upgraded Railway	14,064	7,922	
C3: Three Super Highways	15,155	8,502	
C1: One Super Highway	25,404	14,249	
D: High Speed Guideway	11,943	6,578	

NOTE: This Exhibit depicts the economic value of the TTC primary impact area being better able to compete with other regions of the U.S. for economic activity. These impacts are economic transfers from elsewhere in the U.S. economy.

SOURCE: Wilbur Smith Associates, REMI Model.

Additional Consumers Surplus Impacts

The final impact type comprises the "additional consumers surplus" benefits estimated in the travel efficiency analysis. These impacts constitute benefits but do not yield income or job increases. Rather they are included only as value added impacts.

TOTAL ECONOMIC IMPACTS ON THE TTC CORRIDOR AREA

The total estimated economic impacts on the defined TTC primary impact area are the sum of the construction, competitive position, other efficiencies and additional consumers surplus impacts, plus the residual value of the capital investment itself.

Exhibit 10-4
TTC OTHER EFFICIENCIES ECONOMIC IMPACTS
TTC Primary Impact Area

TTC OPTION	ANNUAL IMPACT Value Added ($ million)	ANNUAL IMPACT Wages ($ million)	EMPLOYMENT IMPACT (Jobs)
YEAR 2001 (Not Discounted)			***YEAR 2001***
A: Upgraded Highway	$745	$249	8,779
B: Upgraded Railway	263	102	3,890
C3: Three Super Highways	2,247	776	22,371
C1: One Super Highway	3,438	1,301	37,551
D: High Speed Guideway	704	266	10,125
YEAR 2040 (Not Discounted)			***YEAR 2040***
A: Upgraded Highway	$2,096	$798	21,849
B: Upgraded Railway	756	347	9,922
C3: Three Super Highways	7,150	3,120	81,623
C1: One Super Highway	11,482	5,228	136,904
D: High Speed Guideway	1,908	860	24,472
TOTAL 1993-2040 (Discounted at 7 Percent)			
A: Upgraded Highway	$12,165	$4,074	
B: Upgraded Railway	4,162	1,644	
C3: Three Super Highways	33,417	12,357	
C1: One Super Highway	52,278	20,775	
D: High Speed Guideway	8,698	3,339	

SOURCE: Wilbur Smith Associates, REMI Model.

Exhibit 10-5 summarizes the TTC region value added impacts; Exhibit 10-6 summarizes the TTC region wages impacts; and, Exhibit 10-7 summarizes the estimated TTC region number of net new jobs attributable to the TTC.

Several points regarding the exhibits should be emphasized.

- Few of these impacts actually constitute net improvements in the U.S. economy. Most involve transfers from elsewhere in the U.S. to the TTC region.

- The impacts would be distributed over a 4,500 km (3,000 mile) corridor. As is discussed later in this chapter, these impacts would not be

Exhibit 10-5
TOTAL ECONOMIC DEVELOPMENT IMPACTS ON TTC CORRIDOR REGION
VALUE ADDED (Millions of Dollars)

TYPES OF IMPACTS	ALT "A"	ALT "B"	ALT "C3"	ALT "C1"	ALT "D"
YEAR 2001 (Not Discounted)					
TTC Construction	2,100	5,501	8,851	8,851	8,526
Corridor Competitive Position	1,144	812	895	1,498	970
Other Efficiencies	745	263	2,247	3,438	704
Additional Consumer Surplus	6	57	1,170	1,966	174
Total Development Effects	**3,995**	**6,633**	**13,163**	**15,753**	**10,374**
YEAR 2040 (Not Discounted)					
TTC Construction	0	0	0	0	0
Corridor Competitive Position	3,553	3,123	3,673	6,134	2,618
Other Efficiencies	2,096	756	7,150	11,482	1,908
Additional Consumer Surplus	8	106	1,776	2,985	294
Total Development Effects	**5,657**	**3,985**	**12,599**	**20,061**	**4,820**
YR 2040 Residual Value	3,091	4,934	9,794	9,794	8,546
Total Impacts	**8,748**	**8,919**	**22,393**	**30,395**	**13,366**
TOTAL 1993–2040 (Discounted at 7 Percent)					
TTC Construction	19,111	43,933	70,732	70,732	68,110
Corridor Competitive Position	18,596	14,064	15,155	25,404	11,943
Other Efficiencies	12,165	4,162	33,417	52,278	8,698
Additional Consumer Surplus	85	781	13,466	22,632	1,736
Total Development Effects	**49,957**	**62,940**	**132,770**	**171,046**	**90,487**
YR 2040 Residual Value	129	205	407	407	355
Total Impacts	**50,086**	**63,145**	**133,177**	**171,453**	**90,842**

SOURCE: Wilbur Smith Associates

Exhibit 10-6
TOTAL ECONOMIC DEVELOPMENT IMPACTS ON TTC CORRIDOR REGION WAGES (Millions of Dollars)

TYPES OF IMPACTS	ALT "A"	ALT "B"	ALT "C3"	ALT "C1"	ALT "D"
YEAR 2001 (Not Discounted)					
TTC Construction	2,804	4,312	6,936	6,936	6,681
Corridor Competitive Position	693	493	544	909	587
Other Efficiencies	249	102	776	1,301	266
Additional Consumer Surplus	–	–	–	–	–
Total Development Effects	**3,746**	**4,907**	**8,256**	**9,146**	**7,534**
YEAR 2040 (Not Discounted)					
TTC Construction	0	0	0	0	0
Corridor Competitive Position	1,981	1,729	2,030	3,392	1,470
Other Efficiencies	798	347	3,120	5,228	860
Additional Consumer Surplus	–	–	–	–	–
Total Development Effects	**2,779**	**2,076**	**5,150**	**8,620**	**2,330**
TOTAL 1993–2040 (Discounted at 7 Percent)					
TTC Construction	16,799	34,486	55,600	56,600	53,532
Corridor Competitive Position	10,496	7,922	8,502	14,249	6,578
Other Efficiencies	4,074	1,644	12,357	20,775	3,339
Additional Consumer Surplus	–	–	–	–	–
Total Development Effects	**31,369**	**44,052**	**76,459**	**90,624**	**63,449**
SOURCE: Wilbur Smith Associates					

evenly distributed: most would occur in metropolitan areas.

- The Single Super Highway (Alternative C1) is estimated to have the greatest economic impact on the TTC region. This is because it is expected to be heavily used and to attract economic activity to what would be a comparatively high technology transportation corridor.

Exhibit 10-7
ECONOMIC DEVELOPMENT IMPACTS ON TTC CORRIDOR REGION
NUMBER OF JOBS

TYPES OF IMPACTS	ALT "A"	ALT "B"	ALT "C3"	ALT "C1"	ALT "D"
YEAR 2001					
TTC Construction	52,227	112,281	180,520	180,520	173,891
Corridor Competitive Position	19,805	14,056	15,495	25,923	16,797
Other Efficiencies	8,779	3,890	22,371	37,551	10,125
Additional Consumer Surplus	–	–	–	–	–
Total Development Effects	**80,811**	**130,227**	**218,386**	**243,994**	**200,813**
YEAR 2040					
TTC Construction	0	0	0	0	0
Corridor Competitive Position	48,778	42,708	50,168	83,796	36,028
Other Efficiencies	21,849	9,922	81,623	136,904	24,472
Additional Consumer Surplus	–	–	–	–	–
Total Development Effects	**70,627**	**52,630**	**131,791**	**220,700**	**60,500**

SOURCE: Wilbur Smith Associates

- The option expected to have the least economic impact is the Upgraded Highway (Alternative A). It would be another Interstate highway crossing the U.S., generally between Interstates 40 and 70.

In summary, the five alternatives vary by as much as three-fold in terms of their economic impacts on the TTC region. In absolute numbers, some of these magnitudes are substantial (e.g., 220,700 net new jobs in the corridor due to the TTC by the year 2040 for Alternative C1). The impacts, however, would be spread over a very large region. Virtually all of the activity locating along the corridor would transfer from other U.S. locations. The greatest transfers would occur in industries that are particularly sensitive to changes in transportation costs.

NET ECONOMIC IMPACTS IN PERSPECTIVE

The TTC is estimated to attract considerable economic activity to the primary impact area. The greatest impact would accompany Alternative C1: Single Super Highway. Over the analysis period that TTC option is estimated to create over $171 billion in value added, accompanied by over 220,000 net new jobs in the corridor. Even the Alternative A: Upgraded Highway option would generate over $50 billion in value added and over 70,000 net new jobs.

While these are large economic effects, as a proportion of economic activity already in the TTC corridor, they are really quite small. Exhibit 10-8 lists the TTC primary impact area value added and number of jobs in the year 2040, as estimated by the REMI model. It then lists the net increase estimated to be attributable to the various TTC options.

Exhibit 10-8
TTC ECONOMIC IMPACT COMPARED WITH TOTAL CORRIDOR ECONOMIC ACTIVITY
Year 2040[a]

	WITH TTC BUILT[b]		TTC PERCENT OF TOTAL
	TTC Alternative	TTC Amount	
VALUE ADDED (billion) [$2,972.8 without TTC]	A: Upgraded Highway	$8.75	.29
	B: Upgrade Railway	8.92	.30
	C3: Three Super Highways	22.39	.75
	C1: One Super Highway	30.40	1.02
	D: High Speed Rail	13.37	.45
JOBS (thousand) [41,956 without TTC]	A: Upgraded Highway	70.63	.17
	B: Upgrade Railway	52.63	.13
	C3: Three Super Highways	131.79	.31
	C1: One Super Highway	220.70	.53
	D: High Speed Rail	60.50	.14

(a) Year 2040 estimates at constant 1993 price levels.
(b) Net increment in year 2040 estimated to be attributable to TTC.

SOURCE: Wilbur Smith Associates.

If the TTC option with the greatest estimated economic impact is built, it would increase total value added in the corridor by one percent, and would increase the number of jobs in the corridor by one-half of one percent, by the year 2040. If Alternative A: Upgraded Highway were built, the increases would be .29 percent and .17 percent, respectively. These are very small increases which, in many communities, would not be noticeable.

Another way of placing the impacts into perspective is to compare the number of jobs transferred to the TTC region with the capital cost of the project needed to transfer them. Dividing the capital cost by the number of new jobs in the corridor in the year 2040 yields costs per job shown in Exhibit 10-9.

Exhibit 10-9
CAPITAL COST PER NEW TTC REGION JOB

TTC Option	Capital Cost Per Job
A: Upgraded Highway	$253,444
B: Upgraded Railway	628,920
C3: Three Super Highways	405,187
C1: One Super Highway	241,957
D: High Speed Rail	849,587

This indicates a public expenditure of several hundred thousand dollars in order to create one new permanent job in the TTC corridor, and these are predominately jobs transferred from elsewhere in the U.S. They are generally not new jobs. This implies that transportation investment may not be an effective way to create new, permanent jobs.

SOCIAL EQUITY IMPLICATIONS

The several TTC alternatives are not economically feasible, and therefore cannot be justified on the grounds that they would improve the Nation's economy. From the corridor perspective, substantial number of value added dollars, wages, and jobs would transfer to the TTC region. On a percentage basis, however, these economic impacts are quite small. The final question remaining is whether the TTC region is sufficiently in need of economic assistance that consideration should be given to investing in the corridor on the grounds of social equity.

To explore the issue of social equity, two questions must be addressed:

- Is the per capita income of the TTC region lower than that of the Nation?
- Would the TTC be likely to benefit those along the corridor whose incomes are particularly low?

These questions are analyzed in the remainder of this Chapter and in Appendix C.

Comparative Per Capita Income

Exhibit 10-10 shows the 1985 per capita income for the TTC study area, as well as various portions of it and the overall Nation. Metropolitan Statistical Areas (MSAs) tend to have appreciably higher per capita incomes than non-MSA areas. Particularly high are the incomes of the corridor's terminal MSAs: Los Angeles, Baltimore, and Washington, DC. Conforming with a national trend, per capita income in the study area's rural areas is quite low.

Per capita income in the TTC study area, exclusive of terminal MSAs, is well below that of the Nation. Largely this is because the corridor contains relatively few larger MSAs. Even then, 68 percent of the total corridor population lives in MSAs, and 73 percent of the total corridor income is generated in MSAs. Nationally, per capita income is much larger in MSAs than in rural areas, just as is the case in the study area.

Distribution of Impacts within the Corridor

Most available evidence suggests that major transportation corridor investments produce winners and losers among the areas through which they pass. In some cases, higher speed transportation facilities may actually worsen the relative economic prospects of rural areas.

Improved rural transportation corridors tend to extend the economic sphere of influence of metropolitan areas served by these corridors. Labor availability on the periphery of metropolitan areas is enhanced by rural workers who are able to commute greater distances. This helps these metropolitan areas be more competitive. While such employment opportunities increase incomes within rural areas,

Exhibit 10-10
1985 PER CAPITA INCOME COMPARISONS

GEOGRAPHIC AREA	PER CAPITA INCOME ($)
Total TTC Study Area	**$10,496**
Metropolitan Statistical Areas (MSAs)	11,142
Rural	8,177
Terminal MSAs[1]	12,161
Study Area Less Terminal MSAs	**$9,739**
Metropolitan Statistical Areas (MSAs)	10,464
Rural	8,177
Subregions of the TTC Study Area[2]	
• Eastern	9,443
• Midwestern	10,295
• Western	9,561
TOTAL US	**$11,013**

NOTES:
1 Terminal MSAs include Los Angeles, Baltimore, and Washington, DC.
2 Eastern portion is east of the Mississippi River; Midwestern portion extends west up to Colorado and Utah; and Western portion includes these states and those in the west.

significant leakage of income also occurs. For example, retail facilities in metropolitan areas attract rural consumers because of the lower prices that volume sales and competition bring about. Generally speaking, the more quickly and easily people from rural areas can journey to these shopping opportunities, the greater will be exodus of rural dollars.

There is considerable evidence that faster, higher capacity transportation facilities do not produce uniform economic gains along a corridor. Rural areas where all of the other necessary factors of production are present (labor, natural resources, capital), but access to makers is not good, stand to benefit the most. Stated differently, when transportation is an obstacle to growth, removing that obstacle can pay good dividends. But if other important elements are missing, improvements to a transportation corridor are not likely to stimulate rural economic development.

OVERALL ECONOMIC DEVELOPMENT EFFECTS

The multi-billion dollar construction project in the TTC region would temporarily stimulate the economy. As many as 190,000 construction-related jobs would be temporarily brought to the Corridor, according to the REMI model. Construction jobs are not net gains in the US economy, however; they constitute transfers from those paying user fees and taxes to those carrying out the construction. Construction-related employment is not a justification for undertaking a project.

An upgraded TTC would experience an improved competitive position due to lower transportation costs than previously existed. The number of jobs, as well as wages paid and value added, would not be extremely large, particularly when distributed over the 4,500 km corridor. In percentage terms, all of these three key measures would increase by one percent or less. Essentially all these gains to the TTC would come at the expense of other parts of the US.

Per capita income varies considerably within the TTC. MSAs, particularly those at either end, have comparatively high per capita income levels. As tends to be true nationally, rural per capita income within the TTC is quite low. An argument could be made for initiating government action to raise the incomes in these rural areas.

Previous research, however, indicates that building major transportation facilities through rural areas is unlikely to stimulate economic development in them. By far the preponderate share of economic activity attracted to the corridor would locate in metropolitan areas, particularly the larger ones.

Chapter 11
FINANCIAL VIABILITY

INTRODUCTION

The purpose of the financial viability analysis was to assess the cost to the public sponsors of building the proposed Transamerica Transportation Corridor (TTC). The analysis examined the comparative viability of alternative transportation technologies, including an assessment of the project costs, the potential project revenues, the project financing options, and the funding requirements of each option. The technology options investigated were:

- Alternative A: Conventional Interstate-type Highway
- Alternative B: Upgraded Railroad (Tilt-Train)
- Alternative C1: Super Highway with No Competing East-West Super Highway
- Alternative C3: Super Highway Competing with Two Other East-West Super Highways
- Alternative D1: Very High-Speed Rail (e.g., French TGV)
- Alternative D2: Maglev Train

The cost to the public project sponsors of each of the above transportation options was measured by calculating the revenue requirement remaining after the debt capacity resulting from the operation of the facility is exhausted. In other words, the toll or fare revenues from the TTC were used to support the maximum amount of 30-year revenue bonds and the remainder of TTC's costs (the revenue requirement) must be financed by other, probably public, means. The revenue requirement for each of the alternative scenarios was used to determine general financial viability for the technologies as well as for comparisons between the technologies. Calculation of this revenue requirement was based on assumptions regarding the project construction costs, levels of usage on the corridor, levels of toll or farebox revenues, operating costs, and the overall operation or staging of the corridor's development.

Methodology and Assumptions

A financial viability analysis is only as good as the cost and revenue information that goes into it. This analysis is conceptual and hypothetical in that the costs, revenues, and pricing of services were based on macro level travel modeling and unit costs rather than specific observations, design specifications, and detailed travel modeling. Moreover, the price and value of high-tech transportation systems, including advanced IVHS and magnetic levitation, is still speculative. Finally, simplifying assumptions had to be made regarding the cross-subsidization among TTC facilities, modes of transportation, and technology services. Therefore, the reader should take care in interpreting the results of the financial analysis, noting that the actual costs and/or revenues, as well as the required subsidies, might be significantly higher or lower than the estimates used in this analysis.

For preparation of this analysis, the following assumptions were relied upon:

- construction costs and construction period for each type of technology;
- operating and maintenance cost projections for each alternative;
- car, truck, rail, and freight usage levels of the corridor for each alternative;
- operating revenue projections for each type of technology, including toll and farebox revenues, concession revenues, joint-use revenues, and other revenues;
- possible financing packages to raise funds for the corridor through bond issues.

CONSTRUCTION COSTS

Construction costs of the different analysis corridors for each technology, as illustrated earlier in this report, were averaged to develop a representative cost per km for the technology alternatives for use in this financial viability analysis. The total and per km construction costs were then used for the financial viability tests reported below. A construction period of three years was assumed for all portions of the TTC, representing the average time needed for the construction of a segment of the TTC. A linear drawdown of the construction costs was assumed, distributing the costs equally among the three years. For the sake of comparison and analysis, the public funding of the revenue requirement was assumed to also come over the three-year period. Using a different financing period for the public funding of the revenue requirement would not change the results significantly.

Several construction costs were broken out from the total construction costs to estimate the impacts on the financial viability of the TTC of public/private donation or contribution of these facilities. The construction costs broken out in this detailed analysis were: right-of-way costs, which may be donated for the TTC; vehicle costs for the rail technologies, which may be privately-financed or provided by an operating company for the TTC; and terminal and maintenance costs for the rail technologies, which also may be privately-financed by private operators. Toll collection facilities and intermodal facilities were not included in the construction costs; these facilities may also may be privately-financed. Neither these costs nor the revenues resulting from the operation of these facilities were included in this analysis.

The costs of the facilities that may be publicly/privately donated or contributed were deducted from the construction costs in the financial assessment. Any donation of right-of-way for the TTC was assumed to occur in the first year of the three-year construction drawdown. Any donation or private financing of vehicles was assumed to occur in the third year of construction. Any private financing of terminal and maintenance facilities was assumed to occur in the second and third years of construction.

Right-of-way, vehicles, terminals, and maintenance facilities were separated from other project costs to provide additional detail for an investigation of financing options such as private development, public-private partnerships, vendor financing, and donated right-of-way. These construction cost line items were broken out based on per km construction costs for each of the alternatives.

OPERATING AND MAINTENANCE COSTS

The total O&M costs for the entire TTC (assuming all km are complete) are presented for each alternative scenario earlier in this report. For Alternatives B, D1, and D2, the O&M costs include maintenance and administration and passenger operations. No costs for freight operations on the upgraded rail were included. Any freight-only operations were assumed to be operated on a cost-recovery basis.

The O&M costs for Alternatives A, C1, and C3 do not include the O&M costs of intermodal and toll collection facilities. Due to their exclusion, it is assumed in this analysis that these costs will be privately, or otherwise, financed.

Due to the use of existing highways, which is expected to require lower O&M costs, the O&M costs for Alternatives A, C1, and C3 are lower than the estimated costs of operating and maintaining the new segments of the TTC. The O&M costs for operating the new segments of the TTC under these scenarios are $20,886, $31,354 and $31,354 per km ($33,612; $50,458; and $50,458 per mile), respectively.

At eight public toll roads surveyed, operating and maintenance costs averaged $151.6 thousand per km ($243.9 thousand per mile), ranging from approximately $31 thousand to $385 thousand per km ($50 thousand to $620 thousand per mile). This is markedly higher than the $14.7 thousand per km ($23.7 thousand per mile) assumed for TTC Alternative A (Conventional Interstate-type Highway). However, the longest system, Oklahoma Turnpike, had one of the lowest per km operating and maintenance costs $37 thousand per km ($60 thousand per mile), which may indicate that a long system such as the TTC would enjoy economies of scale in administration and operations.

CORRIDOR USAGE FORECASTS

Earlier in this report the traffic forecasts for the TTC are described. These forecasts were made for the car, truck, rail, and freight traffic traveling on the TTC in the year 2040. Estimates were also made of the traffic that would have traveled on the TTC if it had been operating in 1990. By linearly interpolating these traffic forecasts, annual TTC usage forecasts were calculated.

In addition to using the total corridor usage figures, the analysis used subsets of the total corridor forecasts to estimate the corridor usage for a staged implementation of the TTC. Therefore, toll and farebox revenues could be estimated for portions of the TTC as they are constructed, rather than only for the entire corridor. The total corridor usage forecasts were allocated to the staged parts of the corridor according to estimates of car flows crossing screenlines placed across the corridor in various locations along the corridor routes. The proportion of these screenline car flows crossing each screenline was used to estimate the proportion of total traffic travelling over that segment of the corridor route. The screenline car flows for each of the alternatives are presented earlier in this report.

TOLLS

The assumed tolls for the tolled TTC under Alternatives A and C were as follows:

- Car tolls for the conventional interstate-type highway and the non-instrumented lanes of the super-highway were $0.0201 per km ($0.0323 per mile) in 1991 dollars.
- Truck tolls for the conventional interstate-type highway and the non-instrumented lanes of the super-highway were $0.0689 per km ($0.1109 per mile) in 1991 dollars.
- Car tolls for the instrumented lanes of the super-highway were $0.0401 per km ($0.0646 per mile) in 1991 dollars.
- Truck tolls for the instrumented lanes of the super-highway were $ 0.1378 per km ($0.2218 per mile) in 1991 dollars.

FARES

The assumed average rail fares may be represented as a function of distance in F = $15 - $0.0078 x K, where F = the on-way rial fare per 100 km of travel and K = the distance between origin and destination cities, in km (F = $24 - $0.02 x D where F = the fare per 100 miles and D = the distance in miles). For Alternative B, the frequency distribution of trip lengths was used to calculate an average trip length of 726 kms (451 miles); therefore, the assumed rail fare was $9.31 per 100 kms ($14.98 per 100 miles).

The fare for the very-high-speed rail or maglev transportation technology of Alternative D was assumed to be the midpoint of the average rail fare described earlier and the average air fare. Average non-discounted air fares may be represented as F = $51 - $0.0109 x D where F = the one-way coach fare per 160 kms (100 miles) of travel and D

= the distance between origin and destination cities in km. The equation to calculate the TTC fare for Alternatives D1 and D2 is F = \$37.50 - \$0.01545 x D. For Alternatives D1 and D2, the frequency distribution of trip lengths was used to calculate an average trip length of 750 kms (466 miles); therefore the assumed very-high-speed rail or maglev fare was \$18.83 per 100 kms (\$30.30 per 100 miles). The actual Alternative D1 and D2 fares will depend on marketing; aggressive marketing may be required to achieve these assumed fares.

REVENUE FORECASTS

Toll revenues were forecast based on the assumed toll rates and estimated traffic levels for Alternatives A, C1, and C3. Rail farebox revenues were forecast based on the assumed fare and projected passenger levels for Alternatives B, D1, and D2. To test the reasonableness of the toll revenue estimates and to determine the magnitude of other sources of revenue, a survey was conducted of 14 public intercity toll roads across the United States. Toll road revenues include: passenger and commercial tolls, gas and restaurant concessions, joint uses of the right-of-way, and other revenues. The same levels of concession, joint use, and other revenue were assumed for the rail alternatives, although the specific types of concessions may be different. Exhibit 11-1 summarizes the results of the survey.

Toll Revenues

The largest source of revenue on the toll road systems surveyed was toll revenue. On average, toll revenues accounted for 95.4 percent of total revenues. The average toll revenue was \$519.6 thousand per km (\$836.2 thousand per mile). In comparison, the assumed TTC toll revenue of roughly \$171 thousand per km (\$275 thousand per mile) (in 1993 dollars for the year 2000) seems reasonable: the 13 systems surveyed are higher volume commuter and inter-city toll roads than the TTC.[1] Toll revenues varied from under \$124 thousand per km (\$200 thousand per mile) on the Oklahoma and Kansas Turnpikes to about \$1.7 million per km (\$2.7 million per mile) on the Delaware and New Jersey Turnpikes. Delaware has a short route (18 kms; 11 miles),

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1 The estimate of \$171 thousand per km (\$275 thousand per mile) applies to Alternative A and is based on projected traffic levels and toll rates of \$0.019 per VKmT (\$0.03 per VMT) for passenger vehicles and \$0.068 per VKmT (\$0.11 per VMT) for commercial vehicles.

Exhibit 11-1
ANNUAL TOLL ROAD REVENUES
(Revenues per tolled route-mile, $000)

TOLL ROAD SYSTEM	Tolls	Concessions	Joint Uses	Other	Total Revenues[1]
Delaware Turnpike	2,724	164	0	8	2,897
Florida Turnpike	632	24	0	0	656
Illinois Toll Highways	951	15	1	0	968
Indiana Toll Road	391	30	1	1	423
Kansas Turnpike	179	2	2	0	184
Maine Turnpike	328	17	N/A	N/A	345
New Hampshire Turnpike	784	0	0	0	785
New Jersey Turnpike	2,649	92	2	6	2,748
Garden State Parkway	952	67	N/A	13	1,032
New York State Thruway	612	14	1	0	627
Ohio Turnpike	347	24	2	0	372
Oklahoma Turnpikes	148	2	N/A	N/A	150
Pennsylvania Turnpike	560	14	N/A	N/A	574
West Virginia Turnpike	450	9	0	0	459
AVERAGES	**836.2**	**36.5**	**1.0**	**2.6**	**876.3**

(1) Numbers may not add due to rounding.

but the high percentage of through traffic (95 percent) allows it to capture greater revenues.

Passenger tolls accounted for a greater portion of revenues than commercial tolls, but this varied widely from system to system. Of the average toll revenue of $519 thousand per km ($836 thousand per mile), approximately $331 thousand per km ($532 thousand) came from passenger tolls, while $189 thousand per km ($304 thousand) were from commercial tolls. For the TTC, approximately 60 percent of toll revenues are assumed to be from passenger tolls, with the remaining 40 percent from commercial tolls. The Maine and New Hampshire turnpikes had a significantly lower than average proportion of commercial traffic and revenues. In these States, tourism and commuting in the main metropolitan areas predominate, while there is relatively little commercial through traffic.

Commercial traffic averaged 18.8 percent of total vehicles, or slightly less than one in five vehicles.[2] This analysis compares with the assumed TTC truck traffic equal to 20 percent of car traffic, or one in six vehicles.

The commercial toll revenue figures include charges for special truck permits (overweight, over-dimension, special materials, etc.). Commercial and passenger figures also reflect special commercial charge account programs, volume discounts, and commuter toll programs.

Concession Revenues

Toll road concessions for the operation of rest areas were also a significant source of revenue. Concession revenues averaged $22.7 thousand per km ($36.5 thousand per mile), of which $7.5 thousand per km ($12.1 thousand) were from gas station concessions and $15.2 thousand per km ($24.4 thousand) were from restaurant concessions. Gas station franchises pay an average of 7 cents per delivered gallon, while restaurant concessions pay an average 12 percent of gross sales. Sometimes, higher rates are charged to franchises in locations with higher traffic levels. The concession contracts often specify graduated scales for these rates. Concessions on some toll roads are operated by a single concessionaire such as Marriott or Exxon, while some toll roads bid each site separately. Concession revenues are assumed to be the same for rail. Although there would be no gas concessions, additional revenue would be derived from rail-specific concessions such as food, phone, and advertising concessions on railcars and parking or rental car concessions at stations. For the TTC concession revenue forecasts, $22.7 thousand per route-km ($36.5 thousand per route-mile) were assumed.

Joint Use Revenues

Many toll roads derive additional revenue through joint uses of their rights-of-way by utilities and communications companies. These joint uses may include fiber optic lines, electric lines, oil or gas pipelines, and water/wastewater

[2] A ratio of 1 commercial vehicle to 4.3 passenger vehicles was the average of five systems for which traffic data were available.

pipelines. The West Virginia Turnpike derives some revenue from coal mining and timber harvesting on turnpike lands.

The toll roads surveyed derived an average of $0.62 thousand per km ($1.0 thousand per mile) from joint use revenues. Fiber optic cable was the most important type of joint use. While revenues varied from 0 to $1.3 thousand per km (0 to $2.1 thousand per mile), the assumed joint use revenues for the TTC are $1.2 thousand per km ($2.0 thousand per mile). This level has been achieved by toll roads in Kansas, New Jersey and Ohio with longer rights-of-way and effective marketing programs. The TTC right-of-way would be attractive to potential users and aggressive marketing should tap this potential.

The ability of a toll road to attract parallel uses depends on the importance of markets near the toll road, the security of the right-of-way, and the cost of alternative rights-of-way. For example, the Kansas Turnpike Authority derives over $1.2 thousand per km ($2.0 thousand per mile) from land easements for fiber optic telecommunications cable because 80 percent of the State's population lives within 32 km (20 miles) of the turnpike, companies can obtain a single, continuous right-of-way for the entire distance, and cables are more secure from being accidentally severed. Some toll roads are able to attract parallel uses over the entire length of the right-of-way, while others derive more modest revenues from discrete crossings of pipelines and cable under the right-of-way.

Toll roads vary widely in their approach to parallel uses of the right-of-way. Some have simply granted right-of-way encroachment permits or require nominal annual permit fees, while others negotiate more sophisticated leases and easement contracts. Some toll roads are more aggressive in marketing their rights-of-way to potential users. Others have not been able to attract joint uses.

Other Revenues

The most common revenue sources in this category were telephone commissions and advertising. Other revenues ranged from 0 to $8.0 thousand per km (0 to $12.9 thousand per mile) and averaged $1.6 thousand per km ($2.6 thousand per mile). The average of the 13 toll roads surveyed was affected by one extremely high value from the Garden State

Parkway. Other revenues for the TTC were assumed to be $0.62 thousand per km ($1.0 thousand per mile).

Commissions on telephone coinbox revenues ranged from 0 to $125 thousand per toll road. Advertising revenues from billboards and logo signs ranged from 0 to $30 thousand per toll road. Florida's turnpike raised $63 thousand in advertising revenues through an innovative concession for travel-related brochures and information.

Several types of non-operating or non-recurring revenue were not included in our per km estimates, such as interest income (which ranged from $1 million to $18 million); the sale of property and investments; and reimbursements for damages, procurement specifications, and the use of equipment.

FINANCIAL ASSESSMENT

This section presents financing plans for the costs of the six alternatives included in the analysis. Sources of financing include tax-exempt revenue bonds, interest income on available balances during construction and operation, and various potential public funding sources. The possible public sources of funding for the TTC will be discussed in further detail in the following sections. The financing plan is only intended to demonstrate the general level of public funding that will be required for the TTC, rather than identifying specific sources to provide this funding.

As presented in the tables, the amount of public funding required represents the net revenue requirement after tax-exempt revenue bonds have been issued and other available revenue sources have been included. The tax-exempt revenue bond financing program assumes a three-year construction period for any portion of the TTC. Bonds would be issued at a 6.5 percent interest rate for a 30-year term with three years of capitalized interest. A deposit to the debt service reserve fund equal to one year's principal and interest would be made at the time of sale. Issuance costs are assumed to be 2 percent of the total issue. A coverage of 1.25 is assumed to be maintained for the life of the bonds. Interest income assumes a 5 percent return on available balances in the construction, operating, and capitalized interest funds, and a 6 percent return on the available balance in the coverage, operating and maintenance reserve, and debt service reserve funds.

Financing the Entire System

The scenarios were first analyzed to determine the public funding necessary to construct the entire corridor simultaneously. Bonds would be issued to finance the costs of the entire corridor (either in one issue or in multiple jurisdictions simultaneously) with land acquisition and construction beginning immediately and the facility opening three years later. The actual marketability of the bonds was not assessed. The scenarios are simply intended to illustrate what may be feasible and the levels of public funding necessary for feasibility.

For Alternative A, bonds were assumed to be issued and construction was assumed to begin in 1997 with the conventional Interstate-type highway opening in the year 2000. For Alternative B, bonds were assumed to be issued and construction was assumed to begin in 2000 with the conventional rail TTC opening in 2003. For Alternatives C1, C3, D1, and D2, bonds were assumed to be issued and construction was assumed to begin in 2010 with the TTC opening in 2013.

All of the additional revenue necessary to finance each of the alternatives was assumed to come from public funding. The potential sources of this public funding will be discussed in the following sections. The public funding, or revenue requirement for each alternative, appears in Exhibit 11-2 and is presented in 1993 dollars. To minimize the public funding (in 1993 dollars) necessary for the project, revenue bonds were assumed to be issued to their maximum capacity and the funding was assumed to be obtained during the three-year construction period for each alternative. Additional public bond issues to raise the public funding necessary for the construction would spread the public funding requirement over time, but will cause the total public funding requirement to increase.

Alternative B does not include a figure for the revenue bond issue because, under this scenario, the TTC would not have positive net operating revenues. Therefore, in addition to the construction costs, the annual operating deficit must be paid. Thus, the least expensive way to pay for the total costs (in 1993 dollars) is to provide all of the necessary funding for construction at the time of construction and then to fund the annual operating deficit during the life of the facility. Bonds could be issued to raise this necessary

Exhibit 11-2
FINANCING THE ENTIRE CORRIDOR

ALTERNATIVE	Year of Bond Issue - Beginning of Construction	Bond Issue Amount - (future dollars) (billions)	Public Funding Requirement - ($ 1993 billion)	Percent Costs Financed by Tolls or Fares
A: Upgraded Highway	1997	$9.4	$11.6	41
B: Upgraded Rail	2000	N/A	$40.9	NA
C1: Super-Highway	2010	$76.4	$21.2	65
C3: Super-Highway	2010	$43.4	$35.1	39
D1: VHSR	2010	$31.4	$38.1	30
D2: Maglev	2010	$31.2	$65.0	20

funding, but doing so would increase the eventual public funding necessary (in 1993 dollars) above the minimum specified in the Exhibit.

Potential Public/ Private Donations or Contributions

A potential method of reducing the costs of constructing the TTC is the public or private donation of right-of-way. In addition, the private financing or donation of costs such as vehicles, terminals, and maintenance facilities for Alternatives B, D1, and D2 will potentially reduce the public funding requirement of the alternatives. The impacts of factoring out the costs for right-of-way, vehicles, terminals, and maintenance costs are illustrated in Exhibit 11-3.

If the public funding requirements in Exhibit 11-3 are compared with the public funding requirements calculated earlier for the entire system, the impacts of the public or private donations and contributions are illustrated. For example, the public funding requirement for Alternative A was reduced from $11.6 billion to $11.1 billion and the public funding requirement for Alternative C2 was reduced from $21.2 billion to $20.0 billion. For each of the alternatives, the public/private donations or contributions provide cost savings of approximately 5 percent of the public funding requirement.

Staging of Construction

Attempting to build the entire TTC in one three-year period as illustrated above may not be reasonable. From an engineering and development standpoint, obtaining all of the necessary land, building the entire system through a series of

Exhibit 11-3
FINANCING WITH PUBLIC/PRIVATE DONATION OR CONTRIBUTION

ALTERNATIVE	Year of Bond Issue - Beginning of Construction	Bond Issue Amount - (future dollars) (billions)	Public Funding Requirement - ($ 1993 billion)	Percent Costs Financed by Tolls or Fares
A: Upgraded Highway (w/o ROW costs)	1997	$9.3	$11.1	42
B: Upgraded Rail (w/o ROW, vehicles, terminals, maintenance facility costs)	2000	N/A	$39.1	NA
C1: Super-Highway (w/o ROW costs)	2010	$76.3	$20.0	66
C3: Super-Highway (w/o ROW costs)	2010	$43.7	$34.1	40
D1: VHSR (w/o ROW, vehicles, terminals, maintenance facility costs)	2010	$31.5	$35.9	31
D2: Maglev (w/o ROW, vehicles, terminals, maintenance facility costs)	2010	$31.4	$62.2	21

contracts with different construction firms across the country, and ensuring coordination and continuity through the entire system may not be feasible for such an enormous project. Breaking the corridor into smaller segments and phasing in their construction should make the logistics of completing the project much simpler.

Likewise, breaking up the corridor will be more attractive from a financial standpoint. Using smaller segments for phased construction would result in a series of smaller bond issues which would make the bonds more attractive on the bond market. The bond market simply may not have the capacity to provide financing for the large bond issues resulting from financing the entire system at once. In addition, if the more cost-effective (higher traffic usage to construction cost ratio) portions of the corridor are built first, then the net operating revenues from these segments can assist in financing the construction of the later segments.

A preliminary phasing of the corridor construction was done for each alternative in order to illustrate the financial advantages of building the more cost-effective segments of the corridor first and putting off the construction more expensive and/or less heavily used portions of the TTC. The phasing assumptions used in this example analysis were based on representative alignments for each alternative. The use of representative alignments is not intended to indicate the attractiveness of the route or even the feasibility of the route. Representative alignments have been used simply for the purposes of analysis in order to show the potential effects of phasing on the public funding required for the TTC.

For Alternative A, the phasing was done with four bond issues made in 1997, 2000, 2003, and 2006, with each having its own three-year construction period. Assumptions regarding the segments constructed under each bond issue are listed below:

- 1997 issues: Simultaneous bond issues for the construction of the corridor from the western terminus in California into Utah and from Cairo, Illinois into Kentucky.
- 2000 issue: Mid-Colorado to Cairo, Illinois.
- 2003 issue: Kentucky to the eastern terminus in Virginia.
- 2006 issue: Mid-Colorado into Utah.

For Alternative B, the phasing was done with three bond issues made in 2000, 2003, and 2006 with each having its own three-year construction period. Assumptions regarding the segments constructed under each bond issue are listed below:

- 2000 issue: New Mexico to Kentucky.
- 2003 issue: the western terminus in California to New Mexico.
- 2006 issue: the eastern terminus in Virginia to Kentucky.

For Alternatives C1 and C3, the phasing was done with two bond issues made in 2010 and 2013 with each having its own three-year construction period. Assumptions regarding the segments constructed under each bond issue are listed below:

- 2010 issue: the eastern terminus in Virginia to Missouri.
- 2013 issue: the western terminus in California to Missouri.

For Alternatives D1 and D2, the phasing was done with three bond issues made in 2010, 2013, and 2016 with each having its own three-year construction period. Assumptions regarding the segments constructed under each bond issue are listed below:

- 2010 issue: Simultaneous bond issues for the construction of the corridor from the western terminus in California into Utah and from Missouri into Kentucky.
- 2013 issue: the eastern terminus in Virginia to Kentucky.
- 2016 issue: Missouri to Utah.

The traffic usage of the portions of the corridor was allocated according to the traffic screenline information presented earlier. The construction costs for each portion of the corridor were calculated according to segment-by-segment construction costs for all possible corridor segments.

By phasing construction, as was done for the hypothetical route segments illustrated above, the most cost-effective portions of the corridor would be built first and could help to finance the later construction of the subsequent segments. This analysis was done simply to illustrate the impacts of this type of phasing. A more detailed examination of the specific segments making up the route can be made using more specific traffic usage and cost information if further studies of the corridor are undertaken.

The results of the phased construction for each alternative are presented in Exhibit 11-4. As in the earlier analyses, the financing package for each alternative was structured to minimize the public funding required. Therefore, the public funding was assumed to be obtained during construction and represents the minimum funding necessary for the construction of the entire TTC after the revenue bonds have been issued to their maximum capacity.

Exhibit 11-4
FINANCING WITH STAGED CONSTRUCTION

ALTERNATIVE	Public Funding Requirement ($ 1993 billion)	Percent Costs Financed by Tolls or Fares
A: Upgraded Highway	$9.4	52
B: Upgraded Rail	$38.3	NA
C1: Super-Highway	$16.0	74
C3: Super-Highway	$30.7	47
D1: VHSR	$32.5	40
D2: Maglev	$59.3	27

As can be seen, the phased construction would provide construction savings over the public funding requirements identified in the "Financing the Entire Corridor" section above. For example, the public funding required for Alternative A was reduced from $11.6 billion to $9.4 billion and the public funding required for Alternative C1 was reduced from $21.2 billion to $16.0 billion.

METHODS FOR MEETING REVENUE REQUIREMENTS

Given the public funding requirements in the above section, the feasibility analysis includes an identification of possible sources to pay for this funding requirement. The possible sources include:

- Donated right-of-way - Public or private donation of right-of-way.
- Private participation - Vehicles, terminals, and maintenance facilities may be financed through private development, public-private partnerships, or vendor financing.

- Intermodal synergies and value capture - There are basically three modes of transportation that might operate in the TTC: highway, passenger rail, and freight rail. Airports have intermodal characteristics as well. This topic is discussed in the following section.

- Public funding - The most significant sources of funding for the TTC facility will most likely be state and Federal transportation funds. The fiscal capacity available for the construction of the TTC will be best approximated through examining the state and Federal budgets available for the TTC on a state-by-state basis. This is discussed more fully in a subsequent section of this Chapter.

INTERMODALISM

Airports - High Speed Rail

Financial synergies are generated when one mode or facility attracts traffic to another, as with the hypothetical high speed rail to hub airport link. The new TGV high speed intercity train terminal being built at Charles de Gaulle airport outside Paris is a good example of such synergies, with the financial benefit (and cost of the new station and rails) split between the additional air traffic for the airport and new rail passengers for the TGV. However, it is difficult to forecast these synergies without detailed regional traffic network analysis and a much more detailed picture of how Americans would react to a national high speed rail system.

An intercity high speed rail service that offers direct connections to major hub airports might attract more passengers than one that does not, and may even be so successful that some smaller airports along the high speed rail corridor would be put out of business, along with the commuter airlines that serve them. Such a shift, if it did occur without substantial government subsidies, would reflect a genuine increase in the efficiency of the national transportation system.

Air freight is time-sensitive and relatively valuable per pound; otherwise it would not be shipped by air. Once it hits the ground, the great majority of air cargo moves by short-haul truck, and even a doubling of highway or rail speeds is unlikely to change that delivery structure very much. After all, shippers would simply send the cargo directly to an airport closer to the cargo's ultimate destination rather than ship it by air and then put it on a long-haul truck or rail. The only exception to this rule might be for air freight shipped from overseas to major international entry airports, in which case medium-to-long haul overland freight may be a more efficient transfer than to an additional airplane/truck combination.

Truck - Rail

Intermodal truck-rail-truck facilities are probably the hottest trend in shipping in the 1990s. Most major railroads and even some trucking companies are investing in intermodal facilities, especially for double-stack containers. However, the market is still so competitive that stand-alone profit margins on these facilities are usually even more modest than the already low margins for the railroads themselves. For this reason, and also because the facilities are invariably privately owned, the added value of these facilities to the overall project financing is difficult to measure. For purposes of these financial analyses, it was assumed that these intermodal facilities were essentially break-even (i.e., the return on investment did not exceed the minimum return on investment required by the railroad company) and that no surpluses were generated for other components of the TTC. Therefore, all costs and revenues from intermodal facilities were left out of the financial model. A more detailed analysis may reveal better cross-subsidy opportunities.

Passenger Car - High Speed Rail

All intermodal connections between passenger car and high speed rail were assumed to be purely local, with parking revenues contributing slightly to reducing the subsidy required for the high speed rail service; i.e., long-haul car and long-haul rail combinations would not exist, except in limited "autotrain" service. Therefore, no material financial contributions from these types of connections were explicitly included in the financial model.

FISCAL CAPACITY FOR PUBLIC FUNDING

In addition to the total public funding requirement necessary for the TTC alternatives, the availability of public funding will help to measure the feasibility of the TTC project. To determine the fiscal capacity of states to support the project, the project's total funding requirement may be compared to the transportation budgets of the states contributing to the project.

This section examines four different methods of attempting to measure of the fiscal capacities of the states included in the financing of the TTC. The first measure is the level of state expenditures on highway and rail projects (rail expenditures are minimal at the State DOT level) as presented in FHWA's *1991 Highway Statistics*. The second measure is the current FY 1993/4 transportation budget for each of the states as received from discussions with the State Departments of Transportation. The third measure is the projected transportation budget for each of the states, as available, through FY 1997. The final measure examined Federal ISTEA apportionments of the 12 TTC states.

Each of the measures of fiscal capacity assume no exceptional future deviations from the current allocations. Currently, states receive funding according to planned and actual expenditures. Expenditures would not be the best measure of financial capacity should the funding of the TTC be made an exceptional case at the Federal level. However, current spending levels will function as a means of illustrating the magnitude of TTC's costs and as a measure of the financial capacity of the TTC states to pay for these costs given current funding trends and procedures.

Highway Spending from FHWA

One measure of fiscal capacity is current state expenditures on highway and rail projects. FHWA's Highway Statistics presents current spending in *State Receipts and Disbursements for Highways - 1991*.[3] Although rail spending is not included, state expenditures on rail are usually a very small fraction of highway spending. Exhibit 11-5 includes the 12 States sponsoring the TTC study.

Exhibit 11-5 also shows the portion of state expenditures used for construction and maintenance. By excluding annual administrative expenses, this portion provides a better measure of funds available to support a new transportation project.

State highway expenditures range from under $400 million per year to almost $2.8 billion per year and average $1.0 billion. The 12 TTC States have a total fiscal capacity of $12.1 billion, of which $8.0 billion is spent on construction

[3] Federal Highway Administration, *1991 Highway Statistics*, Table SF-21.

Exhibit 11-5
1991 STATE SPENDING ON HIGHWAYS
TTC SPONSORS
($000)

STATE	Total Highway Expenditures	Construction and Maintenance
Arizona	1,308,985	706,741
Arkansas	499,261	367,296
Colorado	754,915	513,133
Illinois	2,780,270	1,821,834
Kansas	692,962	452,761
Kentucky	1,052,356	654,244
Missouri	989,199	592,575
New Mexico	398,957	297,830
Oklahoma	851,899	543,530
Utah	342,026	238,595
Virginia	1,736,514	1,277,484
West Virginia	714,084	513,918
TOTAL	**12,121,428**	**7,979,941**

SOURCE: FHWA, *1991 Highway Statistics*, Table SF-21

and O & M. From this total fiscal capacity figure, the fiscal capacity available for a specific route will depend on the states involved in the funding for that route as well as their level of participation.

Exhibit 11-6 presents the expenditures of seven other states which the TTC route may affect: California, Indiana, Maryland, Nevada, Ohio, Tennessee, and Texas.

These seven states have budgets totalling $14.4 billion, of which $8.6 billion is spent on construction and O&M. Only minor portions of the TTC route are expected to pass through some of these states, so this pool of funds may not represent additional fiscal capacity.

For all 19 states, including both TTC sponsors and non-sponsors, the total fiscal capacity is $26.5 billion per year.

Exhibit 11-6
1991 STATE SPENDING ON HIGHWAYS
Seven Other States
($000)

STATE	Total Highway Expenditures	Construction and Maintenance
California	4,793,175	2,477,964
Indiana	1,268,887	845,662
Maryland	1,240,815	679,318
Nevada	244,539	152,574
Ohio	2,685,975	1,318,603
Tennessee	1,108,882	748,905
Texas	3,039,220	2,399,965
TOTAL	**14,381,493**	**8,622,911**

SOURCE: FHWA, *1991 Highway Statistics*, Table SF-21

Transportation Budgets of TTC States

To obtain more current budget information and to determine trends for future levels of funding, a survey was conducted of state transportation officials in the 12 TTC sponsor States. Exhibit 11-7 presents state revenues and expenditures for transportation for the latest fiscal year (FY 1993/4).

Based on current budget information provided by the 12 TTC states, the total expenditures on highways and rail amount to $9.5 billion. Exhibit 11-7 indicates that state spending is approximately equal to the revenues available. The revenues include Federal, state, and local sources but exclude bond revenues. Expenditures include spending on highways and railroads but exclude aviation and port expenditures, portions of which may also be dedicated to the intermodal aspects of the TTC. The O&M/Construction column shows the portion of state expenditures allocated to construction, maintenance, and operations. This category excludes general and administrative expense, debt service, and other costs to provide a better estimate of the fiscal capacity. These figures were provided by state transportation officials and the budgets may differ in categorization from state to state.

Exhibit 11-7
STATE TRANSPORTATION BUDGETS
12 TTC STATES
($000)

STATE	Revenues	Expenditures	Construction, O&M	Percent Construction and O&M
Arizona	482,380	503,340	N/A	71.7%
Arkansas	505,126	493,491	480,618	97.4%
Colorado	560,156	569,848	554,698	97.3%
Illinois	N/A	1,016,094	N/A	N/A
Kansas	601,927	503,960	414,653	82.3%
Kentucky	1,224,622	1,299,261	1,071,190	82.9%
Missouri	1,005,000	965,000	744,000	77.1%
New Mexico	516,915	555,275	N/A	N/A
Oklahoma	627,763	588,188	518,291	88.1%
Utah	390,426	382,799	363,223	94.9%
Virginia	N/A	1,685,974	N/A	N/A
West Virginia	884,450	969,222	868,026	89.6%
TOTAL	**9,500,833**(2)	**9,532,452**	**8,202,967**(3)	**86.8%**

(1) Arizona has a sales tax that is used for transportation purposes, which is not included in the revenues figure.
(2) Illinois and Virginia revenues are assumed to be equal to expenditures.
(3) This sum includes estimates of construction and maintenance spending for N/A cells. The value of N/A cells was calculated by multiplying total state expenditures by 86.8 percent, the average portion spent on construction and maintenance for the other states surveyed.

SOURCE: State Departments of Transportation for the latest fiscal year (FY 1993/4)

To determine fiscal capacity when the TTC is initiated after 1997, future budget trends in each state must be examined. The budgets and revenue trends in each state are described briefly below, as noted in the discussions with transportation officials in each state.

Arizona

Total Arizona highway revenues are $706 million, of which slightly over half is retained by the Arizona Department of Transportation (ADOT) and the remainder is distributed to local governments. The expenditures include $500 million for highways and $336 thousand for rail. Approximately 72 percent of the budget is spent on maintenance, construction, and operations. Based on ADOT projections, total highway revenues will increase 15 percent to $812 million in FY 1997/8 and 39 percent to $979 million in FY 2001/2.

Arkansas

Federal receipts comprise approximately 50 percent of Arkansas revenues for transportation. Of the $518 million budget, $331 million is spent on construction, maintenance, and operations. The budget includes a small amount of rail rehabilitation and construction. A projected 5 percent reduction in Federal revenue by 1997 would reduce the budget to $511 million.

Colorado

The Colorado Department of Transportation's programmed 1994 funding of $560 million includes approximately $270 million from the Federal government. Revenues are expected to decrease to $519 million by 1996 and capital and maintenance expenditures to $500 million.

Illinois

Illinois' five-year highway program totals $5.05 billion for the five years. Federal revenues fund approximately 63 percent of the budget. The transportation budget includes an annual $15 million rail budget for passenger and freight services.

Kansas

Revenues of $602 million do not include $375 million from bond sales. Projected 1993 expenditures are $504 million for maintenance, construction, and local support. Revenues are expected to increase 35 percent to $682 million in 1997 but will fall back to $650 million in 2002.

Kentucky

Kentucky's requested FY 1993 funding of $1.2 billion comes from the state general fund, federal funds, and the road fund but do not include revenues from highway bonds. Total expenditures are $1.3 billion. Excluding debt service and G & A leaves $1,071,190 for capital, operating, and maintenance spending, including $866 million for highways, $487 thousand for rail. These figures exclude $5.9 million for air transportation. Expenditures are expected to decrease to $1.1 billion in 1996. Capital and maintenance spending is projected to decrease to $876 million in 1996.

Missouri

Of $965 million in 1993 disbursements, $744 million, or 77.1 percent, is used for construction and maintenance in Missouri. Total spending is projected to increase by 15 percent to 1997, slightly faster than revenues. Expenditures will reach $1.1 billion, while construction and maintenance will total $851 million.

New Mexico

New Mexico's $517 million in FY 1993/4 revenues includes the general fund, other state funds, Federal funds, and cash. Of the $555 million budgeted appropriations for fiscal year 1993/4, $410 million are to be used for road betterments. This does not include $1.6 million for aviation.

Oklahoma

Oklahoma's expenditures of $588 million for highways and rail include several large county programs. Of this amount, $518 million, or 88.1 percent, is used for construction, maintenance, and operations.

Utah

The FY 1993 adjusted budget of $390 million for highways and rail does not include 9.5 million in bonds. A large portion of the budget, $363 million or 94.9 percent, is used for construction, maintenance, and operations. Both revenues and expenditures are expected to decline by $22 million in FY 1994.

Virginia

The FY 1993/4 improvement program for maintenance, public transit, and construction totals $1.7 billion. Projected spending for FY 1996/7 is $3 million lower, but recovers to the same level in FY 1997/8.

West Virginia

The projected FY 1993/4 expenditures of $969 million include $967 million for highways and $2 million for rail. The portion spent on construction, maintenance and operations is $868 million, or 89.6 percent. By FY 1996/7, expenditures are expected to decrease to $916 million, and capital spending to $826 million.

Future State Fiscal Capacity

Based on the state budget projections described above, total state spending on highways and rail in the 12 TTC states is estimated to be $9.5 billion in 1997.[4] Of this amount, $8.2 billion would be spent on construction, maintenance, and operations.

Federal Funding

Federal ISTEA funding for the 12 TTC states, estimated at $2.7 billion for FY 1994, represents 28.4 percent of total state funding for highways and rail in these states ($9.5 billion).

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[4] Spending in states for which no projections were available is assumed to remain constant in 1993 dollars.

State ISTEA apportionments for 1994, as estimated by FHWA, are presented in Exhibit 11-8 for the 12 TTC sponsors. Future ISTEA apportionments are expected to remain at the same levels.[5]

Exhibit 11-8
1994 ISTEA FUNDING
PRELIMINARY ESTIMATES

STATE	ISTEA Funding	Total State Revenues
Arizona	180,832	482,380
Arkansas	148,840	518,265
Colorado	201,165	1,545,466
Illinois	533,725	N/A
Kansas	183,473	601,927
Kentucky	222,111	1,224,622
Missouri	315,125	1,005,000
New Mexico	138,757	516,915
Oklahoma	195,979	627,763
Utah	123,709	390,426
Virginia	295,002	N/A
West Virginia	158,853	884,450
TOTAL	**2,697,571**	**10,499,282**

DETERMINING STATE SHARES OF PUBLIC FUNDING

Once the public funding requirement has been determined, responsibility for meeting this amount must be allocated among the states. Each state's share of the public funding requirement may be based on the extent of TTC's presence in the state, the ability to pay, or the benefit received. Specifically, funding responsibility may be allocated according to each state's:

- percentage of total TTC route-km
- percentage of total TTC construction costs
- percentage of total TTC vehicle-km traveled

5 Table T-94 Preliminary, "Estimated FY 1994 Federal-Aid Highway Program Apportionments under P.L. 102-240." ISTEA apportionment statistics provided by FHWA, Office of Policy.

- share of total fiscal capacity
- economic benefits.

These different allocation mechanisms are discussed below.

Route Kilometers

If each state were to pay a given amount per route-km within its borders, states with longer portions of the TTC route would pay a greater share of the cost than those with minor portions. However, under this method states with mountainous terrain (and higher per km costs) would pay the same amount per km as states with flat, inexpensive routes. Furthermore, high traffic, high revenue states would pay the same per km as low traffic states.

Construction Costs

Each state may pay in proportion to the share of total project costs within its borders. This method takes into account differences in terrain as well as length.

Vehicle-Km Traveled

Each state may pay in proportion to the share of total vehicle-km traveled within its borders. States with high levels of traffic on the TTC will contribute more in project revenues than states with low traffic.

Fiscal Capacity

A state's ability to pay may be a factor in allocating funding. Although a state's portion of the TTC may cost a great deal, and, likewise may benefit the state a great deal, if funds are limited and budgets contracting, the state's share may be reduced. Using this allocation mechanism places more of the costs with the states having larger available budgets or greater ability to pay

Economic Benefits

Ultimately, public support for the project will have to be justified by the public benefits it creates for taxpayers. Beyond the revenues the project generates, there are economic development impacts, environmental benefits, and other public benefits created by this project. States may choose to provide funding up to the level of the returns to the state. The economic benefits of the TTC project are discussed in Chapters 8, 9 and 10 of this report.

CONCLUSIONS

As this chapter has illustrated, tolls and fare revenues would offset the costs of the TTC to a significant extent. However, the revenue requirements presented in this chapter for the various alternatives and the different scenarios for each of the alternatives still present enormous costs to be covered by Federal, State, or other sources.

As compared to the $9.5 billion expenditures figure for the 12 TTC states, the most financially viable scenario examined (Alternative A with Staged Construction) would cost nearly one year's expenditures for every TTC state. If this cost is spread over a three-year construction period, all 12 of the states would have to increase their transportation budgets by 33% for each of the three years. The other alternatives would require all 12 of the states to increase their transportation budgets by the following amounts for each of the three years: Alternative B, 132%; Alternative C1, 55%; Alternative C3, 108%; Alternative D1, 114%; Alternative D2, 208%. These percentages assume that **every** state increases its budget by the same percentage. In reality, if TTC costs were allocated according to the segments within each state, some states would face much greater increases in their required budgets. Since, at this point, no specific TTC route has been selected, costs cannot be allocated to specific states for this analysis.

Of course, gas-tax-backed bonds or other financing mechanisms could spread the revenue requirement over 10 or 12 years. According to FHWA's *1991 Highway Statistics*, the 12 TTC states currently average approximately 17.7 cents per gallon collected in gas tax revenues. This average would have to increase anywhere from 1 to 7 cents per gallon every year for the 10 or 12 year period with the difference dedicated exclusively to the TTC in order to pay for the staged construction alternatives. As described above, allocating costs among the 12 states would require much greater increases in the gas tax rates for some states.

Increasing **all** of the 12 TTC state budgets by the above percentages is not very realistic given the current expenditure trends and procedures. The revenue requirements presented here cannot be met by the states and their current budgets alone. Such an increase needs a national commitment to the TTC at the Federal level.

Chapter 12
OTHER IMPACTS AND IMPLICATIONS

The feasibility assessments made in the previous chapters focus primarily on the economic considerations for construction of a total coast to coast TTC facility. This section addresses the impacts and implications of safety, energy, and the environment.

SAFETY

Based on current conditions, technologies, and statistics, a passenger using a TTC automobile alternative would be more likely to experience an accident or fatality than an occupant in a TTC rail alternative. (See Exhibit 12-1.) The death rate for the passenger automobile is currently over 37 times higher than that for railroad passenger trains, airlines, and intercity buses. Highway fatalities are lower in urban areas as compared to rural.

Exhibit 12-1
DEATH RATES PER MODE
1988 - 1990

	Average Death Rate*	
Passenger Automobile	1.80	(1.12)
Railroad Passenger Trains	0.05	(0.03)
Scheduled Airlines	0.03	(0.02)
Intercity Buses	0.02	(0.01)

* Based on deaths per 100 million passenger-km (passenger-miles).

SOURCE: Accident Facts, National Safety Council, 1990.

However, projecting safety impacts into the 21st Century requires consideration of more than projections of current trends.

Since the 1970's, fatal motor vehicle accidents have declined nearly 20 percent. Annually, however, fatalities total over 45,000 and injuries total over 4 million. Less than 1,000 individuals die each year from passenger rail accidents, but total passenger rail travel represents only a fraction of the total passenger-km traveled.

Highway Alternatives

In the coming decades, the advantages of new safety features for motorized vehicles (ranging from antilock brakes and airbags to IVHS technology) will become more significant as their availability in the vehicle universe increases. Yet, these effects could be offset to some degree by other factors. Safety, in general, will be affected by more vehicles on the road, a growing population of older drivers, an aging highway infrastructure, lighter passenger vehicles, and more LCV (longer combination vehicle) trucks. A purpose of the TTC Highway alternatives is to design a technology from a safety standpoint that is sensitive to such positive and negative safety issues as these summarized in Exhibit 12-2.

Exhibit 12-2
SAFETY ISSUES - HIGHWAY ALTERNATIVES

POSITIVE	NEGATIVE
• Continued use of seatbelts, airbags, antilock brakes prevents or decreases accident severity.	• Higher speeds increase crash risk and severity.
• Use of basic IVHS technology decreases crashes due to driver error.	• Possibility of driver information overload.
• Improved highway design and separation of auto/truck traffic improves passenger safety.	• Trend toward lighter cars and larger trucks increases auto crash severity.
• Fewer drivers in high risk groups (Age 15-24)	• Higher percentage of driving population is elderly with lower injury tolerance.

It is anticipated that the mix of increasingly smaller passenger automobiles and larger combination trucks will add to safety problems on the conventional interstates. It is estimated that in the next few decades, the ratio of large truck travel to travel by all vehicle types will increase. Truck travel is estimated to grow by 3.3 percent compared to 2.3 percent for other vehicle types. Drivers of large trucks are estimated to be 50 percent less likely to be involved in a crash than automobile drivers; however, a crash with a large truck is more likely to cause serious injuries or a fatality. Crash-worthiness of passenger vehicles becomes more critical as the size of trucks increases. In addition, one should keep in mind that the super highway concept involves very high speeds for both passenger vehicles and trucks. There is no experience data base for vehicles operating on this type of facility.

Increased congestion on existing roadways makes access of emergency vehicles to crash victims more difficult. Crash severity, however, could be less on congested highways because speeds are reduced.

Congestion has been associated with driver disregard for traffic control devices, driving too close, improper weaving, and episodes of driver violence. Driver error, it is estimated, is a major contributing factor in 60-90 percent of all motor vehicle crashes. On conventional interstates and toll roads, major safety factors are drivers inattention to, or lack of knowledge about, adverse conditions.

Automated highway technology has great potential for improving highway safety. However, these systems, without proper design, could create their own hazards. Navigational display systems must be designed to avoid driver distraction through information overload. Studies show that the elderly are more prone to this problem because they sometimes process information more slowly than younger drivers.

Smart cruise control could warn drivers about slow vehicles when the gap between vehicles narrows to a preset interval. Collision warning devices could also improve safety. The reliability of the technology however would be crucial.

Truck safety can be enhanced in a number of ways. Weigh in motion equipment helps police to detect the unsafe practice of overweight vehicles. Separation of trucks from other traffic is also thought to enhance safety for both.

Trucks can be separated from other traffic by designating specific lanes on multi lane highways, putting time of day restrictions on truck travel, or constructing separate truck lanes in certain corridors.

Road-to-vehicle communication could advise a driver to begin slowing in advance of stopped or stop-and-go traffic. An automated TTC highway would operate for considerable distances in rural areas, where access to medical facilities is limited. Increased availability of car phones or other in-car communication devices can reduce response time in emergencies.

High Speed Rail and Maglev

The lack of an experience record for this technology limits sound comparisons with other TTC alternatives. Safety concerns for high speed rail and maglev include guideway, vehicle and operational issues. Safety concerns are summarizes in Exhibit 12-3.

Exhibit 12-3
SAFETY ISSUES - RAIL ALTERNATIVES

POSITIVE	NEGATIVE
• Grade separated ROW and crossings reduce collision risk. • Generally lower death rates for rail.	• Higher speeds for rail increase risk for collisions and severity of injury. • High Speed Rail and Maglev lacks thorough U.S. testing for safety concerns. • Casualty rate for rail tank cars carrying crude oils and petroleum products higher than for highway tank trucks.

<u>Guideway Issues</u> - Many of the issues regarding safety concerns for guideways are mitigated by application of sound design principles. This in turn reflects upon the cost to develop the system. Prudence dictates a conservative approach to cost estimates to allow for unforeseen safety enhancements. For example, safe egress from an elevated maglev system under emergency conditions requires special attention. Research is underway to consider the design of walkways, railing, and platforms with ladders or chutes. At-grade systems must consider fencing type, intrusion devices, barrier locations for urban and rural areas, and bridge structure.

Issues to be studied include monitoring of "track fatigue" and pre-determination of expected failure; air pressure related effects of two trains passing; and effects of climate and environmental variations such as wind, ice, snow, rain, earthquakes, severe electrical storms and lightning.

The majority of current operating experience for high speed rail emanates from European and Japanese systems. Foreign inspection and maintenance standards may not apply directly to U.S. systems, while track geometry and grade crossing standards for the U.S. are still under refinement.

<u>**Vehicle Issues**</u> - The vehicle safety questions include human tolerance issues as well as vehicle operations and crash-worthiness. Vehicles must not only be crashworthy but also provide a comfortable, convenient travel environment.

Concerns regarding ride quality range from protection against ear drum punctures due to changes in air pressure and noise levels at tunnels to safe aisle walking during trips. The use of higher speeds over 160 kilometers per hour (over 100 mph) raises the issue of whether all passengers must be seated and have seatbelts, similar to travel by airplanes. Braking issues include braking capacity of vehicles; a variable braking standard for seated passenger, belted passengers and standees; and need for a backup system in case of electrical failure.

<u>**Operational Issues**</u> - Trains with high frequencies of service (short headways) must maintain safe time and distance separation. The reliability of computers used with high speed ground transportation must be measured against operator control.

Other Safety Issues

There must be safe compatibility between persons and the electric power supply. The biological effects of magnetic and electric fields need to be determined and mitigated. The extent of exposure needs to be determined and shielding standards need to be developed.

Three of the alternative concepts, if actually built, are likely to involve the transport of hazardous materials, including petroleum products and hazardous waste. It is expected that a TTC alternative transporting freight could carry more than the average share of nuclear waste because it connects the waste generating urban centers of the east coast with repository sites in the west.

The scarcity of accident experience data for high speed rail operations is of concern in this matter, also. Perhaps some insight can be gleaned from data on casualty rates for existing modes of transport of hazardous petroleum products. The rail tank car has the worst performance, followed by trucks. Pipelines and water tankers have a significantly better record. These data are summarized in Exhibit 12-4.

Exhibit 12-4
CASUALTY RATES FOR TRANSPORT OF HAZARDOUS MATERIALS
1982-1985

Casualty* Rate per Billion Metric Ton Kilometers(Ton Miles) (of crude oils and petroleum products)		
Rail tank car	2.78	(4.05)
Highway tank truck	1.08	(1.57)
Liquid pipelines	0.03	(0.04)
Water tankers	<0.01	(<0.01)

* Fatalities and injuries

SOURCE: Pipelines and Public Safety, TRB Special Report 219

ENERGY

The energy impacts and implications of the TTC alternatives in the 21st Century will depend largely on technological advances in propulsion systems and vehicle design, clean air standards, and the availability of fuel. This section describes current estimated energy use of the automobile, truck, rail, high speed rail and maglev and makes some general assumptions about energy impacts in the future. The estimates are based on general assumptions about passenger travel and freight transport.

Passenger Travel

Energy Use by Mode Today - Depending upon the mode of travel, the number of energy units required to produce a kilometer of travel vary widely, from nearly 3,600 joules per km (5,500 BTU's per passenger-mile) for gasoline powered automobiles to under 1,000 joules per km (1,400 BTU's per passenger-mile) for the rail alternatives. Exhibit 12-5 describes the average energy requirement per mode. It should be noted that the energy requirements are current estimated averages and that operational considerations such as speed and drag will greatly affect the energy intensity of any TTC passenger trip or shipment.

Exhibit 12-5
CURRENT ENERGY ESTIMATES
JOULES PER PASSENGER KILOMETER
(BTU'S PER PASSENGER MILES)

	Joules/Km	BTUs/Miles
Automobile (gasoline powered)	3,600	(5,500)
Rail (diesel)	1,600	(2,500)
High Speed Rail (turbine)	1,000	(1,400)
Maglev (electric)	1,100	(1,600)

SOURCE: Transportation Research Board, National Cooperative Highway Research Program, Synthesis of Highway Practice, Publications,: #121: *"Energy Conservation in Transportation,"* and #43: *"Energy Effects, Efficiencies, and Prospects for Various Modes of Transportation."*

National Perspective - From a national perspective, the overall energy use of a particular TTC future will depend on the total kilometers traveled in the US on the TTC facility and the changes in passenger travel on existing Interstates and the feeder system that are caused by the implementation of the TTC. Exhibit 12-6 estimates the total passenger kilometers traveled for this system as a whole. If no new TTC facility is built (the base case alternative) it is estimated that the daily passenger-km traveled will be 2.58 billion (1.6 billion passenger-miles) in the year 2040. With the implementation of any TTC alternative, the estimates for daily passenger-km range from 2.58 to 2.74 billion (1.6 billion to 1.7 billion passenger-miles).

Exhibit 12-6 also estimates the total systemwide energy requirements. The greatest energy use saving is for the rail technologies: Alternatives B, D1 and D2. The lower energy requirement for these technologies more than offsets the higher system total for vehicle-km traveled.

Exhibit 12-6
DAILY PASSENGER KILOMETERS (MILES),[1]
NATIONWIDE SYSTEM, ENERGY REQUIREMENTS
(YEAR 2040 - MILLIONS)

	BASE CASE	ALT A HIGHWAY	ALT B RAIL	ALT C[2] SUPER	ALT D1 HSR	ALT D2 MAG LEV
TOTAL PASSENGER KILOMETER	2,580	2,580	2,580	2,740	2,580	2,580
CHANGE		0	0	160	0	0
(TOTAL PASSENGER MILES)	(1,600)	(1,600)	(1,600)	(1,700)	(1,600)	(1,600)
(CHANGE)		(0)	(0)	(100)	(0)	(0)
JOULES REQUIRED	9,300,000	9,300,000	9,200,000	9,900,000	9,200,000	9,200,000
CHANGE		0	-100,000	600,000	-100,000	-100,000
(BTU'S REQUIRED)	(8,800,000)	(8,800,000)	(8,700,000)	(9,400,000)	(8,700,000)	(8,700,000)
(CHANGE)		(0)	(-100,000)	(600,000)	(-100,000)	(-100,000)

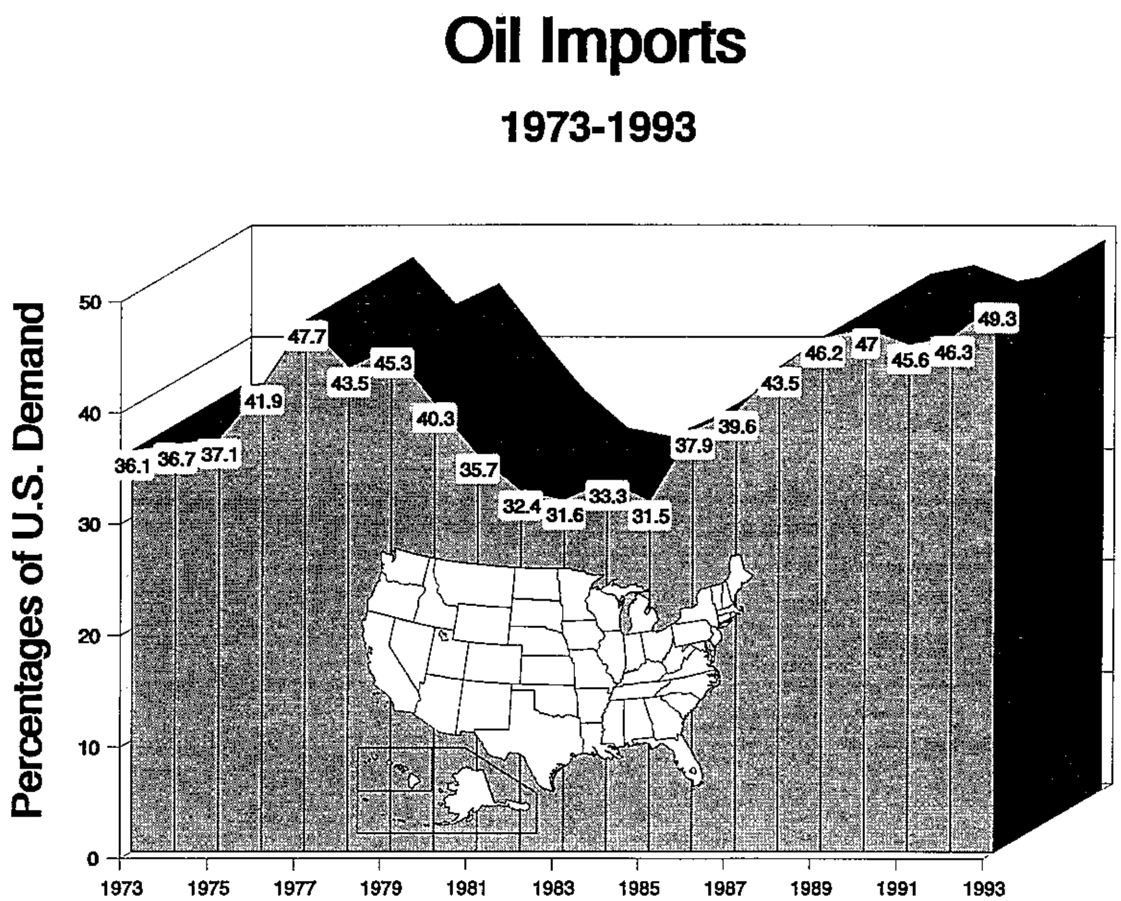
(1) Includes existing interstates, TTC corridor, and feeder system.
(2) Surface transportation only - Alternative C3 and C1.

Implementation of the Super Highways create the greatest energy use increase.

<u>The Future of the Petroleum Powered Automobile</u> - The energy requirements described above are based on the technologies of today. The energy requirement for automobiles on upgraded highways are assumed to be the same as those using the higher speed super highways. Generally however as speed increases for motorized vehicles, the energy requirements per passenger kilometer increases. A race car, for example, traveling at TTC superhighway speeds would use approximately ten times the energy of the conventional interstate user. It is assumed here that in a high speed automotive future that automobiles would be redesigned to promote fuel efficiency at these higher speeds.

The continued use of petroleum into the 21st Century will depend on air quality standards, fuel availability, cost, and development of alternatives which are competitive. In the 1970's when petroleum availability was scarce efforts were made to decrease the United States' dependency on foreign oil. Twenty years later, however, oil imports have increased from 36 percent of the U.S. demand, to nearly 50 percent. (Exhibit 12-7) The use of conventional fuels in the next twenty years will depend in part on the continued access to foreign markets. The Department of Energy estimates that by the year 2030, 80 percent of all petroleum will be imported.

Exhibit 12-7

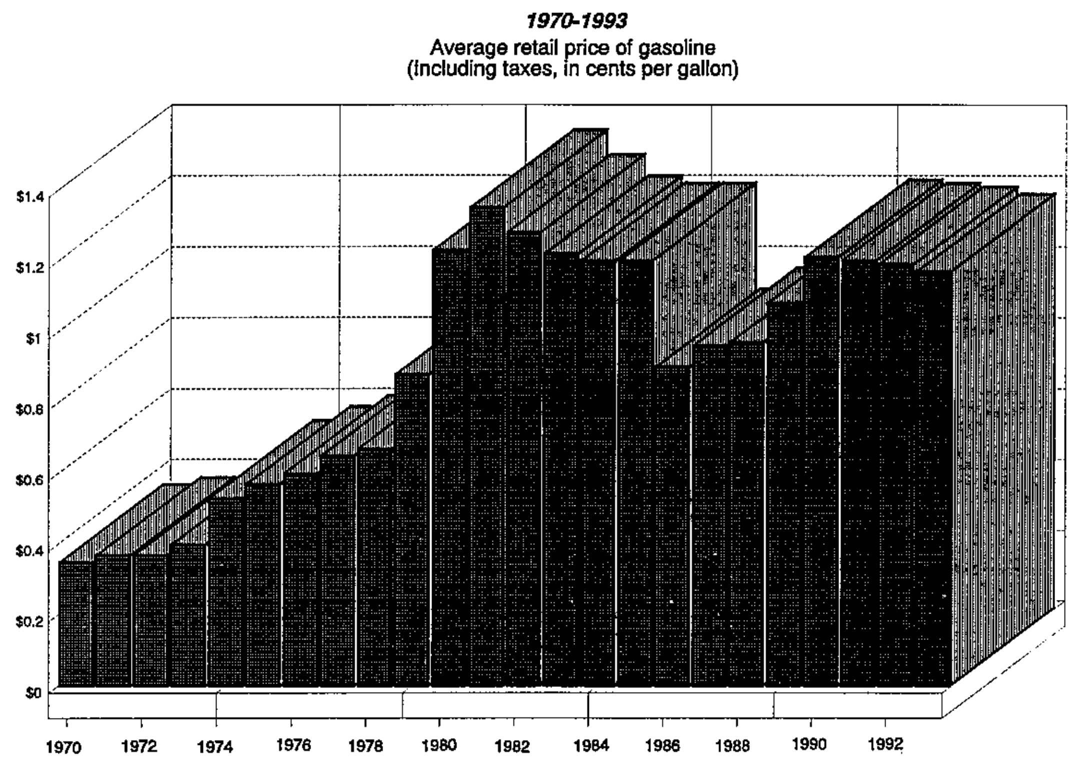


Future Fuel Cost

Fuel costs consists of direct costs and also taxes. The higher direct energy cost for the automobile is generally attributed to the higher cost of refining petroleum as compared to diesel fuel used for rail. In the last twenty years the average retail price of a liter (gallon) of gasoline has increased from $0.09 to $0.31 per liter ($0.35 to $1.17 per gallon) including taxes. (Exhibit 12-8) In the future, given the availability of fuel, direct costs can be expected to fluctuate similar to other commodities. Some groups favor fuel tax increases to reflect the real cost of automobile travel. By imposing these "user fees" there would be a tendency to decrease unessential driving and to promote the use of other transportation modes.

Exhibit 12-8

FUEL COST FLUCTUATION



<u>Indirect Costs</u> - In the future, taxes may be imposed to cover the indirect cost of travel. It has been estimated that an increase of 25 percent or $0.06 per liter ($.21 per gallon) would be required to cover such costs as construction, maintenance, highway patrols, traffic management, and emergency response. Pollution generated by emissions can cause costs associated to damages in human health, materials, crops, trees, and other vegetation and visibility. Fuel production, refining, transportation and storage contribute to the costs of cleaning up air and water pollution through oil spill or ground water contamination.

The World Resources Institute calculates the costs of motor-vehicle generated ozone reflected in health effects, lost labor hours, $0.01 to $0.03 per liter ($0.04 to $0.11 per gallon). It is possible that alternative fuels would be developed in the future to reduce cost, petroleum use and petroleum emissions.

The Fuel Efficient Car Of The 21st Century - The Clinton administration is promoting the 35 kilometers per liter (82.5 mpg) automobile to be developed in the next decade. According to a recent newspaper article, the Big 3 auto manufacturers have identified the technologies necessary to produce a high efficiency car. They are:

- Lightweight, high-strength, structural composite biodegradable plastics that can be repaired.
- Material that can withstand temperature up to 2,600 degrees Fahrenheit.
- Sensors for noise control to reduce engine back-pressure losses by eliminating muffler systems.
- Fuel cells to convert liquid fuel energy directly into electricity with little pollution.

The challenge, as vehicles get lighter and smaller, is to design for crash management. IVHS technology has potential in this area by alerting drivers to dangerous conditions. General Motors is looking into night vision technology to prevent accidents on foggy roads as well as help drivers navigate after dark. The devices detect objects ahead using an infrared light and flash images on a screen in the dashboard for the driver. While it is reported that night vision could run up to $100,000 per car to install, the goal for GM is $30.

Freight Transport

Freight transport includes the metric ton km of freight transported by truck in Alternatives A and C, and rail in Alternative B. Since freight transport is not expected to be significant in the High Speed Rail alternatives, it is not considered here. The current energy requirements to transport freight are lower for rail and pipeline than for truck travel. Exhibit 12-9 describes the kilocalories required per metric ton of freight transported one km (BTU's per ton mile).

Exhibit 12-9
ENERGY FOR FREIGHT TRANSPORT
KILOCALORIES PER METRIC TON-KILOMETER
(BTU'S PER TON MILE)

	TON KILOMETER	TON MILE
Truck	277	(1600)
Rail	121	(700)
Pipeline	95	(550)

Within the TTC Corridor, it is anticipated that the Super Highway would carry significantly more freight than the upgraded rail. Exhibit 12-10 indicates over 0.5 billion metric ton kilometers are travelled on the Super Highway as compared to less than 0.3 billion ton kilometers for Alternatives A and B. The energy requirements are higher for the highway alternatives.

Exhibit 12-10
CORRIDOR FREIGHT, ENERGY USE
Year 2040 (Billion)

	A		B		C3		C1	
Metric Ton Kilometers (Ton Miles)	.175	(.120)	.225	(.154)	.585	(.400)	.970	(.664)
Energy Requirement Joules (BTU's)	200	(190)	115	(110)	675	(640)	1,120	(1,062)

Construction Energy

There will be energy requirements too, to build any of the TTC alternatives. It is expected that the Super Highway would have the highest construction energy requirements of any of the other TTC alternatives. It is estimated that nearly 60 trillion joules of energy (over 55 trillion BTUs) would be required to construct a nearly 5,000-km (3,000-mile) long Super Highway. This amounts to approximately 20 percent of the annual energy use on one of the Super Highway alternatives. It is anticipated that the construction energy for any of the TTC alternatives would not exceed this amount.

ENVIRONMENTAL IMPACTS

The results presented here are an overview of possible environmental impacts of the three analysis corridors. They provide the basis of a general comparison of the potential impacts of implementing the TTC within each of the analysis corridors.

Impacts on Natural Resources

This section provides a summary of the major natural resources that should be avoided or where the effects of building a TTC facility should be mitigated. Because each study corridor is 80 km (50 miles) wide, many of these resources can be avoided by a specific alignment. Exhibit 12-11 summarizes the number of national forests, parks, scenic routes, wildlife refuges, rivers, and lakes that fall within 80-km (50-mile) wide analysis corridor. A detailed inventory of Environmental Resource is included in Appendix B.

Exhibit 12-11
SUMMARY OF NATURAL RESOURCES

Corridor	Number of National Forests Parks, Other	River Crossings
One: Interstate-type Highway and Super Highway		
Option 1 East (North) and Midwest (North)	9	39
Option 2 East (South and Midwest (North)	8	38
Option 3 East (North) and Midwest (South)	7	40
Option 4 East (South) and Midwest (South)	6	39
Two: Upgraded Rail		
Option 1 North	10	28
Option 2 South	9	27
Three: Very High Speed Rail	6	24

• National forests, parks, wildlife refugees, scenic routes, rivers and lakes.

This inventory does not include the wide variety of other more site specific resources such as state parks and smaller wildlife habitat's that would have to be avoided or mitigated if a TTC is built.

Impacts on Air Quality

A listing of all urban areas in each segments that have not attained the Environmental Protection Agency's National Ambient Air Quality Standards was compiled. These standards were developed to protect the public from the harmful effects of six air pollutants. They are:

- **Ozone** close to the ground is called tropospheric ozone or smog. It is a secondary pollutant as it is not emitted directly, but it is formed by the photochemical reaction of hydrocarbons, nitrous oxides and sunlight. Unlike its protective counterpart found in the stratospheric layer of the Earth's atmosphere, ozone near the Earth's surface can cause lung damage in humans and it can harm trees, crops and man-made materials.

- **Carbon Monoxide** is a colorless, odorless gas primarily emitted from mobile sources - the cars and trucks we drive everyday. It reduces the oxygen-carrying capacity of the blood, causing headaches, dizziness, vision problems and slowed reaction time.

- **PM-10** is particulate matter - such as smoke and soot emitted from urban buses - that is less than 10 micrometers in diameter. This matter is small enough to breathe in, but it tends to settle in the lungs, filling up bronchial passages and causing respiratory problems.

- **Nitrogen dioxide** is a brownish gas which can cause the haze seen in the sky in smoggy areas. It is a secondary pollutant which can cause respiratory problems. Nitrogen dioxide is one of the nitrous oxides that reacts with other chemicals to form smog and acid rain.

- **Sulfur dioxide** is formed primarily by the combustion of fossil fuels. It can cause respiratory problems and is the major precursor in the formation of acid rain.

- **Lead** - Since the introduction of unleaded gasoline in the mid-70's, the amount of lead pollution in the air has decreased significantly. However, there are still 70 areas in the U.S. that are in non-attainment.

These air pollutants are emitted primarily by automobiles, buses and trucks. The location of the TTC Analysis Corridors takes into consideration the potential for increased vehicular traffic and emissions that would be caused by a TTC highway alternative in already congested urban areas. It is assumed in this analysis that the TTC rail alternatives would contribute less to urban air pollution than the highway alternatives. In urban areas, existing vehicular congestion would contribute further to most types of emissions. In congested conditions, certain emissions increase as compared to free flow conditions. A recent Transportation Research Board publication states that "the relationship between traffic congestion and vehicular emissions is unclear;" however, the following changes have been documented. The examples are presented in Exhibit 12-12.

Exhibit 12-12
EMISSIONS INCREASE/DECREASE IN CONGESTED VERSUS FREEFLOW CONDITIONS
Based on a 16 kilometer (10 mile) trip from a cold start engine

POLLUTANT	PERCENT INCREASE/DECREASE
Carbon Monoxide (CO)	11 - 22 Increase
Hydrocarbons (HC)	3-8 Increase
Nitrogen Oxide (NOx)	8-19 Decrease

SOURCE: TRB Report 1366, *"Comparison of Vehicular Emissions,"* 1992.

The ability of a high speed rail alternative to reduce urban air pollution problems when compared to a TTC highway alternative, depends on significant demand for high speed rail and access via local public transit to high speed rail terminals.

The urban areas not achieving federal standards are required to comply by deadlines that vary based upon the severity of air quality conditions. Exhibit 12-13 describes categories of "non-attainment" and the compliance schedule established by the Clean Air Act.

Exhibit 12-13
COMPLIANCE SCHEDULE - CLEAN AIR ACT

Marginal	1993
Moderate	1996
Serious	1999
Severe - 15	2005
Severe - 17	2007
Extreme	2010

Exhibit 12-14 provides a summary of the non-attainment areas within the three representative analysis corridors. As noted, the representative corridors identified for the TTC highway alternatives (Corridor 1) have generally been located away from these "non-attainment areas." The exceptions to these locations are the termini in Los Angeles on the west and Norfolk, or Hampton VA on the east. Again, given the 80-km (50-mile) wide study corridor, most urban areas could be avoided. The rail alternatives (Corridors 2 and 3) are located close to six to twelve non-attainment areas.

Exhibit 12-14
SUMMARY OF NON-ATTAINMENT AREAS WITHIN ANALYSIS CORRIDORS

CORRIDOR	NUMBER OF NON-ATTAINMENT AREAS
One: Upgraded Highway	3
Two: Super Highway	6
Three: High Speed Rail	12

Chapter 13
INCREMENTAL IMPLEMENTATION OPPORTUNITIES

The Transamerica Transportation Corridor project would require a substantial public and private commitment if it is undertaken. These improvements may prove, in the long-term, to be one of the largest, single public works undertakings ever considered in the United States. Therefore, it can be expected that it will be difficult to implement all of the improvements at one time, as a single project. As discussed below, there are optional ways in which the TTC modes, technologies and segments could be implemented incrementally over time.

BASIC APPROACHES TO INCREMENTAL IMPLEMENTATION

There are two basic types of incremental opportunities, viz.:

1. Transition options would include concepts to phase in the modes or technologies. For example, a conventional highway could be built first, followed later by rail or a maglev guideway. Also, the joint use concept could involve incremental implementation of one or more types of utility lines. These options can be considered "cross-sectional phasing options."

   Although they are not mutually exclusive, it is helpful to examine the transition options in terms of four basic characteristics:

   - Capacity
   - Speed
   - Mode
   - Technology

2. Segmental opportunities would include consideration of local or regional need. Certain segments along the TTC may have near-term needs; other segments may be much longer term; and still others may be needed only if and when the time comes to tie the entire corridor together, coast-to-coast. Some modes or technologies may be implemented in short segments whereas others may require fairly lengthy "minimum operable segments." These opportunities can be considered "longitudinal phasing options."

Each of these types of incremental opportunities is discussed in more detail in the following sections.

CAPACITY

Incremental capacity expansions are common in transportation improvements, including street and highway widening and dual-tracking railroad lines. For highway improvements in the TTC, two types of capacity improvements can be considered: vehicular volume and vehicle weight. Improving a two-lane highway to a four-lane facility is a common practice and is considered very cost-effective, especially when the initial two-lane facility is designed and constructed with the ultimate expansion in mind. When properly planned, the third and fourth lanes can be added with little or no reconstruction of the initial facilities.

Converting an uncontrolled access highway to a fully controlled access highway also is fairly common. Again, advance planning facilitates this transition. If right-of-way for grade-separated interchanges is acquired with the initial project, then the cost of the transition can be reduced. Another consideration is the accommodation of traffic service during the transition project. For the most part, the access control transition can be undertaken without major reconstruction of the initial facility, although some of the initial project (e.g., at-grade intersections) must be demolished.

Improving a conventional highway to a heavy-duty truck highway (e.g., higher permissible truck weights, LCVs, etc.) is a method for incrementally increasing the vehicle weight capacity of a highway improvement in the TTC. This transition would require significant reconstruction of the initial project. Unless specifically designed for staged improvement, most of the pavement structure would have to be removed and rebuilt. Unless the pavement structure is rebuilt (or initially designed with the transition in mind), vertical clearances at crossroad structures may become critical. In addition to the thicker pavement structure, heavy-duty truck highways should have relatively flat grades to accommodate the high weight/horsepower ratio of heavy trucks. If these geometrics are not provided initially, then major grading and reconstruction may be required to provide the alignment for safe, convenient heavy truck operations.

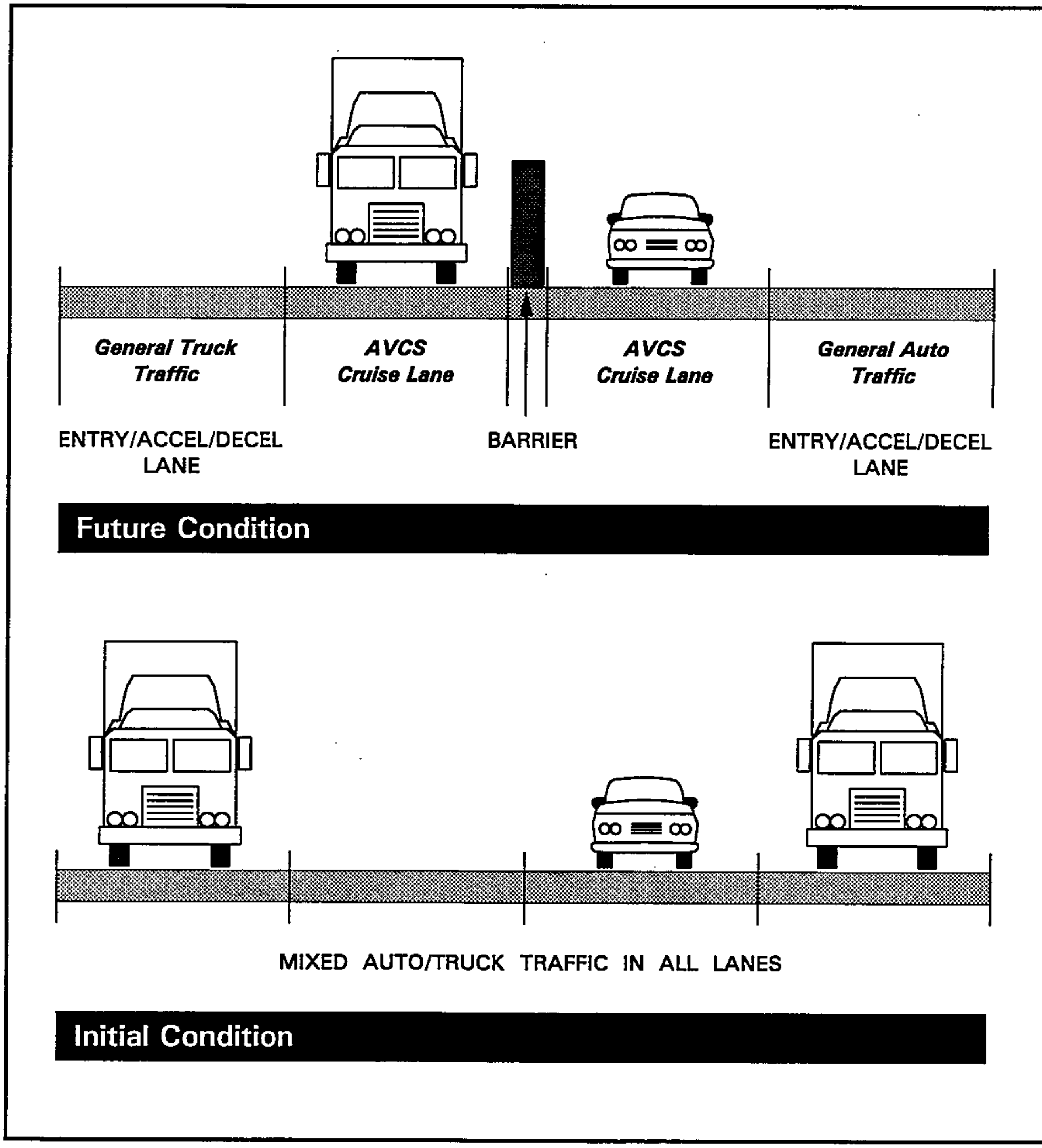
If advance planning is undertaken for a new conventional highway which is later converted to an IVHS facility, this could be a relatively straightforward and cost-effective transition (although initially there could be "learning-curve" problems and higher costs if TTC was the first Super Highway). It is expected that most of the fixed IVHS equipment, such as signs, could be installed within the highway corridor without significant reconstruction of the initial facility. An exception could be any in-pavement navigation or guidance system which might require pavement reconstruction.

The Transamerica Transportation Corridor project could lead the way in highway transportation innovation through an adaptive highway scenario which recognizes the evolutionary nature of the IVHS program and provides the flexibility needed for the development of incremental innovations in products, services and facilities. One potential scenario for evolutionary deployment of technological innovations (see Exhibit 13-1) would include the following general features:

- Geometric design standards for, say, 200 km/h (125 mph) applied initially;
- Speed limit planned for periodic incremental upgrades from initial operating speed -- as technology innovations and deployment permits;
- Initial roadway for manual operation of vehicles allows for future AVCS deployment in a single lane in which all vehicles would travel under electronic control at the same speed with no passing;
- Initial roadway designed for mixed traffic would be planned for future automobile and truck traffic barrier separation;
- Vehicles permitted to utilize IVHS-equipped lanes would be required to meet certain equipment and performance standards not applicable to vehicles using conventional lower-speed roadway;
- Separated truckway designed for high speed (say 110 km/h or 70 mph) operation by heavy (LCV) trucks would be added within the right-of-way

Exhibit 14-1

ADAPTIVE HIGHWAY CONCEPT



subsequent to the initial project as trucks become equipped with suitable electronics; and

- Ultimate deployment of innovations including electronically linked auto platoons; mechanical or electronic lane constraints; aerodynamic trucks; power plant innovations for constant high speeds, etc.

For fixed guideways within the Transamerica Transportation Corridor, capacity could be increased by initially constructing a single track with passing sidings, and adding additional tracks in the future. As in the two-lane to four-lane highway expansion, if the initial project is designed with expansion in mind, this transition can be very cost-effective, with little or no reconstruction of the initial facility required. Incremental stages of development beginning with a conventional 127 km/h (79 mph) railroad which is later upgraded to permit higher speeds is one possibility with the options discussed earlier in this Chapter.

Fixed guideway capacity could also be increased by adding more advanced train control technologies. Fixed equipment required for such a system probably could be added with little or no lost investment in the initial guideway project.

SPEED

Transitional options to increase operating speed significantly generally are not as cost- effective as those to increase capacity. The conventional means of improving operating speed, for highways or fixed guideway facilities, are to improve the horizontal and vertical alignment and to upgrade the pavement/guideway system. Improving the horizontal alignment normally requires right-of-way acquisition and associated impacts. Major adjustments in the vertical alignment necessitate substantial, costly earthwork. Therefore, much of the initial project investment would be lost in such an upgrade.

It is possible that operating speed could be improved incrementally through the addition or use of advanced vehicle/guideway technology. The tilt-train technology and highway vehicle operator assistance systems which would reduce safe stopping distance requirements are examples. These transitions could be implemented with little reconstruction of the initial project, but they probably would provide only marginal improvements in overall speed.

For the foreseeable future, the basic guideway geometry will be the primary determinant of operating speed. Because of the major costs of incrementally improving this geometry, it would appear much more cost-effective to design and construct the initial projects to the ultimate design, if funding sources permit. Although it is not impossible to substantially upgrade operating speed in subsequent increments of improvement, it would probably be very expensive. Of all of the transition option characteristics examined, the ultimate operating speed is probably the most important to design into the initial project.

MODE

Another transition option is to shift from one mode to another -- for example, building a highway first followed later by a fixed guideway facility. Unless the initial mode becomes generally obsolete (e.g., rubber-tired highway vehicles are no longer used), this transition option probably represents a <u>joint use consideration</u>, discussed in earlier sections. This transition option would be relatively cost-effective as long as the cross-sectional and alignment requirements of the second mode (e.g., high-speed guideway) are accounted for in the design of the initial project. As discussed earlier, the primary alignment requirements are determined by design speed.

It is possible that over the 50-year planning horizon for the Transamerica Transportation Corridor, a mode transition option may be considered due to <u>modal evolution</u>. That is, the initial project mode may become obsolete, and that mode may be replaced by the guideway for a different mode within the same right-of-way. An historical example is the replacement of wagon trails with paved roadways. This type of transition option is extremely difficult to anticipate in the design of the initial facility. Again, using a very high design speed for the initial phase improvement may be the only way of considering this type of incremental opportunity.

TECHNOLOGY

Transition options may arise in which technology advances within a given transportation mode are applied to the Transamerica Transportation Corridor. Generally, these transitions could occur cost-effectively if considered during initial planning and design. <u>Converting a conventional railroad to high-speed rail or maglev</u> probably would require alignment improvements which could be minimal, if planned for initially, or prohibitive, if not. If the alignment issues are accounted for, the cross-sectional factors, such horizontal and vertical clearances, should not cause problems in this type of transition.

In the highway mode, an example of a technology transition would be moving from a conventional highway to an Advanced Traveler Information System (ATIS) to an Advanced Vehicle Control System (AVCS). Adding these technological features as a future increment should be relatively straightforward, assuming that the vehicle operating speeds remain fairly constant.

SEGMENTAL ANALYSIS

Segmental development of the TTC is another approach to incrementally implement a facility. While a coast to coast facility may not be feasible for a given transportation concept, limited segments may be feasible.

Data available for this analysis included travel demand based on the full TTC being in place rather than being on a segmental basis. Thus, caution must be taken when considering individual segments using information developed for the full corridor. Nevertheless, some observations can be made from a review of the future travel demands, capital costs, air quality impacts, and environmental constraints for the segments analyzed.

The full TTC corridors could be split into any number of segments, but for this evaluation the analysis corridors were split into six segments. An average per km (mile) cost and an average demand level (year 2040) were calculated for each transportation concept segment. To provide a composite measure of capital cost and demand, the capital cost per annual vehicle/passenger-km (passenger-mile) of travel was calculated.

Segments which will impact existing non-attainment areas are also identified. Air quality impacts in non-attainment areas were considered positive for the rail concepts and negative for highway concepts. Impacts of the highway concepts in the non-attainment areas could severely affect feasibility in view of the current Clean Air Act regulations. For each segment, the number of non-attainment areas impacted was noted along with the affect of the impact, either negative or positive.

Environmental constraints that can not be avoided within the 80 km (50 mile) wide analysis corridor are noted. These environmental constraints do not make segments infeasible, but may impact the time required to implement a segment and the cost of implementing a segment.

Alternative A: Conventional Interstate-type Highway

Segmental information for Alternative A is provided in Exhibit 13-2. Observations regarding this alternative include:

- Because the upgraded highway concept includes the use of existing facilities, pieces of this transportation concept's alignment already exist.
- The greatest usage of this TTC concept is within the central portion of the corridor from Kentucky to Kansas or Oklahoma.
- The lowest ratio of capital cost to demand occurs on the segment from I-75 to I-55 and the highest ratio occurs on the segment from I-25 to Las Vegas.
- The largest number of trips diverted from existing facilities to the TTC, on a percentage basis, occurs within the western portion of the corridor from eastern Kansas or Oklahoma to the intersection with I-15.

Alternative B: Upgraded Rail

Exhibit 13-3 provides a segmental breakdown of Alternative B. Some observations are as follows:

- The segment of the upgraded rail concept's analysis corridor between St. Louis, Missouri and Kansas City, Missouri shows the largest passenger use.
- The segment from St. Louis to Kansas City has the lowest ratio of capital cost to ridership, while the segment through western West Virginia and eastern Kentucky has the highest ratio.

Exhibit 13-2
SEGMENTAL BREAKDOWN - ALTERNATIVE A: UPGRADED HIGHWAY

Segment Description	Average Capital Cost		Average Demand Yr. 2040	Capital Cost Per Annum		Air Quality	Environmental[3]
	Per KM	Per Mile		VKmT[2]	VMT[2]		
Eastern Terminus to I-75	$4.2 mill	$6.7 mill	6,850 vpd[1]	$1.67	$2.68	NEGATIVE 1 Non-attainment	National Forest
I-75 to I-55 (Mississippi River)	$2.1 mill	$3.4 mill	11,700 vpd	$0.50	$0.80	No Non-attainment Areas	No Unavoidable Constraints
I-55 to I-35/I-44	$5.2 mill	$8.3 mill	10,600 vpd	$1.34	$2.15	No Non-attainment Areas	No Unavoidable Constraints
I-35/I-44 to I-25 (Front Range)	$4.0 mill	$6.5 mill	9,000 vpd	$1.23	$1.98	No Non-attainment Areas	No Unavoidable Constraints
I-25 to Las Vegas/Flagstaff	$5.7 mill	$9.1 mill	7,000 vpd	$2.21	$3.56	NEGATIVE 1 Non-attainment	National Forest Indian Res.
Las Vegas/Flagstaff to Western Terminus	Existing I-15						

1 Average of screenline 1 and 2 volumes
2 Capital Cost ÷ (daily vehicle km [miles] of travel x 365 days)
3 "No Unavoidable Constraints" denotes no identified major constraints which cannot be avoided within the 80-km (50-mile) wide analysis corridor.

Exhibit 13-3
SEGMENTAL BREAKDOWN - ALTERNATIVE B: UPGRADED RAIL

Segment Description	Average Capital Cost		Average Demand Yr. 2040	Capital Cost Per Annum		Air Quality	Environmental[3]
	Per KM	Per Mile		PkMT[2]	PMT[2]		
Eastern Terminus to I-75	$9.1 mill	$14.7 mill	1,200 ppd[1]	$20.85	$33.56	POSITIVE 1 Non-attainment	National Forest
I-75 to I-55 (Mississippi River)	$5.7 mill	$9.1 mill	2,200 ppd	$7.04	$11.33	POSITIVE 3 Non-attainment	No Unavoidable Constraints
I-55 to I-35/I-44	$5.8 mill	$9.4 mill	4,000 ppd	$4.00	$6.44	POSITIVE 1 Non-attainment	No Unavoidable Constraints
I-35/I-44 to I-25 (Front Range)	$5.5 mill	$8.8 mill	2,300 ppd	$6.51	$10.48	No Non-attainment Areas	No Unavoidable Constraints
I-25 to Las Vegas/Flagstaff	$6.6 mill	$10.7 mill	2,100 ppd[1]	$8.67	$13.96	POSITIVE 1 Non-attainment	National Forest
Las Vegas/Flagstaff to Western Terminus	$7.5 mill	$12.0 mill	1,750 ppd[1]	$11.68	$18.79	POSITIVE 1 Non-attainment	National Forest

1 Average of two screenlines
2 Capital Cost ÷ (passenger-km [passenger-miles] of travel per day x 365 days).
3 "No Unavoidable Constraints" denotes no identified major constraints which cannot be avoided within the 80-km (50-mile) wide analysis corridor.

Alternative C: Super Highway

Presented in Exhibit 13-4 is a segmental breakdown for Alternative C. Some observations are as follows:

- The highest volume segment is through Virginia and West Virginia.
- The low level of demand, combined with the high capital cost, results in the segment through Colorado and Utah having the highest ratio of capital cost to vehicle-km (miles) of travel.
- The lowest ratio of capital cost to vehicle-km (miles) of travel occurs on the segments through Kentucky, Illinois, and Missouri.

Alternative D: Very High Speed Rail

Exhibit 13-5 presents a segmental breakdown for Alternative D. Observations regarding Alternative D include:

- The segment with the highest ridership and the lowest ratio of capital cost to passenger-km (miles) of travel is from Las Vegas to the western terminus.
- The highest ratio of capital cost to ridership occurs on the segment from I-25 to Las Vegas.

Exhibit 13-4
SEGMENTAL BREAKDOWN - ALTERNATIVE C: SUPER HIGHWAY

Segment Description	Average Capital Cost		Average Demand Yr. 2040	Capital Cost Per Annum		Air Quality	Environmental[4]
	Per KM	Per Mile		VKmT[3]	VMT[3]		
Eastern Terminus to I-75	$15.6 mill	$25.1 mill	22,350 vpd[1]	$1.91	$3.08	NEGATIVE 1 Non-attainment	National Forest
I-75 to I-55 (Mississippi River)	$8.9 mill	$14.3 mill	16,600 vpd	$1.47	$2.36	No Non-attainment Areas	No Unavoidable Constraints
I-55 to I-35/I-44	$11.2 mill	$18.0 mill	19,500 vpd	$1.57	$2.53	No Non-attainment Areas	No Unavoidable Constraints
I-35/I-44 to I-25 (Front Range)	$8.1 mill	$13.1 mill	7,800 vpd	$2.86	$4.60	No Non-attainment Areas	No Unavoidable Constraints
I-25 to Las Vegas/Flagstaff	$15.5 mill	$25.0 mill	7,950 vpd[2]	$5.36	$8.62	NEGATIVE 1 Non-attainment	National Forest Indian Res.
Las Vegas/Flagstaff to Western Terminus	$11.7 mill	$18.8 mill	17,800 vpd	$1.80	$2.89	NEGATIVE 2 Non-attainment	National Forest

1 Average of screenline 1 and 2 volumes
2 Average of screenline 6 and 7 volumes
3 Capital Cost ÷ (vehicle-km [miles] of travel per day x 365 days)
4 "No Unavoidable Constraints" denotes no identified major constraints which cannot be avoided within the 80-km (50-mile) wide analysis corridor.

Exhibit 13-5
SEGMENTAL BREAKDOWN - ALTERNATIVE D: VERY HIGH SPEED RAIL OR MAGLEV

Segment Description	Average Capital Cost		Average Demand Yr. 2040	Capital Cost Per Annum		Air Quality	Environmental[4]
	Per KM[1]	Per Mile[1]		PKmT[3]	PMT[3]		
Eastern Terminus to I-75	$11.4 mill/ $16.5 mill	$18.4 mill/ $26.6 mill	6,400 ppd[2]	$4.90/ $7.08	$7.88/ $11.39	POSITIVE 5 Non-attainment Areas	No Unavoidable Constraints
I-75 to I-55 (Mississippi River)	$9.1 mill/ $15.3 mill	$14.6 mill/ $24.6 mill	3,500 ppd	$7.10/ $11.97	$11.43/ $19.26	POSITIVE 2 Non-attainment Areas	National Forest
I-55 to I-35/I-44	$9.8 mill/ $15.6 mill	$15.8 mill/ $25.1 mill	6,700 ppd	$4.01/ $6.38	$6.46/ $10.26	POSITIVE 1 Non-attainment Area	No Unavoidable Constraints
I-35/I-44 to I-25 (Front Range)	$7.8 mill/ $14.9 mill	$12.6 mill/ $23.9 mill	3,700 ppd	$5.80/ $11.00	$9.33/ $17.70	POSITIVE 1 Non-attainment Area	No Unavoidable Constraints
I-25 to Las Vegas/Flagstaff	$12.3 mill/ $16.9 mill	$19.8 mill/ $27.2 mill	2,700 ppd	$12.48/ $17.15	$20.09/ $27.60	POSITIVE 2 Non-attainment Areas	National Forest Indian Res.
Las Vegas/Flagstaff to Western Terminus	$10.9 mill/ $16.2 mill	$17.6 mill/ $26.1 mill	11,200 ppd	$2.68/ $3.96	$4.31/ $6.38	POSITIVE 2 Non-attainment Areas	National Forest

1 Very High Speed Rail Cost/Maglev Cost.
2 Average of two screenlines.
3 Capital Cost ÷ (passenger-km (passenger-miles) of travel per day x 365 days). Very High Speed Rail Cost/Maglev Cost
4 "No Unavoidable Constraints" denotes no identified major constraints which cannot be avoided within the 80-km (50-mile) wide analysis corridor.

Chapter 14
INSTITUTIONAL ISSUES

The primary barriers to implementation of any of the modal alternatives for the Transamerica Transportation Corridor could be institutional in nature — not technological problems. Whereas advances in ground transportation technologies are to be expected over the next few decades, the technologies already exist to construct and safely operate a conventional rural highway to current Interstate standards; or a conventional railway line for operating speeds in the 200-280 km/h (125-135 mph) range utilizing new tilt-train technology; or a super highway with alignment standards which would eventually permit speeds in the 160-240 km/h (100-150 mph) range and with a basic level of IVHS deployment; or a high speed rail line on dedicated grade-separated track capable of operating speeds in excess of 320 km/h (200 mph). Even the basic technologies for maglev systems already exist, although none have been implemented for a variety of reasons. The institutional framework within which transportation projects are considered today presents many barriers to implementation — even to worthwhile projects.

NEED FOR A NEW "21st CENTURY" VISION

The first and most fundamental institutional issue affecting the prospects for any type of facility in the Transamerica Transportation Corridor (TTC) is the national vision of the kind of transportation system wanted in the 21st Century. In the 19th Century, the vision related to railroads — including the development of the east-west transcontinental main lines that still serve the nation well. This was followed, in the first half of the 20th Century, by the advent of the motor car and the focus of building paved roads. For the second half of the 20th Century, the vision was a special new high-quality (controlled access) highway system to link all the larger cities of the nation — the 64,000-km (40,000-mile) National System of Interstate and Defense Highways.

With Interstate System development nearing completion in the 1980s, there was a considerable amount of debate about various proposals for the "post-Interstate" vision for the nation's transportation program. For example, the American Association of State Highway and Transportation Officials (AASHTO) conducted a series of 65 public hearings throughout the country in 1988 as one element of a "Transportation 2020 Program"[1] in which various issues relating to future transportation needs were discussed.

The policy framework for defining a vision for transportation in the 21st Century was established in 1991 by the Intermodal Surface Transportation Efficiency Act (ISTEA).[2] This legislation (Section 2) calls for the development of a national intermodal surface transportation system which is to include, along with other elements, a 256,000-km (160,000-mile) (±) National Highway System (part of which is to be *"a strategic network of highways which are important to the United States' strategic defense policy and which provide defense access, continuity, and emergency capabilities for the movement of personnel, materials and equipment in both peace time and war time...."* The National Highway System [Section 106(b)(1)] is to provide *"an inter-connected system of principal arterial routes which will serve major population centers, international border crossings, ports, airports, public transportation facilities, and other intermodal transportation facilities and other major travel destinations; meet national defense requirements; and serve interstate and interregional travel."* ISTEA (Section 309) also calls for the Secretary of Transportation to lead and coordinate Federal efforts in the research and development of high-speed ground transportation technologies in order to foster the implementation of magnetic levitation and high-speed steel wheel on rail transportation systems as alternatives to existing systems. In addition, ISTEA prescribed a new pattern of institutional relationships for the planning and implementation of transportation projects in the coming years.

To a great extent, the provisions of ISTEA represent the nation's current official vision for transportation in future years. This vision is reinforced by a Strategic Plan,[3] released

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1 *"A Look Ahead — Year 2020"*; Special Report 220 on Proceedings of the Conference on Long-Range Trends and Requirements for the Nation's Highway and Public Transit Systems; conducted by the Transportation Research Board; Washington, DC; June 1988.

2 Public Law 102-240, Intermodal Surface Transportation Efficiency Act of 1991; December 18, 1991.

3 Department of Transportation Strategic Plan; a pamphlet released to the public by the Secretary of Transportation; January 1994.

to the public in January 1994 by the Secretary of Transportation, which specified six US DOT goals as follows:

Goal 1: To Tie America Together through an Effective Intermodal Transportation System

Goal 2: To Invest Strategically in Transportation Infrastructure which will Increase Productivity, Stimulate the Economy, and Create Jobs

Goal 3: To Create a New Alliance Between the Nation's Transportation and Technology Industries to Make them Both More Efficient and Internationally Competitive

Goal 4: To Promote Safe and Secure Transportation

Goal 5: To Actively Enhance Our Environment through Wise Transportation Decisions

Goal 6: To Put People First in Our Transportation System by Making it Relevant and Accessible to Users

ISTEA and the US DOT Strategic Plan provide a <u>general</u> vision of things to come which does not preclude a Transamerica Transportation Corridor program. On the other hand, the analyses presented in the foregoing sections of this Report suggest that (1) the long-term economic benefits of a TTC program which would stem from travel efficiency would not justify the projected costs; and, (2) the public funding requirement in excess of user-based revenues for any of the options — including the Super Highway option — would be quite high and difficult to provide at this time of concern about the national deficit and competitive demands for public funding (for both other transportation needs and social programs). In other words, even if the Transamerica Transportation Corridor is retained in the National Highway System (NHS) or, is included as a high-speed rail line in the National Transportation System (NTS), its prospects for early implementation are not very good in the absence of a more comprehensive 21st Century vision for the Nation which, in the words of Wilfred Owen, the renowned planner/ philosopher,

> *"emphasizes the use of emerging technologies and new organizational forms to achieve the redesign and the building of more livable cities and new communities along new high-speed intercity corridors,"*

and which places greater emphasis on societal objectives other than economic efficiency.

CONSTRAINTS TO NEW VISION

Various highway corridors are explicitly defined by ISTEA as "high priority corridors" for development, with funding for some corridors specified in the legislation. Nevertheless, these positive initiatives do not yet provide for the visionary linkage between the development and deployment of imaginative new forms of transportation and an urban development policy which would involve the building of urban areas along high-speed intercity corridors as envisioned by Wilfred Owen. A new high-speed Transamerica Transportation Corridor ground transportation facility (highway, rail or maglev) could trigger significant land use changes and population shifts, especially if both were supported by other national policies. However, opposition to such policies would be very strong and the existing institutional structure does not lend itself to the integration of a "new town" development strategy and high-speed transportation technology deployment on a multi-state scale.

FUNDING POLICY AND RESOURCES

A second major institutional issue involves public sector funding policy and resources. The figures on fiscal capacity provided in Chapter 11 are based essentially on current budget information and future budgetary trends — a reasonable and conservative basis for assessing the financial viability of a TTC project. Historically, state gas tax increases have been incremental and justified by statewide (as opposed to corridor) based needs. However, a significant departure from the policies of the past with respect to gasoline tax rates (similar to those presently in force in Europe) might create an entirely different pattern of intercity highway needs and funding capacity for an alternative ground transportation mode (assuming no diversion to non-transportation programs). It was estimated in 1993 by government officials that each 1 cent gas tax increase (nationwide) would generate an additional $1.0 billion per year in federal tax revenues. On this basis, a special 2 cents/gallon gas tax could be expected to generate about $50 billion over 25 years ($1993).

Recent congressional debate relating to potential gasoline tax increases for both transportation needs and/or deficit reduction provided little encouragement for those who would like to see a large increase in gasoline taxes dedicated to transportation. Still, over the long term, the issue of higher (perhaps much higher) gasoline taxes to encourage shifts in modal choice and reduced energy consumption could arise again. In this context, some of the needed increase in intercity travel capacity could be provided by a new high-speed facility in the TTC vs. capacity expansion projects along existing Interstate highway routes and/or at major airports. The general issues of gasoline tax rates and whether gasoline tax revenues should be diverted for non-traditional purposes are major institutional issues which are relevant to the long-term prospects of the TTC.

THE MULTI-JURISDICTIONAL INSTITUTIONAL FRAMEWORK

A third major institutional issue relates to difficulties in reaching consensus in the multi-jurisdictional framework of decision-making which would govern TTC project implementation. The TTC extends across parts of 19 states which, along with other states, could be affected, directly or indirectly. Some states would benefit much more than others; cost-sharing criteria would be a major issue, as well as the need to reach consensus on project technology and location. There are indications that alignments favored by some states are incompatible with alignments favored by other states.

PUBLIC/PRIVATE PARTNERSHIPS

The prospects for financing highway and high-speed rail (or maglev) projects through "privatization" or through public/private sector "partnerships" appear to have been overstated in the past. This is at least partially due to lack of recognition of the need to provide potential private investors with an acceptable risk/reward relationship. Identifying ways to shift the burden of early-year deficits, thereby limiting near-term risks of investors to acceptable levels, can be critical to successful financing involving the private sector. In addition, rather than merely investing through purchase of revenue bonds, the private sector is beginning to require a more direct role in project construction and operation. The private sector might require financing structures embodying guarantees and/or some control over user charge rates to off-set the reluctance of public agencies to escalate these rates to off-set cost inflation in the out years. Few states have legislation that meets these criteria.

CONFLICTING GOALS OF INTERESTED GROUPS

Conflicting goals which would need to be recognized include potential interests of railroad vs. truckers; airline operators vs. high speed rail interests; urban vs. rural development interests; and even IVHS vs. HSGT interests. Such conflicting societal goals have already been cited as an issue in terms of competition for funding and political support. The privately owned railroads are focused on maintaining or increasing freight traffic on their existing systems and could be expected to oppose a major public investment in a new transcontinental highway designed to benefit truck traffic. The primary focus of Amtrak is to operate its existing passenger rail system on a financially sound basis within constrained budgets made available by Congress; Amtrak would probably not look with favor at the prospect of assuming operating responsibility for a new passenger rail line expected to incur large deficits, but probably would enter into a contract to operate the new service (at a profit to Amtrak) for a sponsoring public or private agency. Recent experience (in Texas, for example) suggests that the airlines might resist implementation of a high speed rail line intended to draw intermediate-length traffic away from them; some airport operators and/or smaller communities which might lose airport service altogether, might also join the opponents of HSGT. Businesses in existing urban areas which would be bypassed by a TTC Super Highway might resist the TTC project — especially if it would be seen to divert economic growth and new investment away from the existing urban areas. There seems little doubt that conflicts would develop which could delay or kill the project, no matter which modal alternative was selected, unless these conflicts could be addressed satisfactorily from the start.

It is also worth noting that the implementation of Alternative B (tilt-train technology utilizing sections of existing railroad right-of-way) can only be implemented with the full cooperation of the railroads since they (in most cases) are the owners of the railroad rights-of-way needed. Where the introduction of the new passenger rail line would not conflict with existing or projected freight train operations, the railroads probably would be only too pleased to sell right-of-way (or "rail operating capacity") to the passenger train operating agency — at a fair market price. Negotiations over the price of one segment owned by a particular railroad company could be complicated by the need for simultaneous agreement with another railroad for an adjoining segment if both segments were needed to create a practical alignment.

ADVANCE RIGHT-OF-WAY ACQUISITION

Given the length of the TTC and the magnitude of capital investment required, plus the fact that some segments are less feasible than others, the corridor project would certainly be implemented in stages. To ensure the ability to complete the entire program, advance acquisition of right-of-way would be highly desirable. Although the ability to acquire and reserve right-of-way in advance of need has diminished greatly in recent years, Section 1017 of ISTEA does apportion some funding to the states for early acquisition of right-of-way under certain terms and conditions. A report (The Preservation of Transportation Corridors Report) must be submitted to Congress to identify the rights-of-way proposed for early acquisition and to present a strategy for preventing the loss of these rights-of-way. Pursuant to ISTEA, the desirability of creating a "transportation right-of-way land bank to preserve vital corridors" is under consideration.

A TRB Special Report on HSGT prepared by a committee of 19 experts recommended that *"the US DOT and states should consider preserving and acquiring ROW suitable for HSGT systems in the more promising corridors"* but the more recent designation of promising HSGT corridors by the USDOT in 1992 did not include the TTC.

In addition, easements through lands under the jurisdiction of Indian tribal governments may be needed.

SAFETY ISSUES

Regulatory requirements also include compliance with US safety standards — a major hurdle with respect to the high speed rail, high speed maglev, and high-speed (automated) Super Highway options. Existing foreign high-speed rail systems, although safely operated for many years, do not meet current US safety regulations. In fact, there is no US safety standard for rail speeds greater than 175 km/h (110 mph); Amtrak operations in the Northeast Corridor in excess of 175 km/h (110 mph) required a waiver.

The requirement of fail-safe operations is also a major hurdle for the application of Advanced Vehicle Control Systems with the Super Highway option. Safety and security concerns relate to:

- Certification and maintenance of in-vehicle equipment;
- Operation and monitoring of control systems;
- Security and integrity of information databases and data distribution systems; and,
- Operational conditions such as maneuvers involving automated vehicles entering and exiting from moving platoons of electronically linked vehicles.

Product liability is also a key issue in determining the future pace of IVHS deployment — an issue which is presently under study under the auspices of IVHS America.

ENVIRONMENTAL CLEARANCES

Any TTC project would require numerous permits, certifications, and technical reviews by federal, state and local agencies of government. These can create costly delays and uncertainties which can undermine the investment attractiveness of a project; long lead times for payback discourages private investment. Any of the TTC options could affect:

- Wetlands,
- Wildlife habitat
- Water/air quality
- Noise/vibration
- Section 4(f) lands (parks, historic sites, etc.)
- Lands under the jurisdiction of Indian Tribal governments

- Navigable waterways
- Community businesses.

The existence of any of the conditions noted above could generate strong opposition to the TTC project and/or the need for costly impact mitigating measures or project redesign/relocation. Even where these adverse impacts would not occur, various certifications and permits would be required. For example, a certification would be required from every State Historic Preservation Officer (SHPO) regarding the existence or acceptability of any impacts on historic sites. A "401 permit" would be required from the Corps of Engineers relating to wetlands impacts and from the Coast Guard for situations where navigable waterways would be crossed. State environmental agency clearances would be required which confirm that National Ambient-Air Quality Standards (NAAQS) would not be exceeded. Certifications would be required from State archeology officials at least to confirm that adequate "Phase 1" field testing and data/literature research has been completed to identify archeological sites or, where archeological sites of significant value are potentially impacted, more detailed Phase 2 field surveys might be needed. US Fish and Wildlife could have to sign-off on the acceptability of impacts on endangered species and/or wildlife habitats. There may be legal covenants which control the future use of certain lands which would require legal clearances. The Environmental Protection Agency (EPA) would have ultimate control over the environmental impact study process, including veto power over permits issued by other agencies of government.

The process of obtaining environmental clearances would require that the Transamerica Transportation Corridor be divided into logical operable segments with logical termini — not necessarily at state lines. Thus, several multi-state route planning environmental clearance programs would need to be anticipated — each extending over a lengthy period. In order to ensure overall route continuity, these separate efforts would need to be coordinated at various states of the project planning and design process.

ROLES AND RESPONSIBILITIES

If a major coast-to-coast transportation facility is implemented in the Transamerica Transportation Corridor, cooperative efforts of the public and private sectors will be required — whether the facility is to be a Super Highway or an HSGT (rail or Maglev) line.

The organizational framework for the IVHS program may be a good model for implementing a full-automated Super Highway; new relationships between governmental agencies and the private sector are being forged through IVHS America. With the Super Highway option, the private sector would have a major role in technology development and deployment — and possibly in financing and even operation of the facility. The public sector role would include planning, program administration, financial support and possibly road construction through the states involved. Long-established relationships between the states and FHWA would apply.

If, on the other hand, the TTC facility would be a high-speed guideway (rail or maglev) several different organizational options would warrant consideration. One of these would involve the creation of a new "joint powers agency," the members of which would include the federal government (probably represented by FRA and/or Amtrak) and the states directly involved to the extent of funding commitment. The joint powers agency would have the power to contract with the private sector to the extent required for assistance in planning, design, construction, operation and even financing the system. The joint powers agency approach has been used previously with success to implement rail projects which cross jurisdictional boundaries. A cost-sharing formula would be required which reflects the fact that the states would not share project benefits equally. Amtrak was designated by Congress as the operator of the existing intercity passenger rail network and would be a logical candidate to operate a new HSGT line — with private sector support as required — as a contractor of the joint powers agency.

Whether a highway or guideway project, the federal government (FHWA or FRA) would need to supply leadership and provide the national emphasis and perspective which the TTC project would require.

INSTITUTIONAL ISSUES RELATING TO IVHS TECHNOLOGIES

Some of the key institutional and legal issues which represent challenges to successful implementation of intelligent vehicle highway system technologies — especially future developments leading to a fully automated Super Highway — were identified by IVHS America in preparing its 1992 Strategic Plan for IVHS in the United States.[4] The authors of this Strategic Plan concluded that *"institutional and legal changes will be required in order for IVHS to succeed...."* The required changes relate to:

1. Private vs. public sector roles and responsibilities (i.e., a greatly expanded role will evolve for the private sector as compared to the predominant role of the public sector in the provision of transportation infrastructure in past decades);

2. The need to control investment risks of the private sector, and offer the promise of a reasonable return on investment (a constraint not faced by the public sector to any significant degree);

3. The need for a much greater degree of cooperation and direct collaboration between various levels of government, between states, and between governmental agencies and the private sector in the implementation of particular projects which cross state and county lines;

4. Product liability doctrine and practices applied by the courts, which can inhibit the private sector from developing new technology products. (The exposure to risks of liability suits arising from IVHS equipment in vehicles can raise costs significantly);

5. Antitrust laws which may impact collaboration among competitive companies in research and development of new products;

6. The need for safeguards to control the use of information generated by IVHS technology (the privacy issue) in order to secure public acceptance;

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4 Strategic Plan for Intelligent Vehicle-Highway Systems in the United States; prepared by IVHS America; May 20, 1992.

7. Red tape involved in relationships between private companies and the government which can cause delays and impact procurement costs;

8. Intellectual property rights relating to technological innovations;

9. Regulations and the regulatory process, such as regulations relating to a) environmental impacts, b) public safety, c) communications by radio and other media; and

10. Standards and protocols in product development and system architecture (the compatibility issue).

All of the issues listed above have been identified by IVHS America as subjects for further study and action. Progress has already been made in some aspects of the overall problem of institutional barriers and the pace of implementation of currently available IVHS technologies on existing interstate highways has been accelerated.

For example, multi-agency interregional traffic incident management arrangements have been developed for several major Interstate highway corridors — all involving new forms of collaboration between state and local public agencies and the private sector. IVHS technologies are in place on several major toll roads, which enable automatic toll collection and the monitoring of traffic operations. Various cities and states have received grants from FHWA to develop area traffic management plans with a special emphasis on the early deployment of state-of-the-art computer software and communications technologies.

It is not yet clear when the stage will be reached that (1) all the technologies needed for high-speed and fully-automated vehicle operations are available; (2) an institutional framework will exist which will encourage deployment of these technologies in a multi-state context; or (3) when the level of public acceptance of fully-automated vehicle operations will reach the point where enough individuals have confidence in the safety provisions and elect to pay the cost to equip their vehicles to use an automated Super Highway and to use it if the operating speeds exceed 160 km/h (100 mph). The point in time when the Super Highway option could offer high-speed (160+ km/h [100+ mph])) performance must be expected to be more remote than the point in time when speeds in excess of 160 km/h (100 mph) could be offered by the HSGT (rail) option.

INSTITUTIONAL ISSUES RELATING TO HSGT

Whereas a stable funding source for interstate highway system development (the gasoline tax) has been in place for several decades, no such source of funds has been established to upgrade and maintain the nation's interstate rail system. Amtrak relies on annual budget allocations from Congress and is expected to operate with minimal operating cost support from public funds and with very limited allocations of public funds for capital needs. There is no federal commitment at present to upgrade the Amtrak system to modern standards of performance (except perhaps in the Northeast Corridor). Although several intercity corridors have been designated by FRA (or by the Federal Railroad Administration) as high-speed ground transportation corridors, funding commitments for the upgrading of these corridors are small.

Several states have provided the leadership in recent efforts to implement high-speed rail projects (Texas, Florida and Ohio, for example). In each case, the private sector was expected to finance the project with little or no public funding support. These efforts at "privatization" proved unsuccessful. One of the government actions proposed by some HSGT advocates is to change existing laws relating to tax-exempt bond financing and loan guarantee programs to encourage private sector improvements (i.e., to reduce private sector risk). The federal government is sponsoring maglev research and development projects aimed at: a) defining a "standard" US maglev technology; b) developing new (lower cost) guideway construction materials and related design criteria (guideway costs represent a major proportion of HSGT system implementation costs); and c) resolving other specific technological issues. When and if these limited current efforts do lead to a stronger federal commitment to HSGT implementation, it is highly likely that the focus of federal interest will initially be the five previously designated intercity corridors (plus the Northeast Corridor) - not the Transamerica Transportation Corridor - since these corridors have been shown to be more financially feasible. Thus, unless federal transportation policy relating to HSGT is changed, the TTC is likely to have a lower priority for federal action than at least six other HSGT corridors - corridors which already have state-level or regional support constituencies as well as federal recognition.

PUBLIC/POLITICAL SUPPORT

Given the challenges created by the institutional barriers noted above, it is clear that a strong public and political constituency for a TTC program would be needed. The January 1994 Department of Transportation Strategic Plan[5] identifies as an objective: *"Accelerate the IVHS Program."* The IVHS community generally believes that this can best be accomplished by the early deployment of available IVHS technologies on existing highways and implementation of specific highway projects (not in the TTC) mandated by ISTEA.

The generation of greater interest in the TTC appears to depend in large measure on the ability of its advocates to establish a public perception of potential linkages with the major societal concerns of today — such as job creation, oil-based energy conservation, economic development, training in needed job skills, etc. A strong constituency for the TTC as an element of a broader vision for the future of this country would be essential if the program is to move ahead. Feasibility of the project clearly depends on changes in existing forms of development and changes in fundamental goals and objectives extending well beyond the limits of traditional transportation programs. An early indication of the evolving federal vision of future things to come may come later this year when Congress is scheduled to define the new 256,000 km (160,000-mile) National Highway System (NHS) — roads which will receive a substantial share of federal dollars made available for transportation in the years leading to the dawn of the 21st Century. Because the TTC was included in ISTEA as a high priority corridor, the NHS plan submitted to Congress for approval includes the Transamerica Transportation Corridor without defining its location.

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5 Department of Transportation Strategic Plan; a pamphlet released to the public by the Secretary of Transportation; January 1994.

Chapter 15
FINDINGS AND CONCLUSIONS

INTRODUCTION

Work reported herein covers evaluations of coast to coast, surface transportation alternatives for a 21st Century system. These studies show that such a facility is not feasible due to relatively high costs and low benefits for a full transcontinental route. However, further study may show that some segments of the TTC could represent a good investment. The Transamerica Transportation Corridor concept is compatible with ideas proposed by the U.S. Department of Transportation through the 1991 ISTEA legislation as well as by the Government Accounting Office through its 1992 Transportation Issues report to Congress. This latter document stated:

> *"New and emerging technologies, such as high-speed rail and intelligent vehicle/highway systems, could in some instances benefit the nation's overall transportation system by reducing pollution, energy usage, and congestion, and by making more efficient use of the transportation infrastructure."*

CORRIDOR VISION

Given conditions in the Transamerica Transportation Corridor, the feasibility of a new transportation facility is most likely to be achieved if it can serve a number of important functions. The vision for this corridor consciously embodies those features which will enhance its feasibility, including the following:

- It must contribute significantly to economic development and increased productivity.
  - From the national perspective, the vision involves contributions to the national economy. If economic development in the corridor primarily reflects a transfer from another part of the country, there is little net increase to off-set the high cost of a coast-to-coast transportation facility.
  - From the perspective of communities in proximity to the corridor, any kind of eco-

nomic growth probably is good, even if it is growth that is transferred to the corridor from elsewhere in the U.S.

- Given these two perspectives, it is a matter of national policy rather than technical analysis to decide whether the feasibility of the TTC is based upon increased net national benefits or economic development which favors this particular corridor.

- A high speed facility designed principally for long distance travel has the greatest potential for attracting sufficient traffic to justify the heavy expenditures that would be required.

- A high degree of automation also would make the Transamerica Transportation Corridor a more attractive alternative for long distance travel.

- Likewise, features which improve the safety of travellers will make the Transamerica Transportation Corridor more attractive (and, consequently, contribute to its feasibility).

- A particularly important feature is the ability of the Transamerica Transportation Corridor to divert traffic away from parallel routes, especially from I-70 and I-40.
  - Therefore, increases in travel speeds are important;
  - Another feature is the incorporation of higher safety levels than is available with existing facilities;
  - Another feature is the provision of an effective feeder system to connect the corridor with the major urban areas to its north and south.

- Because improvements in freight transport efficiency can yield economic/productivity benefits, the Transamerica Transportation Corridor should facilitate such movements.

— Through the higher safe speeds already mentioned.

— And also by accommodating heavy and/or multiple-trailer vehicles (e.g., LCVs).

- In recognition of the pace of technology development, the Transamerica Transportation Corridor should be adaptable to technological innovations of the future.

- The immensity of the Transamerica Transportation Corridor dictates that a transportation facility be adaptable to incremental implementation. This could be accomplished by two approaches, viz.:

  — Transitional options which incrementally increase capacity and upgrade services along the TTC; and

  — Segmental options in which sections of the TTC would be implemented as each becomes a viable improvement element.

Because of this vision, this study of the Transamerica Transportation Corridor has maintained a broad view of the opportunities and constraints associated with the corridor. Appropriately, the corridor has been described in broad terms so that all reasonable alternatives could be assessed. Likewise, a 30 to 50 year planning horizon has guided the feasibility analysis so that opportunities afforded by emerging conditions and technologies could be considered. In doing so, this has afforded the widest range of possibilities to be evaluated as the study has attempted to identify these circumstances and transportation technologies which offer the greatest opportunities for the corridor.

TRANSPORTATION ALTERNATIVES

With passage of ISTEA, Congress provided the final authorizations for the Interstate System. Given this national policy, a new facility for the Transamerica Transportation Corridor requires a new vision for the 21st Century, as discussed above. Consequently, this Study has explored a wide range of transportation alternatives, some of which incorporate conventional concepts and others which are innovative departures from the past. By considering all reasonable concepts, the Study has attempted to investigate various means whereby the feasibility of a transportation facility in the corridor could be enhanced. These attempts to enhance the corridor's feasibility have included transportation features that would give the corridor travel advantages relative to other transcontinental transportation routes and services. Also, they have included the concept of feeder routes which would funnel traffic onto the TTC which might otherwise travel by other routes or means.

Initially, the Study investigated some 19 transportation concepts. Through a successive screening analysis procedure, the principal alternatives were identified. Again, these principal alternatives have features which would enhance the attractiveness of the TTC, including higher speeds, greater safety, less demands on drivers, improved freight transportation operations and similar features. The principal alternatives which evolved out of the Study's analyses were:

Alternative A: Conventional Interstate-type Highway

The main features of this alternative are:

- Built to Interstate standards
- Somewhat higher speeds than other Interstates because urban areas are not penetrated
- Includes basic level of IVHS technologies
- Longer combination trucks (LCVs) accommodated

Alternative B: Upgraded Railroad

This alternative features:

- Tilt train technology
- Speeds ranging from 200 kph to 220 kph (125 mph to 135 mph)

Alternative C: Super-highway and Truckway

Features of this alternative include:

- Vehicle speeds up to 240 kph (150 mph)

- Substantial deployment of IVHS technologies, including Advanced Vehicle Control Systems (AVCS)
- Separated truck roadway

<u>Alternative D: Very High Speed Fixed Guideway</u>

This alternative is distinguished by the following features:

- Considers both high speed rail (i.e., steel wheel) and maglev technologies
- Design speeds from 200 kph (125 mph) in mountainous terrain to over 480 kph (300 mph) in flat terrain
- Electrically-powered trains on primarily new alignments

Additional features of all Alternatives are feeder networks which would make the TTC a more attractive facility.

All of the alternatives include accommodations for joint uses should they be determined to be feasible. This includes uses such as fiber optic lines, electric lines, oil or gas pipelines and water/wastewater pipelines.

Two versions of Alternative C were examined. One version, designated as C3, assumed that there would be two additional transcontinental Super Highways (one north of I-70 and one south of I-40). In the Alternative C3 concept, the Study's feasibility assessments essentially determined whether a third Super Highway (i.e., the TTC) was warranted.

The other version of Alternative C, designated as C1, assumed that the TTC would be the only transcontinental Super Highway. Therefore, it would enjoy a substantial speed advantage for east-west travel.

CONCLUSIONS REGARDING STRATEGIC ISSUES

As noted in Chapter 1, this Study addressed a number of strategic issues. The Study's analyses have permitted certain conclusions regarding these issues. These are presented below.

Corridor Attributes

One strategic issue is whether this corridor has attributes that make it a good candidate for a transcontinental transportation facility. A number of corridor features are relevant. There are few major population centers within the corridor and population density tends to be low. While there are sizable population centers at the Corridor's termini on the two coasts, the interaction between these centers is diminished by the distance between them.

The corridor also has some challenging physiographic features because of the mountain ranges that must be transversed. Land ownership patterns also are a challenge in the western portion of the corridor.

Despite these features, there are no constraints that would be insurmountable. Still, they do have unfavorable effects upon the amount of travel that would be attracted to the TTC and the cost to build it.

Opportunities to Enhance Feasibility

The study incorporated a number of features which were intended to enhance the feasibility of the TTC. A major opportunity to improve the attractiveness of the Corridor is to provide a high speed facility. In doing so, this would attract traffic away from I-40 and I-70, thereby relieving these routes of some of the traffic which would otherwise use them. As a minimum, the Study has assumed that the higher speeds permitted by conventional interstate highways should be considered. Further, the impedances typically experienced by through traffic when passing through urban areas can be avoided by routing the TTC facility around urban areas and providing suitable connections to the urban centers. This will avoid some of the problems experienced on the existing interstate system which tend to penetrate urban areas where congestion and lower speed limits are encountered.

Other study options considered the use of IVHS technologies, such as Advanced Vehicle Control Systems (AVCS), as a means of achieving higher travel speeds. Likewise, the Study's assumptions regarding fixed guideway systems employed higher speeds than currently are achieved on most systems.

A second means of enhancing the feasibility of the TTC is to provide a feeder network. These north-south oriented routes would connect the TTC facility to major population centers located along the edges of the corridor or outside of it. Such facilities were assumed to be provided in the Study's feasibility assessments.

A third opportunity to enhance feasibility is to improve safety. All of the principal alternatives would achieve this. Rural interstate highways have the best safety records of current roads while the addition of IVHS technologies would provide even greater safety. Anticipated safety features of high speed fixed guideway systems are also assumed.

A fourth opportunity is to remove as many impediments as possible that would slow down traffic (while also maintaining a safe travel environment). Locating the TTC facility so as to avoid penetrating urban areas is one means of achieving this. Deployment of IVHS technologies also will permit smoother traffic flow with fewer speed change cycles.

Improvements in other aspects of travel also can make the TTC more attractive. For instance, AVCS technologies can greatly reduce demands upon vehicle drivers. The amenities of high speed guideway systems (e.g., freedom to move about, availability of food and beverages, etc.) also offer attractive travel features.

Another opportunity to enhance the feasibility of the TTC is to improve the efficiency of freight transportation. Regarding the highway options, this would involve heavier pavement designs to accommodate higher vehicle gross weights, geometric features to accommodate longer combination vehicles (LCVs) and IVHS technologies that reduce demands on drivers and improve safety. The fixed guideway alternatives examined in the Study primarily make passenger travel more attractive and are expected to have more modest impacts on freight transportation.

Constructing the TTC in stages also would enhance its feasibility. While segmental analyses were not included in the scope of work for this study, it is clear that some segments logically would be more feasible than others. Also, a hypothetical financial analysis of very long segments demonstrated that improved financial performance could be achieved by staged construction.

Finally, there are a number of measures that could be employed to enhance the financial feasibility of the TTC. These include tolls (as a means of cost recovery from those who benefit from the facility), joint use revenues (from fiber optic lines and other joint uses), donation of rights-of-way, and public/private financing.

Travel Efficiency Economic Benefits

The Study's economic analyses have produced estimates of the travel efficiencies that would be achieved by a transcontinental transportation facility in the study corridor. Each of the alternatives would generate significant savings in travel time, operating costs, and accident reductions for both freight and person transportation. The large travel efficiencies are reflective of the magnitude of the TTC project as well as the growth that will occur in the period to 2040. These economic benefits are summarized in Exhibit 16-1.

Exhibit 16-1
TRAVEL EFFICIENCY BENEFITS
($Million)

TRANSPORTATION ALTERNATIVE	ANNUAL BENEFITS[1]		TOTAL BENEFITS THROUGH 2040[4]
	1990[2]	2040[3]	
A: Interstate-Type Highway	$579	$1,782	$12,772
B: Upgraded Railroad[5]	956	1,449	13,525
C1: One Super Highway	3,049	7,926	51,735
C3: Three Super Highways	1,815	4,717	30,954
D: Very High Speed Guideway	738	1,719	10,138

(1) Constant price levels, not discounted.
(2) Base year for travel forecasts. Represents benefits that would have been realized had the TTC been in operation in 1990.
(3) Excluding residual value.
(4) Discounted to 1993 at 7%.
(5) Excludes rail cost savings so as to be consistent with other benefits on exhibit.

As noted, the travel efficiency benefits created by the Alternative C1 Super Highway Concept exceed all other alternatives, reflective of the considerable speed and other advantages embodied in this concept. The next highest benefits would derive from Alternative C3 in which the TTC Super Highway would have to compete with two other transcontinental Super Highways. This would reduce use of the TTC with a concomitant reduction in benefits of 40 percent.

Capital Costs

Because of the significant difference in the type of transportation concepts studied, there is a corresponding wide range in the costs associated with them. As noted in

Exhibit 16-2, Alternative A: Conventional Interstate-Type Highway, has the lowest capital cost for the full coast-to-coast facility. The Alternative C: Super Highway concept involves a high initial capital cost because it embodies an 8-lane cross-section to accommodate both instrumented cars and trucks, as well as vehicles which are not equipped to use the AVCS technology.

Exhibit 16-2
CAPITAL COSTS FOR TTC ALTERNATIVES

TRANSPORTATION ALTERNATIVE	CAPITAL[1] COST ($ billions)
A: Interstate-Type Highway	$17.9
B: Upgraded Railroad	33.1
C: Super Highway	53.4
D1: High Speed Rail	51.4
D2: Maglev	78.1

(1) 1993 dollars.

Capital costs for Alternative D: Very High Speed Fixed Guideway, also are quite high. The capital cost for a steel wheel technology is roughly comparable to the Alternative C: Super Highway cost. If a maglev technology is employed, capital costs would be about 50 percent higher than for a steel wheel technology.

Economic Feasibility

A major public investment such as the TTC is "economically feasible" if the economy is better off with it than without it. This Study has defined economic benefits as "an increase in the prosperity and incomes of people and institutions." Increases of this type in the corridor can occur in two ways:

- Travel efficiency benefits; and
- Attraction of resources (i.e., corridor economic development).

Travel efficiency benefits are net gains to the nation. On the other hand, resources attracted to the TTC are, in essence, transferred from other locations in the U.S. Therefore, given the national perspective of the TTC, only the first category, i.e., travel efficiency benefits, are considered as true economic benefits in determining the economic feasibility of a new coast-to-coast transportation facility.

The Study's economic analysis has determined whether the TTC project produces benefits which are equal to or greater than the costs of the potential facility. Costs include the capital costs discussed above and the operating and maintenance costs of each transportation alternative. Conventional feasibility indicators were developed and the results are initially presented in Exhibit 9-7 of this report and are replicated in Exhibit 16-3.

Exhibit 16-3
NATIONAL PERSPECTIVE
TRAVEL EFFICIENCY FEASIBILITY FINDINGS

TTC OPTION	NET PRESENT VALUE[a] ($ billion)	INTERNAL RATE OF RETURN	DISCOUNTED BENEFIT/COST RATIO[a]
A: Interstate-Type Highway	($5.9)	4.8%	.68
B: Upgraded Railroad	($34.9)	-4.5%	.49
C1: One Super Highway	($3.3)	6.7%	.94
C3: Three Super Highways	($23.4)	4.1%	.57
D: High Speed Guideway[b]	($47.1)	-1.2%	.18

NOTES: (a) Discounted at 7%.
(b) Based on the steel wheel technology.

SOURCE: Wilbur Smith Associates

Based upon the Study's analyses, none of the transcontinental transportation alternatives were found to be economically feasible from a national perspective. In every case, costs exceed benefits, negative Net Present Values would be realized and the project's Internal Rate of Return would be less than the discount rate of seven percent. Of the options, Alternative C1: One Super Highway comes closest to attaining this measure of feasibility.

Economic Development Effects

A new transcontinental transportation facility in the TTC should help the communities in the corridor to develop economically by attracting firms and economic activity to them and by helping them compete with other communities in the U.S. By creating a new transportation facility, and by reducing transportation costs in the region, the TTC would become more economically attractive and competitive, thereby attracting new industries and tourists to the corridor and encouraging existing corridor industries to expand.

The Study estimated the economic development gains that would occur as a result of the TTC transportation facility. These economic development gains are significant and, from the corridor's perspective, make the project very attractive. However, economic development gains in the TTC would come at the expense of other places in the U.S. For example, by improving the corridor's competitive position, firms may choose to locate in the TTC rather than some other part of the country. Therefore, at the National (federal) level, these effects constitute economic transfers rather than a net increase in the National economy.

Three measures of economic development impacts were developed by the Study's analyses. The results are summarized in Exhibit 16-4.

According to the Exhibit 16-4 calculations, the Super Highway is expected to have the greatest economic impact on the TTC region. The Alternative C1 Super Highway is estimated to attract over 220,000 jobs to the region (excluding TTC construction jobs). All of the options would create value added in the corridor amounting to many billions of dollars.

While these impacts are sizable, they represent one percent or less of total jobs and total value added already in the corridor area. In addition, the value added and jobs impacts primarily represent a redistribution of jobs, and money, from elsewhere in the U.S. Investment in transportation is a very expensive way of creating jobs.

Exhibit 16-4
ECONOMIC DEVELOPMENT IMPACTS

TRANSPORTATION ALTERNATIVE	VALUE ADDED 1993-2040(1) ($Million)	WAGES 1993-2040(1) ($Million)	NUMBER OF JOBS	
			2001(2)	2040
A: Interstate-Type Highway	50,086	31,369	80,811	70,627
B: Upgraded Railroad	63,145	44,052	130,227	52,630
C1: One Super Highway	171,453	90,624	243,994	220,700
C3: Three Super Highways	133,177	76,459	218,386	131,791
D: Very High Speed Guideway	90,842	63,449	200,813	60,500

(1) Discounted at 7 percent. Constant 1993 price levels.
(2) Includes TTC construction jobs.

Financial Viability

Analyses were undertaken to assess project costs relative to potential project revenues, to identify funding options, and to determine funding requirements for each of the principal transportation alternatives.

For the highway alternatives, revenue forecasts were made on the basis of a toll road concept. Although tolls would be the largest source of revenues, other revenues were assumed for joint use of the TTC right-of-way (e.g., fiber optic lines), telephone commissions (from telephone coinboxes) and advertising (e.g., billboards). For the fixed guideway alternatives, fares would be the principal source of revenues.

The public funding requirement of the Alternative A: Conventional Interstate-Type Highway was the least of the principal transportation alternatives. The highest public funding requirement would occur with the fixed guideway options (i.e., Alternative B: Upgraded Roadway and Alternative D: Very High Speed Fixed Guideway). The public funding requirement for Alternative C1: Super Highway is about twice that for Alternative A while for Alternative C3 it is more than three times the requirements for Alternative A. This difference reflects the reduced traffic which would use a TTC Super Highway if there were two other transcontinental Super Highways.

As mentioned earlier, there are various means of reducing costs such as right-of-way donations or by staging construction. Also, there are financial advantages of building the more cost-effective segments first and putting off construction of the more expensive and/or less utilized portions of the TTC. Further, breaking the corridor into segments would result in a series of smaller bond issues which would make them more attractive on the bond market.

Study analyses suggest that the public funding requirements for the TTC will be substantial. These requirements would have to compete with the many other funding needs in the TTC States. Also, if federal funds are applied to the TTC, this could be at the expense of other states, a matter of considerable controversy. Alternatively, special funding for the TTC could avoid this difficulty.

Institutional Issues

The primary barriers to implementation of the TTC could be institutional in nature rather than technological.

The first and most fundamental institutional issue affecting the prospects for any type of TTC facility is the national vision of the desired 21st Century transportation system. The policy framework for defining this vision was established in ISTEA which calls for a national intermodal surface transportation system which will include, as one element, the National Highway System. This vision has been reinforced by a Strategic Plan released by the Secretary of Transportation in January 1994. While this vision does not preclude a TTC program, there are serious questions whether sufficient funding could be provided for it, particularly given concerns about the national deficit and the competitive demands for public funding.

Concerns also exist concerning the difficulties in reaching consensus regarding the TTC in the multijurisdictional framework of decision-making. This is particularly true since each state will have interests and expectations which will vary significantly from those of other states.

A further institutional issue concerns the conflicting goals of interested groups. For example, there will be conflicts between the interests of railroads versus truckers; airline operators versus high-speed rail interests; urban versus rural development interests, etc. Consequently, not only could there be competition regarding funding but also regarding political support.

Various other institutional concerns also were identified in the Study, such as the need for advance acquisition of right-of-way, safety standards and regulations, privatization issues and environmental clearances. Further, there are a number of important issues regarding IVHS (both legal and institutional) and regarding high-speed ground transportation.

Given the institutional challenges associated with a project of this magnitude, it is clear that a strong public and political constituency for a TTC program is needed. A TTC constituency must recognize the need to operate within the broader vision of the National Transportation System if the TTC program is to move ahead.

Environmental Impacts

The Study investigated a large number of potential project locations. Because the Study was not concerned with specific alignment issues, each of the locations was considered to encompass a band which is 80 km (50 miles) wide. Consequently, it was determined that within this band it would be possible to avoid many of the natural resources which exist within the TTC.

There are several urban areas within the study area for the TTC which have not met National Ambient Air Quality Standards. The representative locations identified for the TTC highway alternatives generally are located away from the "non-attainment areas." This could be helpful to those areas since through traffic would not have to pass through them.

The rail alternatives are located close to six of the non-attainment areas. The rail technologies would have a positive effect on air quality by reducing the number of highway vehicles passing through urban areas.

FURTHER CONSIDERATIONS

There are two major areas of analysis which need to be addressed to validate or modify the conclusions derived by the TTC studies. These two areas are (1) a segment analysis (to address the possibility of feasibility of a facility shorter than coast-to-coast) and (2) a construction savings analysis (to address the trade-offs of saved construction on routes parallel or near to the TTC versus increased construction on routes feeding the TTC and the cost associated with development of the TTC itself). There is reason to believe that evaluations within these two areas of consideration would provide helpful insight on the feasibility of portions on the TTC.

CONCLUSIONS

Based upon the Study's analyses, a number of conclusions emerged, as follows:

- While the study's travel demand analyses show a significant variation in volumes at different locations in the corridor, they do not, on the whole, indicate a pressing need for a coast-to-coast TTC at this point in time.
  - Nevertheless, there may be traffic congestion on parallel facilities in certain segments of the TTC which could be relieved by provision of a new facility in the corridor. This topic was not examined as part of the current study.
  - Additionally, it is possible that costs to improve parallel existing routes could be reduced if the TTC were implemented.
- The low population densities and challenging physiographic and land ownership patterns in the corridor detract from the feasibility of the TTC.
- The Study has identified various ways to enhance the feasibility of the TTC. A very important opportunity would be to develop a TTC facility that enjoys higher speeds and improved safety for all vehicles and also has the ability to serve larger and heavier trucks than is possible with existing interstate highways.
  - Future technologies, particularly those associated with Intelligent Vehicle-Highway Systems (IVHS) have considerable promise, particularly since the TTC could be designed from the beginning to incorporate them. It will be more challenging and costly to retrofit existing facilities to accommodate these emerging technologies.

- The TTC does not meet economic feasibility criteria, generally because of its high costs and low travel demands in some segments.
  - The most feasible technologies (the Super Highway concept) are in the development stage, making costs and benefits difficult to estimate.
  - If future IVHS research reveals ways to reduce the cost assumptions of this study, it is quite possible that a coast-to-coast Super Highway in the TTC would achieve economic viability.
- Even if the TTC is economically feasible, it would be an extremely expensive project. It could not be funded under current funding programs, even if tolls are imposed.
- The Study shows that the corridor would benefit from the economic development that would accompany construction and use of a new coast-to-coast facility.
  - Nevertheless, these benefits would be at the expense of economic development elsewhere. That is, they would be transfers to the TTC because of the advantages the new facility would offer.
- Study findings regarding a coast-to-coast facility do not mean that individual segments of the corridor are not feasible or would not be desirable from a state or regional perspective.
  - Additional analysis of individual segments could find that some are feasible.
  - These segments may provide linkage to the National Highway System and/or key elements of a state's transportation system.

— Ultimately, if segments are built and as technologies advance, review of the overall corridor may be warranted.

- The Study's economic analyses are based upon a number of estimates (e.g., costs, usage) and assumptions (e.g., discount rates, value of time, etc.). A series of sensitivity tests show that there are circumstances under which the TTC would be economically feasible.

  — Within the range of variation examined, there are more favorable circumstances under which the highway alternatives (conventional Interstate-type highway and Super Highway) would achieve economic feasibility.

  — Even under considerably improved circumstances, the rail alternatives would not achieve economic feasibility.

Appendix A

This Appendix contains the detailed economic analysis calculations summarized in Chapters 9 and 10.

EXHIBITS A-1 THROUGH A-5

These exhibits present the life cycle (1993-2040) comparison of costs and benefits as summarized on Exhibit 9-7 in the Economic Feasibility Chapter. Each TTC option has its own exhibit number.

EXHIBITS A-6 THROUGH A-15

These exhibits present the life cycle (1993-2040) estimation of value added impacts on the TTC region. The results were summarized in Exhibit 10-5 in the Economic Development Chapter. Each TTC option has its own Exhibit number, and the calculations are shown inclusive and exclusive of the impacts attributable to TTC construction.

Exhibit A-1

TRAVEL EFFICIENCY FEASIBILITY CALCULATIONS
ALTERNATE 'A' – UPGRADED HIGHWAY

(1993 Dollars in Thousands)

Year	Project Costs		Travel Efficiency Benefits						Undiscounted			Present	Discounted to 1993		
	Const.	Maint. & Operations	VOC	Freight Time	Time	Accident	Additional Surplus	Residual Value	Total Costs	Total Benefits	Net Benefits	Worth Factor	Total Costs	Total Benefits	Net Benefits
1990			264,855	10,045	249,553	48,289	6,000								
1991															
1992															
1993	17,855,800								17,855,800	0	(17,855,800)	1.0000	17,855,800	0	(17,855,800)
1994									0	0	0	0.9346	0	0	0
1995		66,890	292,655	10,749	336,678	52,732	6,200		66,890	699,014	632,124	0.8734	58,424	610,546	552,122
1996		66,890	298,215	10,889	354,104	53,621	6,240		66,890	723,069	656,179	0.8163	54,602	590,240	535,637
1997		66,890	303,775	11,030	371,529	54,510	6,280		66,890	747,123	680,233	0.7629	51,030	569,977	518,947
1998		66,890	309,335	11,171	388,954	55,398	6,320		66,890	771,178	704,288	0.7130	47,692	549,839	502,148
1999		66,890	314,895	11,311	406,379	56,287	6,360		66,890	795,233	728,343	0.6663	44,572	529,897	485,325
2000		66,890	320,455	11,452	423,804	57,176	6,400		66,890	819,287	752,397	0.6227	41,656	510,211	468,555
2001		66,890	326,015	11,593	441,229	58,064	6,440		66,890	843,342	776,452	0.5820	38,931	490,832	451,902
2002		66,890	331,575	11,734	458,654	58,953	6,480		66,890	867,396	800,506	0.5439	36,384	471,806	435,422
2003		66,890	337,135	11,874	476,079	59,842	6,520		66,890	891,451	824,561	0.5083	34,003	453,168	419,165
2004		66,890	342,695	12,015	493,505	60,730	6,560		66,890	915,505	848,615	0.4751	31,779	434,950	403,171
2005		66,890	348,255	12,156	510,930	61,619	6,600		66,890	939,560	872,670	0.4440	29,700	417,176	387,476
2006		66,890	353,815	12,297	528,355	62,508	6,640		66,890	963,614	896,724	0.4150	27,757	399,866	372,109
2007		66,890	359,375	12,437	545,780	63,396	6,680		66,890	987,669	920,779	0.3878	25,941	383,035	357,094
2008		66,890	364,935	12,578	563,205	64,285	6,720		66,890	1,011,723	944,833	0.3624	24,244	366,695	342,451
2009		66,890	370,495	12,719	580,630	65,174	6,760		66,890	1,035,778	968,888	0.3387	22,658	350,854	328,196
2010		66,890	376,055	12,859	598,055	66,062	6,800		66,890	1,059,832	992,942	0.3166	21,178	335,518	314,340
2011		66,890	381,615	13,000	615,480	66,951	6,840		66,890	1,083,887	1,016,997	0.2959	19,790	320,683	300,893
2012		66,890	387,175	13,141	632,906	67,840	6,880		66,890	1,107,941	1,041,051	0.2765	18,496	306,355	287,859
2013		66,890	392,735	13,282	650,331	68,728	6,920		66,890	1,131,996	1,065,106	0.2584	17,286	292,529	275,244
2014		66,890	398,295	13,422	667,756	69,617	6,960		66,890	1,156,050	1,089,160	0.2415	16,155	279,201	263,046
2015		66,890	403,855	13,563	685,181	70,506	7,000		66,890	1,180,105	1,113,215	0.2257	15,098	266,365	251,267
2016		66,890	409,415	13,704	702,606	71,394	7,040		66,890	1,204,159	1,137,269	0.2109	14,110	254,014	239,903
2017		66,890	414,975	13,844	720,031	72,283	7,080		66,890	1,228,214	1,161,324	0.1971	13,187	242,138	228,951
2018		66,890	420,535	13,985	737,456	73,172	7,120		66,890	1,252,268	1,185,378	0.1842	12,324	230,729	218,405
2019		66,890	426,095	14,126	754,881	74,060	7,160		66,890	1,276,323	1,209,433	0.1722	11,518	219,777	208,259
2020		66,890	431,655	14,267	772,307	74,949	7,200		66,890	1,300,378	1,233,488	0.1609	10,765	209,270	198,506
2021		66,890	437,215	14,407	789,732	75,838	7,240		66,890	1,324,432	1,257,542	0.1504	10,060	199,198	189,137
2022		66,890	442,775	14,548	807,157	76,726	7,280		66,890	1,348,487	1,281,597	0.1406	9,402	189,547	180,145
2023		66,890	448,335	14,689	824,582	77,615	7,320		66,890	1,372,541	1,305,651	0.1314	8,787	180,307	171,520
2024		66,890	453,895	14,829	842,007	78,504	7,360		66,890	1,396,596	1,329,706	0.1228	8,212	171,464	163,252
2025		66,890	459,455	14,970	859,432	79,392	7,400		66,890	1,420,650	1,353,760	0.1147	7,675	163,007	155,332
2026		66,890	465,015	15,111	876,857	80,281	7,440		66,890	1,444,705	1,377,815	0.1072	7,173	154,922	147,750
2027		66,890	470,575	15,252	894,282	81,170	7,480		66,890	1,468,759	1,401,869	0.1002	6,704	147,198	140,494
2028		66,890	476,136	15,392	911,708	82,058	7,520		66,890	1,492,814	1,425,924	0.0937	6,265	139,821	133,556
2029		66,890	481,696	15,533	929,133	82,947	7,560		66,890	1,516,868	1,449,978	0.0875	5,855	132,780	126,925
2030		66,890	487,256	15,674	946,558	83,836	7,600		66,890	1,540,923	1,474,033	0.0818	5,472	126,061	120,589
2031		66,890	492,816	15,815	963,983	84,724	7,640		66,890	1,564,977	1,498,087	0.0765	5,114	119,653	114,539
2032		66,890	498,376	15,955	981,408	85,613	7,680		66,890	1,589,032	1,522,142	0.0715	4,780	113,544	108,765
2033		66,890	503,936	16,096	998,833	86,502	7,720		66,890	1,613,086	1,546,196	0.0668	4,467	107,723	103,256
2034		66,890	509,496	16,237	1,016,258	87,390	7,760		66,890	1,637,141	1,570,251	0.0624	4,175	102,177	98,002
2035		66,890	515,056	16,377	1,033,683	88,279	7,800		66,890	1,661,195	1,594,305	0.0583	3,902	96,895	92,994
2036		66,890	520,616	16,518	1,051,109	89,168	7,840		66,890	1,685,250	1,618,360	0.0545	3,646	91,867	88,221
2037		66,890	526,176	16,659	1,068,534	90,056	7,880		66,890	1,709,304	1,642,414	0.0509	3,408	87,083	83,675
2038		66,890	531,736	16,800	1,085,959	90,945	7,920		66,890	1,733,359	1,666,469	0.0476	3,185	82,531	79,346
2039		66,890	537,296	16,940	1,103,384	91,834	7,960		66,890	1,757,413	1,690,523	0.0445	2,977	78,202	75,226
2040		66,890	542,856	17,081	1,120,809	92,722	8,000	3,091,000	66,890	4,872,468	4,805,578	0.0416	2,782	202,634	199,852
PV's	17,855,800	653,318	4,594,736	158,920	6,994,418	810,374	85,290	128,547	18,709,118	12,772,285	(5,936,833)		18,709,118	12,772,285	(5,936,833)

File: A-1

FEASIBILITY INDICATORS	
Discount Rate	7.00%
IRR	4.78%
NPV =	($5,937) Million
B/C Ratio =	0.68

Exhibit A-2

TRAVEL EFFICIENCY FEASIBILITY CALCULATIONS
ALTERNATE "B" – UPGRADED RAILWAY
(1993 Dollars in Thousands)

Year	COSTS: Capital	COSTS: Passenger Operations	COSTS: Freight Operations	COSTS: Maint. & Operation	PASSENGER BENEFITS: User Cost Savings Auto	PASSENGER BENEFITS: User Cost Savings Other	PASSENGER BENEFITS: Time Savings Auto	PASSENGER BENEFITS: Time Savings Other	PASSENGER BENEFITS: Other Induced	PASSENGER BENEFITS: Other Surplus	FREIGHT BENEFITS: Truck Cost	FREIGHT BENEFITS: Truck Time	FREIGHT BENEFITS: Rail Cost	FREIGHT BENEFITS: Freight Time	OTHER BENEFITS: Accident	OTHER BENEFITS: Residual
1990		363,526	2,356,000	118,946	51,173	62,531	41,769	(188)	0	43000	533,270	178,750	1,620,480	9,808	15,526	0
1991																
1992																
1993	33,105,000															
1994																
1995																
1996		372,595	2,404,000	119,070	55,814	80,070	55215	(296)	0	50,560	546,972	182,376	1,653,514	10,009	16,716	
1997		374,106	2,412,000	119,091	56,355	82,993	57,457	(313)	0	51,820	549,256	182,980	1,659,019	10,042	16,914	
1998		375,618	2,420,000	119,111	57,095	85,916	59,698	(331)	0	53,080	551,539	183,585	1,664,525	10,076	17,113	
1999		377,129	2,428,000	119,132	57,835	88,839	61,939	(349)	0	54,340	553,823	184,189	1,670,030	10,109	17,311	
2000		378,641	2,436,000	119,153	58,575	91,763	64,180	(367)	0	55,600	556,107	184,793	1,675,536	10,142	17,509	
2001		380,152	2,444,000	119,173	59,315	94,686	66,421	(385)	0	56,860	558,390	185,398	1,681,042	10,176	17,708	
2002		381,664	2,452,000	119,194	60,056	97,609	68,662	(403)	0	58,120	560,674	186,002	1,686,547	10,209	17,906	
2003		383,175	2,460,000	119,215	60,796	100,532	70,903	(421)	0	59,380	562,958	186,606	1,692,053	10,243	18,104	
2004		384,686	2,468,000	119,236	61,536	103,455	73,144	(439)	0	60,640	565,241	187,211	1,697,558	10,276	18,303	
2005		386,198	2,476,000	119,256	62,276	106,378	75,385	(457)	0	61,900	567,525	187,815	1,703,064	10,310	18,501	
2006		387,709	2,484,000	119,277	63,017	109,302	77,626	(475)	0	63,160	569,809	188,419	1,708,570	10,343	18,699	
2007		389,221	2,492,000	119,298	63,757	112,225	79,867	(493)	0	64,420	572,092	189,024	1,714,075	10,376	18,898	
2008		390,732	2,500,000	119,318	64,497	115,148	82,108	(511)	0	65,680	574,376	189,628	1,719,581	10,410	19,096	
2009		392,244	2,508,000	119,339	65,237	118,071	84,350	(528)	0	66,940	576,660	190,232	1,725,086	10,443	19,294	
2010		393,755	2,516,000	119,360	65,977	120,994	86,591	(546)	0	68,200	578,943	190,837	1,730,592	10,477	19,493	
2011		395,267	2,524,000	119,380	66,718	123,917	88,832	(564)	0	69,460	581,227	191,441	1,736,098	10,510	19,691	
2012		396,778	2,532,000	119,401	67,458	126,841	91,073	(582)	0	70,720	583,511	192,045	1,741,603	10,544	19,889	
2013		398,290	2,540,000	119,422	68,198	129,764	93,314	(600)	0	71,980	585,794	192,650	1,747,109	10,577	20,088	
2014		399,801	2,548,000	119,442	68,938	132,687	95,555	(618)	0	73,240	588,078	193,254	1,752,614	10,611	20,286	
2015		401,313	2,556,000	119,463	69,679	135,610	97,796	(636)	0	74,500	590,362	193,859	1,758,120	10,644	20,485	
2016		402,824	2,564,000	119,484	70,419	138,533	100,037	(654)	0	75,760	592,645	194,463	1,763,626	10,677	20,683	
2017		404,335	2,572,000	119,504	71,159	141,456	102,278	(672)	0	77,020	594,929	195,067	1,769,131	10,711	20,881	
2018		405,847	2,580,000	119,525	71,899	144,379	104,519	(690)	0	78,280	597,212	195,672	1,774,637	10,744	21,080	
2019		407,358	2,588,000	119,546	72,639	147,303	106,760	(708)	0	79,540	599,496	196,276	1,780,142	10,778	21,278	
2020		408,870	2,596,000	119,566	73,380	150,226	109,001	(726)	0	80,800	601,780	196,880	1,785,648	10,811	21,476	
2021		410,381	2,604,000	119,587	74,120	153,149	111,242	(744)	0	82,060	604,063	197,485	1,791,154	10,845	21,675	
2022		411,893	2,612,000	119,608	74,860	156,072	113,484	(761)	0	83,320	606,347	198,089	1,796,659	10,878	21,873	
2023		413,404	2,620,000	119,628	75,600	158,995	115,725	(779)	0	84,580	608,631	198,693	1,802,165	10,912	22,071	
2024		414,916	2,628,000	119,649	76,340	161,918	117,966	(797)	0	85,840	610,914	199,298	1,807,670	10,945	22,270	
2025		416,427	2,636,000	119,670	77,081	164,842	120,207	(815)	0	87,100	613,198	199,902	1,813,176	10,978	22,468	
2026		417,939	2,644,000	119,690	77,821	167,765	122,448	(833)	0	88,360	615,482	200,506	1,818,682	11,012	22,666	
2027		419,450	2,652,000	119,711	78,561	170,688	124,689	(851)	0	89,620	617,765	201,111	1,824,187	11,045	22,865	
2028		420,961	2,660,000	119,732	79,301	173,611	126,930	(869)	0	90,880	620,049	201,715	1,829,693	11,079	23,063	
2029		422,473	2,668,000	119,753	80,042	176,534	129,171	(887)	0	92,140	622,333	202,319	1,835,198	11,112	23,261	
2030		423,984	2,676,000	119,773	80,782	179,457	131,412	(905)	0	93,400	624,616	202,924	1,840,704	11,146	23,460	
2031		425,496	2,684,000	119,794	81,522	182,381	133,653	(923)	0	94,660	626,900	203,528	1,846,210	11,179	23,658	
2032		427,007	2,692,000	119,815	82,262	185,304	135,894	(941)	0	95,920	629,184	204,132	1,851,715	11,212	23,856	
2033		428,519	2,700,000	119,835	83,002	188,227	138,135	(959)	0	97,180	631,467	204,737	1,857,221	11,246	24,055	
2034		430,030	2,708,000	119,856	83,743	191,150	140,377	(976)	0	98,440	633,751	205,341	1,862,726	11,279	24,253	
2035		431,542	2,716,000	119,877	84,483	194,073	142,618	(994)	0	99,700	636,035	205,945	1,868,232	11,313	24,451	
2036		433,053	2,724,000	119,897	85,223	196,996	144,859	(1,012)	0	100,960	638,318	206,550	1,873,738	11,346	24,650	
2037		434,565	2,732,000	119,918	85,963	199,920	147,100	(1,030)	0	102,220	640,602	207,154	1,879,243	11,380	24,848	
2038		436,076	2,740,000	119,939	86,704	202,843	149,341	(1,048)	0	103,480	642,886	207,758	1,884,749	11,413	25,046	
2039		437,588	2,748,000	119,959	87,444	205,766	151,582	(1,066)	0	104,740	645,169	208,363	1,890,254	11,447	25,245	
2040		439,099	2,756,000	119,980	88,184	208,689	153,823	(1,084)	0	106,000	647,453	208,967	1,895,760	11,480	25,443	4,934,000
PV's	33,105,000	4,643,948	29,712,395	1,417,938	766,772	1,369,620	976,701	(6,075)	0	781,053	6,826,624	2,253,721	20,437,147	123,722	227,015	205,193

Exhibit A-2 (Continued)

TRAVEL EFFICIENCY FEASIBILITY CALCULATIONS
ALTERNATE "B" – UPGRADED RAILWAY
(1993 Dollars In Thousands)

Year	Undiscounted Totals Costs	Benefits	Net Benefits	Present Worth Factor	Discounted to 1993 Total Costs	Total Benefits	Net Benefits
1990							
1991							
1992							
1993	33,105,000	0	(33,105,000)	1.0000	33,105,000	0	(33,105,000)
1994	0	0	0	0.9346	0	0	0
1995	0	0	0	0.8734	0	0	0
1996	2,895,665	2,650,751	(244,914)	0.8163	2,363,725	2,163,802	(199,923)
1997	2,905,197	2,666,522	(238,675)	0.7629	2,216,361	2,034,277	(182,084)
1998	2,914,729	2,682,294	(232,435)	0.7130	2,078,162	1,912,439	(165,723)
1999	2,924,261	2,698,066	(226,195)	0.6663	1,948,559	1,797,835	(150,723)
2000	2,933,793	2,713,838	(219,955)	0.6227	1,827,019	1,690,042	(136,977)
2001	2,943,326	2,729,610	(213,715)	0.5820	1,713,042	1,588,658	(124,384)
2002	2,952,858	2,745,382	(207,476)	0.5439	1,606,159	1,493,306	(112,853)
2003	2,962,390	2,761,154	(201,236)	0.5083	1,505,929	1,403,631	(102,298)
2004	2,971,922	2,776,926	(194,996)	0.4751	1,411,939	1,319,297	(92,641)
2005	2,981,454	2,792,698	(188,756)	0.4440	1,323,801	1,239,991	(83,810)
2006	2,990,986	2,808,470	(182,517)	0.4150	1,241,153	1,165,415	(75,738)
2007	3,000,518	2,824,242	(176,277)	0.3878	1,163,653	1,095,290	(68,363)
2008	3,010,051	2,840,014	(170,037)	0.3624	1,090,981	1,029,352	(61,629)
2009	3,019,583	2,855,785	(163,797)	0.3387	1,022,837	967,353	(55,484)
2010	3,029,115	2,871,557	(157,557)	0.3166	958,940	909,062	(49,879)
2011	3,038,647	2,887,329	(151,318)	0.2959	899,026	854,257	(44,769)
2012	3,048,179	2,903,101	(145,078)	0.2765	842,847	802,732	(40,115)
2013	3,057,711	2,918,873	(138,838)	0.2584	790,171	754,292	(35,878)
2014	3,067,243	2,934,645	(132,598)	0.2415	740,779	708,755	(32,024)
2015	3,076,776	2,950,417	(126,358)	0.2257	694,469	665,948	(28,521)
2016	3,086,308	2,966,189	(120,119)	0.2109	651,047	625,708	(25,339)
2017	3,095,840	2,981,961	(113,879)	0.1971	610,334	587,884	(22,451)
2018	3,105,372	2,997,733	(107,639)	0.1842	572,162	552,330	(19,832)
2019	3,114,904	3,013,505	(101,399)	0.1722	536,372	518,912	(17,461)
2020	3,124,436	3,029,277	(95,160)	0.1609	502,817	487,503	(15,314)
2021	3,133,968	3,045,049	(88,920)	0.1504	471,356	457,982	(13,374)
2022	3,143,500	3,060,820	(82,680)	0.1406	441,859	430,238	(11,622)
2023	3,153,033	3,076,592	(76,440)	0.1314	414,205	404,163	(10,042)
2024	3,162,565	3,092,364	(70,200)	0.1228	388,278	379,659	(8,619)
2025	3,172,097	3,108,136	(63,961)	0.1147	363,970	356,631	(7,339)
2026	3,181,629	3,123,908	(57,721)	0.1072	341,181	334,991	(6,190)
2027	3,191,161	3,139,680	(51,481)	0.1002	319,816	314,657	(5,159)
2028	3,200,693	3,155,452	(45,241)	0.0937	299,786	295,549	(4,237)
2029	3,210,225	3,171,224	(39,002)	0.0875	281,009	277,595	(3,414)
2030	3,219,758	3,186,996	(32,762)	0.0818	263,405	260,724	(2,680)
2031	3,229,290	3,202,768	(26,522)	0.0765	246,901	244,874	(2,028)
2032	3,238,822	3,218,540	(20,282)	0.0715	231,430	229,981	(1,449)
2033	3,248,354	3,234,312	(14,042)	0.0668	216,926	215,989	(938)
2034	3,257,886	3,250,083	(7,803)	0.0624	203,330	202,843	(487)
2035	3,267,418	3,265,855	(1,563)	0.0583	190,584	190,493	(91)
2036	3,276,950	3,281,627	4,677	0.0545	178,635	178,890	255
2037	3,286,483	3,297,399	10,917	0.0509	167,435	167,991	556
2038	3,296,015	3,313,171	17,156	0.0476	156,935	157,752	817
2039	3,305,547	3,328,943	23,396	0.0445	147,092	148,133	1,041
2040	3,315,079	8,278,715	4,963,636	0.0416	137,866	344,291	206,425
PV's	68,879,281	33,961,493	(34,917,788)		68,879,281	33,961,493	(34,917,788)

File: A-2

FEASIBILITY INDICATORS	
Discount Rate =	7.00%
IRR =	-4.54%
NPV =	**($34,918)** Million
B/C Ratio=	**0.49**

Exhibit A-3

TRAVEL EFFICIENCY FEASIBILITY CALCULATIONS
ALTERNATE "C" – THREE SUPER HIGHWAYS
(1993 Dollars in Thousands)

Year	COSTS				PASSENGER BENEFITS						FREIGHT BENEFITS				OTHER BENEFITS	
					User Cost Savings		Time Savings		Other							
	Capital	Passenger Operations	Freight Operations	Maint. & Operation	Auto	Other	Auto	Other	Induced	Surplus	Truck Cost	Truck Time	Rail Cost	Freight Time	Accident	Residual
1990		0	0	91,940	(402,567)	11,258	720,000	(9,540)	34,499	999,000	(200,065)	201,378	0	37,089	423,594	0
1991																
1992																
1993	53,365,000															
1994		0	0	10,000												
1995		0	0	10,000												
1996		0	0	10,000												
1997		0	0	10,000												
1998		0	0	91,940	(416,533)	17,876	985,792	(15,616)	40,535	1,123,320	(205,488)	235,915	0	37,979	475,467	
1999		0	0	91,940	(418,278)	18,478	1,019,016	(16,376)	41,290	1,138,860	(206,166)	240,232	0	38,090	481,951	
2000		0	0	91,940	(420,024)	19,281	1,052,240	(17,135)	42,045	1,154,400	(206,844)	244,550	0	38,201	488,435	
2001		0	0	91,940	(421,770)	20,083	1,085,464	(17,895)	42,799	1,169,940	(207,522)	248,867	0	38,312	494,919	
2002		0	0	91,940	(423,515)	20,885	1,118,688	(18,654)	43,554	1,185,480	(208,200)	253,184	0	38,423	501,403	
2003		0	0	91,940	(425,261)	21,687	1,151,912	(19,414)	44,308	1,201,020	(208,877)	257,501	0	38,535	507,888	
2004		0	0	91,940	(427,007)	22,490	1,185,136	(20,173)	45,063	1,216,560	(209,555)	261,818	0	38,646	514,372	
2005		0	0	91,940	(428,753)	23,292	1,218,360	(20,933)	45,817	1,232,100	(210,233)	266,135	0	38,757	520,856	
2006		0	0	91,940	(430,498)	24,094	1,251,584	(21,692)	46,572	1,247,640	(210,911)	270,453	0	38,868	527,340	
2007		0	0	91,940	(432,244)	24,896	1,284,808	(22,452)	47,327	1,263,180	(211,589)	274,770	0	38,979	533,824	
2008		0	0	91,940	(433,990)	25,699	1,318,032	(23,211)	48,081	1,278,720	(212,267)	279,087	0	39,091	540,308	
2009		0	0	91,940	(435,735)	26,501	1,351,256	(23,971)	48,836	1,294,260	(212,945)	283,404	0	39,202	546,792	
2010		0	0	91,940	(437,481)	27,303	1,384,480	(24,730)	49,590	1,309,800	(213,623)	287,721	0	39,313	553,276	
2011		0	0	91,940	(439,227)	28,105	1,417,704	(25,490)	50,345	1,325,340	(214,300)	292,038	0	39,424	559,761	
2012		0	0	91,940	(440,972)	28,908	1,450,928	(26,249)	51,099	1,340,880	(214,978)	296,356	0	39,535	566,245	
2013		0	0	91,940	(442,718)	29,710	1,484,152	(27,009)	51,854	1,356,420	(215,656)	300,673	0	39,647	572,729	
2014		0	0	91,940	(444,464)	30,512	1,517,376	(27,768)	52,608	1,371,960	(216,334)	304,990	0	39,758	579,213	
2015		0	0	91,940	(446,209)	31,315	1,550,601	(28,528)	53,363	1,387,500	(217,012)	309,307	0	39,869	585,697	
2016		0	0	91,940	(447,955)	32,117	1,583,825	(29,288)	54,118	1,403,040	(217,690)	313,624	0	39,980	592,181	
2017		0	0	91,940	(449,701)	32,919	1,617,049	(30,047)	54,872	1,418,580	(218,368)	317,941	0	40,091	598,665	
2018		0	0	91,940	(451,447)	33,721	1,650,273	(30,807)	55,627	1,434,120	(219,046)	322,258	0	40,203	605,149	
2019		0	0	91,940	(453,192)	34,524	1,683,497	(31,566)	56,381	1,449,660	(219,724)	326,576	0	40,314	611,633	
2020		0	0	91,940	(454,938)	35,326	1,716,721	(32,326)	57,136	1,465,200	(220,401)	330,893	0	40,425	618,118	
2021		0	0	91,940	(456,684)	36,128	1,749,945	(33,085)	57,890	1,480,740	(221,079)	335,210	0	40,536	624,602	
2022		0	0	91,940	(458,429)	36,930	1,783,169	(33,845)	58,645	1,496,280	(221,757)	339,527	0	40,647	631,086	
2023		0	0	91,940	(460,175)	37,733	1,816,393	(34,604)	59,399	1,511,820	(222,435)	343,844	0	40,759	637,570	
2024		0	0	91,940	(461,921)	38,535	1,849,617	(35,364)	60,154	1,527,360	(223,113)	348,161	0	40,870	644,054	
2025		0	0	91,940	(463,666)	39,337	1,882,841	(36,123)	60,909	1,542,900	(223,791)	352,479	0	40,981	650,538	
2026		0	0	91,940	(465,412)	40,139	1,916,065	(36,883)	61,663	1,558,440	(224,469)	356,796	0	41,092	657,022	
2027		0	0	91,940	(467,158)	40,942	1,949,289	(37,642)	62,418	1,573,980	(225,147)	361,113	0	41,203	663,506	
2028		0	0	91,940	(468,904)	41,744	1,982,513	(38,402)	63,172	1,589,520	(225,824)	365,430	0	41,315	669,991	
2029		0	0	91,940	(470,649)	42,546	2,015,737	(39,161)	63,927	1,605,060	(226,502)	369,747	0	41,426	676,475	
2030		0	0	91,940	(472,395)	43,348	2,048,961	(39,921)	64,681	1,620,600	(227,180)	374,064	0	41,537	682,959	
2031		0	0	91,940	(474,141)	44,151	2,082,185	(40,680)	65,436	1,636,140	(227,858)	378,382	0	41,648	689,443	
2032		0	0	91,940	(475,886)	44,953	2,115,409	(41,440)	66,191	1,651,680	(228,536)	382,699	0	41,759	695,927	
2033		0	0	91,940	(477,632)	45,755	2,148,633	(42,199)	66,945	1,667,220	(229,214)	387,016	0	41,871	702,411	
2034		0	0	91,940	(479,378)	46,557	2,181,857	(42,959)	67,700	1,682,760	(229,892)	391,333	0	41,982	708,895	
2035		0	0	91,940	(481,123)	47,360	2,215,081	(43,718)	68,454	1,698,300	(230,570)	395,650	0	42,093	715,379	
2036		0	0	91,940	(482,869)	48,162	2,248,305	(44,478)	69,209	1,713,840	(231,247)	399,967	0	42,204	721,864	
2037		0	0	91,940	(484,615)	48,964	2,281,529	(45,237)	69,963	1,729,380	(231,925)	404,285	0	42,315	728,348	
2038		0	0	91,940	(486,361)	49,766	2,314,753	(45,997)	70,718	1,744,920	(232,603)	408,602	0	42,427	734,832	
2039		0	0	91,940	(488,106)	50,569	2,347,977	(46,756)	71,472	1,760,460	(233,281)	412,919	0	42,538	741,316	
2040		0	0	91,940	(489,852)	51,371	2,381,201	(47,516)	72,227	1,776,000	(233,959)	417,236	0	42,849	747,800	9,794,000
PV's	53,365,000	0	0	981,258	(4,504,497)	279,744	14,199,997	(253,316)	509,493	13,465,717	(2,199,900)	2,956,186	0	404,875	5,688,252	407,308

Exhibit A-3 (Continued)

TRAVEL EFFICIENCY FEASIBILITY CALCULATIONS
ALTERNATE "C" – THREE SUPER HIGHWAYS

(1993 Dollars in Thousands)

Year	Undiscounted Totals Costs	Undiscounted Totals Benefits	Undiscounted Totals Net Benefits	Present Worth Factor	Discounted to 1993 Total Costs	Discounted to 1993 Total Benefits	Discounted to 1993 Net Benefits
1990							
1991							
1992							
1993	53,365,000	0	(53,365,000)	1.0000	53,365,000	0	(53,365,000)
1994	10,000	0	(10,000)	0.9346	9,346	0	(9,346)
1995	10,000	0	(10,000)	0.8734	8,734	0	(8,734)
1996	10,000	0	(10,000)	0.8163	8,163	0	(8,163)
1997	10,000	0	(10,000)	0.7629	7,629	0	(7,629)
1998	91,940	2,279,048	2,187,108	0.7130	65,552	1,624,930	1,559,378
1999	91,940	2,337,098	2,245,158	0.6663	61,264	1,557,307	1,496,044
2000	91,940	2,395,148	2,303,208	0.6227	57,256	1,491,578	1,434,322
2001	91,940	2,453,198	2,361,258	0.5820	53,510	1,427,784	1,374,274
2002	91,940	2,511,249	2,419,309	0.5439	50,009	1,365,953	1,315,944
2003	91,940	2,569,299	2,477,359	0.5083	46,736	1,306,101	1,259,364
2004	91,940	2,627,349	2,535,409	0.4751	43,680	1,248,235	1,204,555
2005	91,940	2,685,399	2,593,459	0.4440	40,822	1,192,349	1,151,527
2006	91,940	2,743,450	2,651,510	0.4150	38,152	1,138,434	1,100,282
2007	91,940	2,801,500	2,709,560	0.3878	35,656	1,086,470	1,050,814
2008	91,940	2,859,550	2,767,610	0.3624	33,323	1,036,433	1,003,109
2009	91,940	2,917,600	2,825,660	0.3387	31,143	988,292	957,149
2010	91,940	2,975,650	2,883,710	0.3166	29,106	942,015	912,909
2011	91,940	3,033,701	2,941,761	0.2959	27,202	897,563	870,361
2012	91,940	3,091,751	2,999,811	0.2765	25,422	854,895	829,473
2013	91,940	3,149,801	3,057,861	0.2584	23,759	813,968	790,209
2014	91,940	3,207,851	3,115,911	0.2415	22,205	774,738	752,533
2015	91,940	3,265,902	3,173,962	0.2257	20,752	737,157	716,405
2016	91,940	3,323,952	3,232,012	0.2109	19,394	701,177	681,783
2017	91,940	3,382,002	3,290,062	0.1971	18,126	666,750	648,625
2018	91,940	3,440,052	3,348,112	0.1842	16,940	633,827	616,887
2019	91,940	3,498,102	3,406,162	0.1722	15,832	602,357	586,526
2020	91,940	3,556,153	3,464,213	0.1609	14,796	572,293	557,497
2021	91,940	3,614,203	3,522,263	0.1504	13,828	543,584	529,756
2022	91,940	3,672,253	3,580,313	0.1406	12,923	516,182	503,259
2023	91,940	3,730,303	3,638,363	0.1314	12,078	490,039	477,961
2024	91,940	3,788,353	3,696,413	0.1228	11,288	465,108	453,820
2025	91,940	3,846,404	3,754,464	0.1147	10,549	441,341	430,791
2026	91,940	3,904,454	3,812,514	0.1072	9,859	418,693	408,834
2027	91,940	3,962,504	3,870,564	0.1002	9,214	397,120	387,905
2028	91,940	4,020,554	3,928,614	0.0937	8,611	376,577	367,966
2029	91,940	4,078,605	3,986,665	0.0875	8,048	357,023	348,975
2030	91,940	4,136,655	4,044,715	0.0818	7,522	338,415	330,893
2031	91,940	4,194,705	4,102,765	0.0765	7,029	320,714	313,685
2032	91,940	4,252,755	4,160,815	0.0715	6,570	303,881	297,311
2033	91,940	4,310,805	4,218,865	0.0668	6,140	287,877	281,737
2034	91,940	4,368,856	4,276,916	0.0624	5,738	272,667	266,929
2035	91,940	4,426,906	4,334,966	0.0583	5,363	258,215	252,852
2036	91,940	4,484,956	4,393,016	0.0545	5,012	244,487	239,475
2037	91,940	4,543,006	4,451,066	0.0509	4,684	231,450	226,766
2038	91,940	4,601,057	4,509,117	0.0476	4,378	219,072	214,695
2039	91,940	4,659,107	4,567,167	0.0445	4,091	207,324	203,232
2040	91,940	14,511,157	14,419,217	0.0416	3,824	603,482	599,659
PV's	54,346,256	30,953,855	(23,392,403)		54,346,258	30,953,855	(23,392,403)

File: A-3

FEASIBILITY INDICATORS	
Discount Rate =	7.00%
IRR =	4.13%
NPV =	**($23,392)** Million
B/C Ratio =	**0.57**

Exhibit A-4

TRAVEL EFFICIENCY FEASIBILITY CALCULATIONS
ALTERNATE "C" – ONE SUPER HIGHWAY
(1993 Dollars in Thousands)

Year	COSTS				PASSENGER BENEFITS						FREIGHT BENEFITS				OTHER BENEFITS	
	Capital	Passenger Operations	Freight Operations	Maint. & Operation	User Cost Savings Auto	User Cost Savings Other	Time Savings Auto	Time Savings Other	Other Induced	Other Surplus	Truck Cost	Truck Time	Rail Cost	Freight Time	Accident	Residual
1990		0	0	154,459	(676,313)	18,913	1,209,600	(16,027)	57,958	1,679,000	(336,109)	338,315	0	62,310	711,638	0
1991																
1992																
1993	53,365,000															
1994		0	0	10,000												
1995		0	0	10,000												
1996		0	0	10,000												
1997		0	0	10,000												
1998		0	0	154,459	(699,775)	29,696	1,656,131	(26,235)	68,100	1,887,960	(345,220)	396,338	0	63,804	798,784	
1999		0	0	154,459	(702,708)	31,044	1,711,947	(27,511)	69,367	1,914,080	(346,359)	403,590	0	63,991	809,676	
2000		0	0	154,459	(705,640)	32,391	1,767,764	(28,787)	70,635	1,940,200	(347,498)	410,843	0	64,178	820,571	
2001		0	0	154,459	(708,573)	33,739	1,823,580	(30,063)	71,903	1,966,320	(348,636)	418,096	0	64,364	831,464	
2002		0	0	154,459	(711,506)	35,087	1,879,396	(31,339)	73,170	1,992,440	(349,775)	425,349	0	64,551	842,356	
2003		0	0	154,459	(714,439)	36,435	1,935,213	(32,615)	74,438	2,018,560	(350,914)	432,602	0	64,738	853,251	
2004		0	0	154,459	(717,371)	37,783	1,991,029	(33,891)	75,706	2,044,680	(352,053)	439,855	0	64,925	864,144	
2005		0	0	154,459	(720,304)	39,130	2,046,845	(35,167)	76,973	2,070,800	(353,192)	447,107	0	65,112	875,036	
2006		0	0	154,459	(723,237)	40,478	2,102,662	(36,443)	78,241	2,096,920	(354,331)	454,360	0	65,299	885,931	
2007		0	0	154,459	(726,170)	41,826	2,158,478	(37,719)	79,509	2,123,040	(355,469)	461,613	0	65,485	896,824	
2008		0	0	154,459	(729,103)	43,174	2,214,294	(38,995)	80,776	2,149,160	(356,608)	468,866	0	65,672	907,718	
2009		0	0	154,459	(732,035)	44,522	2,270,111	(40,271)	82,044	2,175,280	(357,747)	476,119	0	65,859	918,611	
2010		0	0	154,459	(734,968)	45,869	2,325,927	(41,547)	83,312	2,201,400	(358,886)	483,372	0	66,046	929,504	
2011		0	0	154,459	(737,901)	47,217	2,381,743	(42,823)	84,579	2,227,520	(360,025)	490,624	0	66,233	940,398	
2012		0	0	154,459	(740,834)	48,565	2,437,560	(44,099)	85,847	2,253,640	(361,164)	497,877	0	66,419	951,291	
2013		0	0	154,459	(743,766)	49,913	2,493,376	(45,375)	87,115	2,279,760	(362,302)	505,130	0	66,606	962,184	
2014		0	0	154,459	(746,699)	51,261	2,549,192	(46,651)	88,382	2,305,880	(363,441)	512,383	0	66,793	973,078	
2015		0	0	154,459	(749,632)	52,608	2,605,009	(47,927)	89,650	2,332,000	(364,580)	519,636	0	66,980	983,971	
2016		0	0	154,459	(752,565)	53,956	2,660,825	(49,203)	90,918	2,358,120	(365,719)	526,889	0	67,167	994,864	
2017		0	0	154,459	(755,498)	55,304	2,716,642	(50,479)	92,185	2,384,240	(366,858)	534,141	0	67,354	1,005,758	
2018		0	0	154,459	(758,430)	56,652	2,772,458	(51,755)	93,453	2,410,360	(367,997)	541,394	0	67,540	1,016,651	
2019		0	0	154,459	(761,363)	58,000	2,828,274	(53,031)	94,720	2,436,480	(369,136)	548,647	0	67,727	1,027,544	
2020		0	0	154,459	(764,296)	59,347	2,884,091	(54,307)	95,988	2,462,600	(370,274)	555,900	0	67,914	1,038,438	
2021		0	0	154,459	(767,229)	60,695	2,939,907	(55,583)	97,256	2,488,720	(371,413)	563,153	0	68,101	1,049,331	
2022		0	0	154,459	(770,161)	62,043	2,995,723	(56,859)	98,523	2,514,840	(372,552)	570,406	0	68,288	1,060,224	
2023		0	0	154,459	(773,094)	63,391	3,051,540	(58,135)	99,791	2,540,960	(373,691)	577,658	0	68,474	1,071,118	
2024		0	0	154,459	(776,027)	64,739	3,107,356	(59,411)	101,059	2,567,080	(374,830)	584,911	0	68,661	1,082,011	
2025		0	0	154,459	(778,960)	66,086	3,163,172	(60,687)	102,326	2,593,200	(375,969)	592,164	0	68,848	1,092,904	
2026		0	0	154,459	(781,892)	67,434	3,218,989	(61,963)	103,594	2,619,320	(377,107)	599,417	0	69,035	1,103,797	
2027		0	0	154,459	(784,825)	68,782	3,274,805	(63,239)	104,862	2,645,440	(378,246)	606,670	0	69,222	1,114,691	
2028		0	0	154,459	(787,758)	70,130	3,330,621	(64,515)	106,129	2,671,560	(379,385)	613,923	0	69,409	1,125,584	
2029		0	0	154,459	(790,691)	71,478	3,386,438	(65,791)	107,397	2,697,680	(380,524)	621,175	0	69,595	1,136,477	
2030		0	0	154,459	(793,624)	72,825	3,442,254	(67,067)	108,665	2,723,800	(381,663)	628,428	0	69,782	1,147,371	
2031		0	0	154,459	(796,556)	74,173	3,498,070	(68,343)	109,932	2,749,920	(382,802)	635,681	0	69,969	1,158,264	
2032		0	0	154,459	(799,489)	75,521	3,553,887	(69,619)	111,200	2,776,040	(383,940)	642,934	0	70,156	1,169,157	
2033		0	0	154,459	(802,422)	76,869	3,609,703	(70,895)	112,468	2,802,160	(385,079)	650,187	0	70,343	1,180,051	
2034		0	0	154,459	(805,355)	78,216	3,665,520	(72,171)	113,735	2,828,280	(386,218)	657,440	0	70,529	1,190,944	
2035		0	0	154,459	(808,287)	79,564	3,721,336	(73,447)	115,003	2,854,400	(387,357)	664,692	0	70,716	1,201,837	
2036		0	0	154,459	(811,220)	80,912	3,777,152	(74,723)	116,271	2,880,520	(388,496)	671,945	0	70,903	1,212,731	
2037		0	0	154,459	(814,153)	82,260	3,832,969	(75,999)	117,538	2,906,640	(389,635)	679,198	0	71,090	1,223,624	
2038		0	0	154,459	(817,086)	83,608	3,888,785	(77,275)	118,806	2,932,760	(390,773)	686,451	0	71,277	1,234,517	
2039		0	0	154,459	(820,019)	84,955	3,944,601	(78,551)	120,074	2,958,880	(391,912)	693,704	0	71,464	1,245,411	
2040		0	0	154,459	(822,951)	86,303	4,000,418	(79,827)	121,341	2,985,000	(393,051)	700,956	0	71,650	1,256,304	9,794,000
PV's	53,365,000	0	0	1,625,481	(7,567,555)	469,969	23,855,995	(425,574)	855,948	22,832,023	(3,695,833)	4,966,393	0	680,190	9,556,263	407,308

Exhibit A-4 (Continued)

TRAVEL EFFICIENCY FEASIBILITY CALCULATIONS
ALTERNATE "C" – ONE SUPER HIGHWAY

(1993 Dollars in Thousands)

Year	Undiscounted Totals Costs	Undiscounted Totals Benefits	Undiscounted Totals Net Benefits	Present Worth Factor	Discounted to 1993 Total Costs	Discounted to 1993 Total Benefits	Discounted to 1993 Net Benefits
1990							
1991							
1992							
1993	53,365,000	0	(53,365,000)	1.0000	53,365,000	0	(53,365,000)
1994	10,000	0	(10,000)	0.9346	9,346	0	(9,346)
1995	10,000	0	(10,000)	0.8734	8,734	0	(8,734)
1996	10,000	0	(10,000)	0.8163	8,163	0	(8,163)
1997	10,000	0	(10,000)	0.7629	7,629	0	(7,629)
1998	154,459	3,829,583	3,675,123	0.7130	110,127	2,730,439	2,620,312
1999	154,459	3,927,120	3,772,661	0.6663	102,923	2,616,806	2,513,883
2000	154,459	4,024,657	3,870,198	0.6227	96,189	2,506,354	2,410,165
2001	154,459	4,122,194	3,967,735	0.5820	89,897	2,399,155	2,309,258
2002	154,459	4,219,731	4,065,272	0.5439	84,016	2,295,254	2,211,239
2003	154,459	4,317,268	4,162,809	0.5083	78,519	2,194,680	2,116,161
2004	154,459	4,414,806	4,260,346	0.4751	73,382	2,097,442	2,024,060
2005	154,459	4,512,343	4,357,884	0.4440	68,582	2,003,534	1,934,952
2006	154,459	4,609,880	4,455,421	0.4150	64,095	1,912,936	1,848,841
2007	154,459	4,707,417	4,552,958	0.3878	59,902	1,825,618	1,765,716
2008	154,459	4,804,954	4,650,495	0.3624	55,983	1,741,537	1,685,553
2009	154,459	4,902,492	4,748,032	0.3387	52,321	1,660,643	1,608,323
2010	154,459	5,000,029	4,845,569	0.3166	48,898	1,582,861	1,533,963
2011	154,459	5,097,566	4,943,107	0.2959	45,699	1,508,186	1,462,487
2012	154,459	5,195,103	5,040,644	0.2765	42,709	1,436,489	1,393,780
2013	154,459	5,292,640	5,138,181	0.2584	39,915	1,367,719	1,327,804
2014	154,459	5,390,177	5,235,718	0.2415	37,304	1,301,798	1,264,494
2015	154,459	5,487,715	5,333,255	0.2257	34,863	1,238,649	1,203,786
2016	154,459	5,585,252	5,430,792	0.2109	32,583	1,178,191	1,145,609
2017	154,459	5,682,789	5,528,330	0.1971	30,451	1,120,343	1,089,892
2018	154,459	5,780,326	5,625,867	0.1842	28,459	1,065,020	1,036,561
2019	154,459	5,877,863	5,723,404	0.1722	26,597	1,012,142	985,544
2020	154,459	5,975,400	5,820,941	0.1609	24,857	961,623	936,766
2021	154,459	6,072,938	5,918,478	0.1504	23,231	913,383	890,152
2022	154,459	6,170,475	6,016,016	0.1406	21,711	867,339	845,628
2023	154,459	6,268,012	6,113,553	0.1314	20,291	823,411	803,120
2024	154,459	6,365,549	6,211,090	0.1228	18,963	781,518	762,554
2025	154,459	6,463,086	6,308,627	0.1147	17,723	741,582	723,859
2026	154,459	6,560,623	6,406,164	0.1072	16,563	703,526	686,963
2027	154,459	6,658,161	6,503,701	0.1002	15,480	667,276	651,797
2028	154,459	6,755,698	6,601,239	0.0937	14,467	632,759	618,291
2029	154,459	6,853,235	6,698,776	0.0875	13,521	599,901	586,380
2030	154,459	6,950,772	6,796,313	0.0818	12,636	568,635	555,998
2031	154,459	7,048,309	6,893,850	0.0765	11,809	538,892	527,082
2032	154,459	7,145,846	6,991,387	0.0715	11,037	510,607	499,570
2033	154,459	7,243,384	7,088,924	0.0668	10,315	483,716	473,401
2034	154,459	7,340,921	7,186,462	0.0624	9,640	458,158	448,518
2035	154,459	7,438,458	7,283,999	0.0583	9,009	433,875	424,865
2036	154,459	7,535,995	7,381,536	0.0545	8,420	410,807	402,387
2037	154,459	7,633,532	7,479,073	0.0509	7,869	388,901	381,032
2038	154,459	7,731,069	7,576,610	0.0476	7,354	368,103	360,749
2039	154,459	7,828,607	7,674,147	0.0445	6,873	348,362	341,489
2040	154,459	17,720,144	17,565,685	0.0416	6,424	736,936	730,512
PV's	54,990,481	51,735,127	(3,255,354)		54,990,481	51,735,127	(3,255,354)

File: A-4

FEASIBILITY INDICATORS	
Discount Rate =	7.00%
IRR =	6.65%
NPV =	**($3,255)** Million
B/C Ratio =	**0.94**

Exhibit A-5

TRAVEL EFFICIENCY FEASIBILITY CALCULATIONS
ALTERNATE 'D' – HIGH SPEED GUIDEWAY

(1993 Dollars in Thousands)

	COSTS				PASSENGER BENEFITS						FREIGHT BENEFITS				OTHER BENEFITS	
		Passenger	Freight	Maint. &	User Cost Savings		Time Savings		Other		Truck	Truck	Rail	Freight		
Year	Capital	Operations	Operations	Operation	Auto	Other	Auto	Other	Induced	Surplus	Cost	Time	Cost	Time	Accident	Residual
1990		490,386	0	163,784	173,468	119,868	116,111	(139)	19,304	140,000	69,952	38,893	0	7,163	53,813	0
1991																
1992																
1993	51,385,600															
1994		0	0	5,000												
1995		0	0	5,000												
1996		0	0	5,000												
1997		0	0	5,000												
1998		0	0	5,000												
1999		0	0	5,000												
2000		0	0	5,000												
2001		513,895	0	164,399	198,701	179,237	174,086	(328)	27,757	173,880	80,856	47,613	0	7,353	65,055	
2002		516,032	0	164,455	200,995	184,633	179,357	(345)	28,525	176,960	81,847	48,405	0	7,370	66,077	
2003		518,169	0	164,511	203,288	190,028	184,627	(363)	29,294	180,040	82,838	49,198	0	7,388	67,098	
2004		520,307	0	164,567	205,582	195,423	189,898	(380)	30,062	183,120	83,830	49,991	0	7,405	68,120	
2005		522,444	0	164,623	207,876	200,819	195,168	(397)	30,831	186,200	84,821	50,784	0	7,422	69,142	
2006		524,581	0	164,679	210,170	206,214	200,439	(414)	31,599	189,280	85,812	51,576	0	7,439	70,164	
2007		526,718	0	164,735	212,464	211,609	205,709	(431)	32,367	192,360	86,803	52,369	0	7,457	71,186	
2008		528,855	0	164,791	214,758	217,005	210,980	(449)	33,136	195,440	87,795	53,162	0	7,474	72,208	
2009		530,992	0	164,846	217,052	222,400	216,250	(466)	33,904	198,520	88,786	53,954	0	7,491	73,230	
2010		533,130	0	164,902	219,346	227,796	221,521	(483)	34,673	201,600	89,777	54,747	0	7,509	74,252	
2011		535,267	0	164,958	221,639	233,191	226,791	(500)	35,441	204,680	90,768	55,540	0	7,526	75,274	
2012		537,404	0	165,014	223,933	238,586	232,062	(517)	36,210	207,760	91,760	56,332	0	7,543	76,296	
2013		539,541	0	165,070	226,227	243,982	237,332	(535)	36,978	210,840	92,751	57,125	0	7,560	77,318	
2014		541,678	0	165,126	228,521	249,377	242,603	(552)	37,747	213,920	93,742	57,918	0	7,578	78,340	
2015		543,816	0	165,182	230,815	254,772	247,873	(569)	38,515	217,000	94,733	58,711	0	7,595	79,362	
2016		545,953	0	165,238	233,109	260,168	253,143	(586)	39,283	220,080	95,725	59,503	0	7,612	80,384	
2017		548,090	0	165,294	235,403	265,563	258,414	(603)	40,052	223,160	96,716	60,296	0	7,630	81,406	
2018		550,227	0	165,350	237,697	270,959	263,684	(621)	40,820	226,240	97,707	61,089	0	7,647	82,428	
2019		552,364	0	165,406	239,991	276,354	268,955	(638)	41,589	229,320	98,699	61,881	0	7,664	83,450	
2020		554,501	0	165,462	242,284	281,749	274,225	(655)	42,357	232,400	99,690	62,674	0	7,681	84,472	
2021		556,639	0	165,518	244,578	287,145	279,496	(672)	43,126	235,480	100,681	63,467	0	7,699	85,494	
2022		558,776	0	165,573	246,872	292,540	284,766	(689)	43,894	238,560	101,672	64,259	0	7,716	86,516	
2023		560,913	0	165,629	249,166	297,936	290,037	(707)	44,663	241,640	102,664	65,052	0	7,733	87,538	
2024		563,050	0	165,685	251,460	303,331	295,307	(724)	45,431	244,720	103,655	65,845	0	7,751	88,560	
2025		565,187	0	165,741	253,754	308,726	300,578	(741)	46,199	247,800	104,646	66,638	0	7,768	89,582	
2026		567,324	0	165,797	256,048	314,122	305,848	(758)	46,968	250,880	105,637	67,430	0	7,785	90,604	
2027		569,462	0	165,853	258,342	319,517	311,119	(775)	47,736	253,960	106,629	68,223	0	7,802	91,626	
2028		571,599	0	165,909	260,635	324,912	316,389	(793)	48,505	257,040	107,620	69,016	0	7,820	92,647	
2029		573,736	0	165,965	262,929	330,308	321,660	(810)	49,273	260,120	108,611	69,808	0	7,837	93,669	
2030		575,873	0	166,021	265,223	335,703	326,930	(827)	50,042	263,200	109,602	70,601	0	7,854	94,691	
2031		578,010	0	166,077	267,517	341,099	332,201	(844)	50,810	266,280	110,594	71,394	0	7,871	95,713	
2032		580,148	0	166,133	269,811	346,494	337,471	(861)	51,578	269,360	111,585	72,186	0	7,889	96,735	
2033		582,285	0	166,189	272,105	351,889	342,742	(879)	52,347	272,440	112,576	72,979	0	7,906	97,757	
2034		584,422	0	166,244	274,399	357,285	348,012	(896)	53,115	275,520	113,567	73,772	0	7,923	98,779	
2035		586,559	0	166,300	276,693	362,680	353,283	(913)	53,884	278,600	114,559	74,565	0	7,941	99,801	
2036		588,696	0	166,356	278,986	368,075	358,553	(930)	54,652	281,680	115,550	75,357	0	7,958	100,823	
2037		590,833	0	166,412	281,280	373,471	363,824	(947)	55,421	284,760	116,541	76,150	0	7,975	101,845	
2038		592,971	0	166,468	283,574	378,866	369,094	(965)	56,189	287,840	117,532	76,943	0	7,992	102,867	
2039		595,108	0	166,524	285,868	384,262	374,365	(982)	56,958	290,920	118,524	77,735	0	8,010	103,889	
2040		597,245	0	166,580	288,162	389,657	379,635	(999)	57,726	294,000	119,515	78,528	0	8,027	104,911	6,545,900
PV's	51,385,600	4,469,210	0	1,397,144	1,867,229	1,999,783	1,945,173	(4,356)	303,325	1,735,715	765,302	470,476	0	62,686	637,027	355,402

Exhibit A-5 (Continued)

TRAVEL EFFICIENCY FEASIBILITY CALCULATIONS
ALTERNATE "D" – HIGH SPEED GUIDEWAY

(1993 Dollars in Thousands)

Year	Undiscounted Totals Costs	Undiscounted Totals Benefits	Undiscounted Totals Net Benefits	Present Worth Factor	Discounted to 1993 Total Costs	Discounted to 1993 Total Benefits	Discounted to 1993 Net Benefits
1990							
1991							
1992							
1993	51,385,600	0	(51,385,600)	1.0000	51,385,600	0	(51,385,600)
1994	5,000	0	(5,000)	0.9346	4,673	0	(4,673)
1995	5,000	0	(5,000)	0.8734	4,367	0	(4,367)
1996	5,000	0	(5,000)	0.8163	4,081	0	(4,081)
1997	5,000	0	(5,000)	0.7629	3,814	0	(3,814)
1998	5,000	0	(5,000)	0.7130	3,565	0	(3,565)
1999	5,000	0	(5,000)	0.6663	3,332	0	(3,332)
2000	5,000	0	(5,000)	0.6227	3,114	0	(3,114)
2001	678,294	954,209	275,915	0.5820	394,773	555,358	160,585
2002	680,487	973,823	293,336	0.5439	370,140	529,695	159,555
2003	682,680	993,437	310,757	0.5083	347,040	505,013	157,973
2004	684,873	1,013,052	328,178	0.4751	325,378	481,293	155,915
2005	687,067	1,032,666	345,599	0.4440	305,066	458,516	153,450
2006	689,260	1,052,280	363,020	0.4150	286,018	436,659	150,641
2007	691,453	1,071,894	380,441	0.3878	268,157	415,699	147,542
2008	693,646	1,091,508	397,862	0.3624	251,409	395,613	144,204
2009	695,839	1,111,122	415,284	0.3387	235,705	376,376	140,671
2010	698,032	1,130,737	432,705	0.3166	220,979	357,962	136,983
2011	700,225	1,150,351	450,126	0.2959	207,171	340,347	133,176
2012	702,418	1,169,965	467,547	0.2765	194,224	323,505	129,281
2013	704,611	1,189,579	484,968	0.2584	182,085	307,410	125,325
2014	706,804	1,209,193	502,389	0.2415	170,703	292,036	121,333
2015	708,998	1,228,808	519,810	0.2257	160,030	277,358	117,328
2016	711,191	1,248,422	537,231	0.2109	150,023	263,351	113,327
2017	713,384	1,268,036	554,652	0.1971	140,641	249,989	109,348
2018	715,577	1,287,650	572,073	0.1842	131,844	237,248	105,404
2019	717,770	1,307,264	589,494	0.1722	123,597	225,105	101,508
2020	719,963	1,326,878	606,915	0.1609	115,864	213,535	97,671
2021	722,156	1,346,493	624,336	0.1504	108,614	202,515	93,902
2022	724,349	1,366,107	641,758	0.1406	101,817	192,024	90,207
2023	726,542	1,385,721	659,179	0.1314	95,444	182,038	86,594
2024	728,735	1,405,335	676,600	0.1228	89,469	172,537	83,068
2025	730,929	1,424,949	694,021	0.1147	83,868	163,500	79,633
2026	733,122	1,444,563	711,442	0.1072	78,616	154,907	76,291
2027	735,315	1,464,178	728,863	0.1002	73,693	146,739	73,046
2028	737,508	1,483,792	746,284	0.0937	69,077	138,976	69,899
2029	739,701	1,503,406	763,705	0.0875	64,750	131,601	66,851
2030	741,894	1,523,020	781,126	0.0818	60,693	124,597	63,903
2031	744,087	1,542,634	798,547	0.0765	56,891	117,945	61,054
2032	746,280	1,562,249	815,968	0.0715	53,325	111,630	58,305
2033	748,473	1,581,863	833,389	0.0668	49,983	105,637	55,654
2034	750,666	1,601,477	850,811	0.0624	46,850	99,951	53,100
2035	752,860	1,621,091	868,232	0.0583	43,913	94,556	50,643
2036	755,053	1,640,705	885,653	0.0545	41,160	89,439	48,279
2037	757,246	1,660,319	903,074	0.0509	38,579	84,587	46,008
2038	759,439	1,679,934	920,495	0.0476	36,160	79,988	43,828
2039	761,632	1,699,548	937,916	0.0445	33,892	75,627	41,736
2040	763,825	10,265,062	9,501,237	0.0416	31,766	426,898	395,132
PV's	57,251,954	10,137,763	(47,114,191)		57,251,954	10,137,763	(47,114,191)

File: A-5

FEASIBILITY INDICATORS	
Discount Rate =	7.00%
IRR =	-1.21%
NPV =	**($47,114)** Million
B/C Ratio =	**0.18**

Exhibit A-6

CORRIDOR PERSPECTIVE ECONOMIC IMPACT CALCULATIONS
ALTERNATE "A" – UPGRADED HIGHWAY

Inclusive of Construction Impacts

(1993 Dollars in Thousands)

Year	Economic Development Impacts (Undiscounted)						Present Discounted to 1993	
	Const.	Competitive Position	Other Efficiency	Addn'l Surplus	Residual Value	Total Impacts	Present Worth Factor	Total Impacts
1990								
1991								
1992								
1993	3,020,257					3,020,257	1.0000	3,020,257
1994	2,924,035					2,924,035	0.9346	2,732,743
1995	2,794,948	550,609	565,443	6,200		3,917,201	0.8734	3,421,435
1996	2,654,761	655,002	594,291	6,240		3,910,293	0.8163	3,191,964
1997	2,486,708	759,394	623,138	6,280		3,875,521	0.7629	2,956,616
1998	2,359,813	863,787	651,986	6,320		3,881,905	0.7130	2,767,745
1999	2,243,877	968,179	680,833	6,360		3,899,249	0.6663	2,598,235
2000	2,146,552	1,072,571	709,681	6,400		3,935,205	0.6227	2,450,648
2001	2,099,614	1,144,107	745,163	6,440		3,995,324	0.5820	2,325,315
2002	2,052,368	1,215,642	780,645	6,480		4,055,135	0.5439	2,205,725
2003	0	1,287,178	816,127	6,520		2,109,825	0.5083	1,072,528
2004	0	1,358,713	851,609	6,560		2,216,882	0.4751	1,053,225
2005	0	1,430,249	887,091	6,600		2,323,940	0.4440	1,031,857
2006	0	1,485,388	921,788	6,640		2,413,816	0.4150	1,001,648
2007	0	1,540,527	956,486	6,680		2,503,693	0.3878	970,975
2008	0	1,595,666	991,183	6,720		2,593,570	0.3624	940,029
2009	0	1,650,805	1,025,881	6,760		2,683,446	0.3387	908,976
2010	0	1,705,944	1,060,578	6,800		2,773,323	0.3166	877,963
2011	0	1,755,170	1,090,708	6,840		2,852,717	0.2959	844,016
2012	0	1,804,395	1,120,837	6,880		2,932,112	0.2765	810,753
2013	0	1,853,620	1,150,966	6,920		3,011,506	0.2584	778,230
2014	0	1,902,845	1,181,096	6,960		3,090,900	0.2415	746,493
2015	0	1,952,070	1,211,225	7,000		3,170,295	0.2257	715,577
2016	0	2,000,949	1,242,482	7,040		3,250,471	0.2109	685,677
2017	0	2,049,828	1,273,740	7,080		3,330,647	0.1971	656,626
2018	0	2,098,707	1,304,997	7,120		3,410,823	0.1842	628,441
2019	0	2,147,586	1,336,254	7,160		3,491,000	0.1722	601,134
2020	0	2,196,465	1,367,511	7,200		3,571,176	0.1609	574,711
2021	0	2,245,751	1,394,293	7,240		3,647,284	0.1504	548,560
2022	0	2,295,038	1,421,074	7,280		3,723,392	0.1406	523,370
2023	0	2,344,324	1,447,855	7,320		3,799,500	0.1314	499,129
2024	0	2,393,611	1,474,637	7,360		3,875,608	0.1228	475,820
2025	0	2,442,897	1,501,418	7,400		3,951,715	0.1147	453,424
2026	0	2,505,140	1,536,774	7,440		4,049,354	0.1072	434,231
2027	0	2,567,383	1,572,131	7,480		4,146,994	0.1002	415,609
2028	0	2,629,625	1,607,487	7,520		4,244,633	0.0937	397,565
2029	0	2,691,868	1,642,843	7,560		4,342,272	0.0875	380,103
2030	0	2,754,111	1,678,200	7,600		4,439,911	0.0818	363,224
2031	0	2,834,034	1,720,001	7,640		4,561,675	0.0765	348,771
2032	0	2,913,958	1,761,802	7,680		4,683,440	0.0715	334,655
2033	0	2,993,881	1,803,603	7,720		4,805,204	0.0668	320,893
2034	0	3,073,804	1,845,404	7,760		4,926,969	0.0624	307,500
2035	0	3,153,728	1,887,205	7,800		5,048,733	0.0583	294,485
2036	0	3,233,651	1,929,006	7,840		5,170,498	0.0545	281,858
2037	0	3,313,575	1,970,808	7,880		5,292,262	0.0509	269,622
2038	0	3,393,498	2,012,609	7,920		5,414,027	0.0476	257,781
2039	0	3,473,422	2,054,410	7,960		5,535,791	0.0445	246,335
2040	0	3,553,345	2,096,211	8,000	3,091,000	8,748,556	0.0416	363,830
TOTALS								
Discounted	19,111,206	18,596,199	12,165,066	85,290	128,547	50,086,308		50,086,308
Undiscounted	24,782,935	95,852,038	59,499,510	326,600	3,091,000	183,552,083		n.a.

Exhibit A-7

CORRIDOR PERSPECTIVE ECONOMIC IMPACT CALCULATIONS
ALTERNATE "B" – UPGRADED RAILWAY
Inclusive of Construction Impacts
(1993 Dollars in Thousands)

Year	Economic Development Impacts (Undiscounted)						Present Worth	Discounted to 1993
	Const.	Competitive Position	Other Efficiency	Addn1 Surplus	Residual Value	Total Impacts	Factor	Total Impacts
1990								
1991								
1992								
1993	6,176,497					6,176,497	1.0000	6,176,497
1994	6,161,001					6,161,001	0.9346	5,757,945
1995	6,101,386					6,101,386	0.8734	5,329,187
1996	5,966,980	438,234	205,237	50,560		6,661,010	0.8163	5,437,369
1997	5,793,620	516,279	216,099	51,820		6,577,818	0.7629	5,018,186
1998	5,664,226	594,323	226,962	53,080		6,538,591	0.7130	4,661,925
1999	5,562,210	672,367	237,825	54,340		6,526,742	0.6663	4,349,044
2000	5,496,955	750,412	248,688	55,600		6,551,654	0.6227	4,080,041
2001	5,500,711	811,965	262,896	56,860		6,632,431	0.5820	3,860,135
2002	5,532,947	873,518	277,104	58,120		6,741,689	0.5439	3,667,032
2003	0	935,071	291,312	59,380		1,285,763	0.5083	653,617
2004	0	996,624	305,521	60,640		1,362,785	0.4751	647,449
2005	0	1,058,177	319,729	61,900		1,439,806	0.4440	639,291
2006	0	1,110,781	332,686	63,160		1,506,627	0.4150	625,197
2007	0	1,163,385	345,643	64,420		1,573,448	0.3878	610,210
2008	0	1,215,988	358,601	65,680		1,640,269	0.3624	594,509
2009	0	1,268,592	371,558	66,940		1,707,090	0.3387	578,250
2010	0	1,321,196	384,515	68,200		1,773,911	0.3166	561,575
2011	0	1,370,639	394,752	69,460		1,834,851	0.2959	542,866
2012	0	1,420,082	404,990	70,720		1,895,791	0.2765	524,202
2013	0	1,469,525	415,227	71,980		1,956,732	0.2584	505,657
2014	0	1,518,968	425,464	73,240		2,017,672	0.2415	487,294
2015	0	1,568,411	435,702	74,500		2,078,612	0.2257	469,170
2016	0	1,618,292	447,218	75,760		2,141,270	0.2109	451,694
2017	0	1,668,173	458,735	77,020		2,203,928	0.1971	434,497
2018	0	1,718,055	470,251	78,280		2,266,586	0.1842	417,617
2019	0	1,767,936	481,768	79,540		2,329,243	0.1722	401,085
2020	0	1,817,817	493,284	80,800		2,391,901	0.1609	384,930
2021	0	1,867,699	500,640	82,060		2,450,399	0.1504	368,545
2022	0	1,917,580	507,996	83,320		2,508,896	0.1406	352,657
2023	0	1,967,461	515,352	84,580		2,567,393	0.1314	337,271
2024	0	2,017,342	522,708	85,840		2,625,890	0.1228	322,388
2025	0	2,067,224	530,064	87,100		2,684,387	0.1147	308,010
2026	0	2,127,934	543,554	88,360		2,759,847	0.1072	295,951
2027	0	2,188,643	557,044	89,620		2,835,308	0.1002	284,153
2028	0	2,249,353	570,535	90,880		2,910,768	0.0937	272,631
2029	0	2,310,063	584,025	92,140		2,986,228	0.0875	261,401
2030	0	2,370,772	597,516	93,400		3,061,688	0.0818	250,473
2031	0	2,446,063	613,383	94,660		3,154,106	0.0765	241,153
2032	0	2,521,354	629,249	95,920		3,246,524	0.0715	231,980
2033	0	2,596,646	645,116	97,180		3,338,942	0.0668	222,976
2034	0	2,671,937	660,983	98,440		3,431,360	0.0624	214,157
2035	0	2,747,228	676,850	99,700		3,523,778	0.0583	205,537
2036	0	2,822,519	692,717	100,960		3,616,196	0.0545	197,129
2037	0	2,897,810	708,584	102,220		3,708,613	0.0509	188,941
2038	0	2,973,101	724,450	103,480		3,801,031	0.0476	180,980
2039	0	3,048,392	740,317	104,740		3,893,449	0.0445	173,253
2040	0	3,123,683	756,184	106,000	4,934,000	8,919,867	0.0416	370,955
TOTALS								
Discounted	43,933,484	14,064,810	4,162,471	781,053	205,193	63,147,011		63,147,011
Undiscounted	57,956,532	78,597,611	21,089,031	3,522,600	4,934,000	166,099,774		n.a.

Exhibit A-8

CORRIDOR PERSPECTIVE ECONOMIC IMPACT CALCULATIONS
ALTERNATE "C" – THREE SUPER HIGHWAYS

Inclusive of Construction Impacts

(1993 Dollars in Thousands)

Year	Economic Development Impacts (Undiscounted)						Present Worth Factor	Discounted to 1993 Total Impacts
	Const.	Competitive Position	Other Efficiency	Addn'l Surplus	Residual Value	Total Impacts		
1990								
1991								
1992								
1993	9,944,821					9,944,821	1.0000	9,944,821
1994	9,923,851					9,923,851	0.9346	9,274,627
1995	9,830,910					9,830,910	0.8734	8,586,697
1996	9,591,834					9,591,834	0.8163	7,829,794
1997	9,335,378					9,335,378	0.7629	7,121,915
1998	9,107,877	647,644	1,981,108	1,123,320		12,859,949	0.7130	9,168,966
1999	8,961,268	735,328	2,066,769	1,138,860		12,902,225	0.6663	8,597,297
2000	8,865,520	823,011	2,152,430	1,154,400		12,995,361	0.6227	8,092,858
2001	8,850,959	895,080	2,247,448	1,169,940		13,163,426	0.5820	7,661,234
2002	8,891,963	967,148	2,342,465	1,185,480		13,387,057	0.5439	7,281,672
2003	0	1,039,217	2,437,483	1,201,020		4,677,720	0.5083	2,377,916
2004	0	1,111,286	2,532,501	1,216,560		4,860,347	0.4751	2,309,116
2005	0	1,183,355	2,627,519	1,232,100		5,042,973	0.4440	2,239,141
2006	0	1,246,505	2,742,786	1,247,640		5,236,931	0.4150	2,173,140
2007	0	1,309,655	2,858,053	1,263,180		5,430,888	0.3878	2,106,192
2008	0	1,372,805	2,973,321	1,278,720		5,624,846	0.3624	2,038,703
2009	0	1,435,955	3,088,588	1,294,260		5,818,803	0.3387	1,971,030
2010	0	1,499,105	3,203,855	1,309,800		6,012,760	0.3166	1,903,486
2011	0	1,559,031	3,319,402	1,325,340		6,203,772	0.2959	1,835,472
2012	0	1,618,956	3,434,948	1,340,880		6,394,784	0.2765	1,768,211
2013	0	1,678,881	3,550,495	1,356,420		6,585,796	0.2584	1,701,895
2014	0	1,738,806	3,666,042	1,371,960		6,776,808	0.2415	1,636,688
2015	0	1,798,732	3,781,588	1,387,500		6,967,820	0.2257	1,572,729
2016	0	1,859,911	3,901,641	1,403,040		7,164,592	0.2109	1,511,348
2017	0	1,921,089	4,021,695	1,418,580		7,361,364	0.1971	1,451,268
2018	0	1,982,268	4,141,748	1,434,120		7,558,136	0.1842	1,392,580
2019	0	2,043,447	4,261,801	1,449,660		7,754,908	0.1722	1,335,360
2020	0	2,104,626	4,381,855	1,465,200		7,951,681	0.1609	1,279,667
2021	0	2,165,177	4,501,877	1,480,740		8,147,794	0.1504	1,225,446
2022	0	2,225,727	4,621,900	1,496,280		8,343,907	0.1406	1,172,843
2023	0	2,286,278	4,741,923	1,511,820		8,540,021	0.1314	1,121,878
2024	0	2,346,829	4,861,945	1,527,360		8,736,134	0.1228	1,072,561
2025	0	2,407,380	4,981,968	1,542,900		8,932,247	0.1147	1,024,896
2026	0	2,480,387	5,111,970	1,558,440		9,150,797	0.1072	981,283
2027	0	2,553,394	5,241,973	1,573,980		9,369,346	0.1002	938,990
2028	0	2,626,401	5,371,975	1,589,520		9,587,896	0.0937	898,030
2029	0	2,699,408	5,501,977	1,605,060		9,806,445	0.0875	858,412
2030	0	2,772,415	5,631,980	1,620,600		10,024,994	0.0818	820,133
2031	0	2,862,446	5,783,798	1,636,140		10,282,384	0.0765	786,159
2032	0	2,952,477	5,935,616	1,651,680		10,539,773	0.0715	753,120
2033	0	3,042,509	6,087,434	1,667,220		10,797,163	0.0668	721,039
2034	0	3,132,540	6,239,252	1,682,760		11,054,553	0.0624	689,932
2035	0	3,222,572	6,391,070	1,698,300		11,311,942	0.0583	659,809
2036	0	3,312,603	6,542,889	1,713,840		11,569,332	0.0545	630,675
2037	0	3,402,635	6,694,707	1,729,380		11,826,721	0.0509	602,529
2038	0	3,492,666	6,846,525	1,744,920		12,084,111	0.0476	575,367
2039	0	3,582,697	6,998,343	1,760,460		12,341,500	0.0445	549,179
2040	0	3,672,729	7,150,161	1,776,000	9,794,000	22,392,890	0.0416	931,264
TOTALS								
Discounted	70,731,894	15,155,310	33,417,140	13,465,717	407,308	133,177,368		133,177,368
Undiscounted	93,304,382	89,811,108	186,954,824	62,335,380	9,794,000	442,199,693		n.a.

Exhibit A-9

CORRIDOR PERSPECTIVE ECONOMIC IMPACT CALCULATIONS
ALTERNATE "C" – ONE SUPER HIGHWAY
Inclusive of Construction Impacts
(1993 Dollars in Thousands)

	Economic Development Impacts (Undiscounted)						Present	Discounted to 1993
Year	Const.	Competitive Position	Other Efficiency	Addn'l Surplus	Residual Value	Total Impacts	Worth Factor	Total Impacts
1990								
1991								
1992								
1993	9,944,821					9,944,821	1.0000	9,944,821
1994	9,923,851					9,923,851	0.9346	9,274,627
1995	9,830,910					9,830,910	0.8734	8,586,697
1996	9,591,834					9,591,834	0.8163	7,829,794
1997	9,335,378					9,335,378	0.7629	7,121,915
1998	9,107,877	1,080,839	3,012,219	1,887,960		15,088,894	0.7130	10,758,173
1999	8,961,268	1,228,011	3,146,692	1,914,080		15,250,052	0.6663	10,161,753
2000	8,865,520	1,375,184	3,281,166	1,940,200		15,462,070	0.6227	9,629,000
2001	8,850,959	1,497,665	3,437,608	1,966,320		15,752,552	0.5820	9,168,129
2002	8,891,963	1,620,145	3,594,051	1,992,440		16,098,600	0.5439	8,756,572
2003	0	1,742,626	3,750,494	2,018,560		7,511,680	0.5083	3,818,557
2004	0	1,865,107	3,906,937	2,044,680		7,816,724	0.4751	3,713,669
2005	0	1,987,588	4,063,380	2,070,800		8,121,768	0.4440	3,606,162
2006	0	2,092,106	4,249,768	2,096,920		8,438,793	0.4150	3,501,799
2007	0	2,196,623	4,436,155	2,123,040		8,755,819	0.3878	3,395,657
2008	0	2,301,141	4,622,543	2,149,160		9,072,844	0.3624	3,288,416
2009	0	2,405,659	4,808,930	2,175,280		9,389,870	0.3387	3,180,674
2010	0	2,510,177	4,995,318	2,201,400		9,706,895	0.3166	3,072,954
2011	0	2,611,599	5,187,527	2,227,520		10,026,646	0.2959	2,966,523
2012	0	2,713,020	5,379,737	2,253,640		10,346,397	0.2765	2,860,865
2013	0	2,814,441	5,571,946	2,279,760		10,666,147	0.2584	2,756,335
2014	0	2,915,862	5,764,155	2,305,880		10,985,898	0.2415	2,653,238
2015	0	3,017,284	5,956,365	2,332,000		11,305,648	0.2257	2,551,834
2016	0	3,120,428	6,154,962	2,358,120		11,633,510	0.2109	2,454,053
2017	0	3,223,571	6,353,560	2,384,240		11,961,372	0.1971	2,358,144
2018	0	3,326,715	6,552,158	2,410,360		12,289,233	0.1842	2,264,281
2019	0	3,429,859	6,750,756	2,436,480		12,617,095	0.1722	2,172,607
2020	0	3,533,003	6,949,353	2,462,600		12,944,956	0.1609	2,083,237
2021	0	3,634,455	7,146,787	2,488,720		13,269,962	0.1504	1,995,832
2022	0	3,735,907	7,344,221	2,514,840		13,594,968	0.1406	1,910,947
2023	0	3,837,359	7,541,655	2,540,960		13,919,974	0.1314	1,828,627
2024	0	3,938,811	7,739,089	2,567,080		14,244,980	0.1228	1,748,899
2025	0	4,040,263	7,936,522	2,593,200		14,569,986	0.1147	1,671,777
2026	0	4,163,716	8,150,763	2,619,320		14,933,798	0.1072	1,601,421
2027	0	4,287,168	8,365,003	2,645,440		15,297,611	0.1002	1,533,117
2028	0	4,410,620	8,579,244	2,671,560		15,661,424	0.0937	1,466,895
2029	0	4,534,072	8,793,484	2,697,680		16,025,236	0.0875	1,402,776
2030	0	4,657,525	9,007,724	2,723,800		16,389,049	0.0818	1,340,769
2031	0	4,805,197	9,255,135	2,749,920		16,810,252	0.0765	1,285,259
2032	0	4,952,870	9,502,545	2,776,040		17,231,454	0.0715	1,231,274
2033	0	5,100,542	9,749,955	2,802,160		17,652,657	0.0668	1,178,851
2034	0	5,248,215	9,997,365	2,828,280		18,073,859	0.0624	1,128,018
2035	0	5,395,888	10,244,775	2,854,400		18,495,062	0.0583	1,078,791
2036	0	5,543,560	10,492,185	2,880,520		18,916,265	0.0545	1,031,176
2037	0	5,691,233	10,739,595	2,906,640		19,337,467	0.0509	985,175
2038	0	5,838,905	10,987,005	2,932,760		19,758,670	0.0476	940,779
2039	0	5,986,578	11,234,415	2,958,880		20,179,872	0.0445	897,976
2040	0	6,134,250	11,481,825	2,985,000	9,794,000	30,395,075	0.0416	1,264,054
TOTALS								
Discounted	70,731,894	25,403,646	52,278,028	22,632,023	407,308	171,452,899		171,452,899
Undiscounted	93,304,382	150,545,790	296,215,069	104,768,640	9,794,000	654,627,880		n.a.

Exhibit A-10

CORRIDOR PERSPECTIVE ECONOMIC IMPACT CALCULATIONS
ALTERNATE "D" – HIGHWAY SPEED GUIDEWAY
Inclusive of Construction Impacts
(1993 Dollars in Thousands)

Year	Economic Development Impacts (Undiscounted)						Present	Discounted to 1993
	Const.	Competitive Position	Other Efficiency	Addn'l Surplus	Residual Value	Total Impacts	Worth Factor	Total Impacts
1990								
1991								
1992								
1993	9,575,710					9,575,710	1.0000	9,575,710
1994	9,555,535					9,555,535	0.9346	8,930,406
1995	9,465,247					9,465,247	0.8734	8,267,313
1996	9,234,926					9,234,926	0.8163	7,538,450
1997	8,988,813					8,988,813	0.7629	6,857,523
1998	8,769,439					8,769,439	0.7130	6,252,489
1999	8,630,034					8,630,034	0.6663	5,750,556
2000	8,537,721					8,537,721	0.6227	5,316,863
2001	8,525,518	970,058	704,330	173,880		10,373,786	0.5820	6,037,638
2002	8,565,099	1,023,382	738,666	176,960		10,504,107	0.5439	5,713,538
2003	0	1,076,706	773,002	180,040		2,029,749	0.5083	1,031,821
2004	0	1,130,030	807,339	183,120		2,120,489	0.4751	1,007,429
2005	0	1,183,355	841,675	186,200		2,211,230	0.4440	981,812
2006	0	1,221,408	874,068	189,280		2,284,756	0.4150	948,092
2007	0	1,259,461	906,461	192,360		2,358,282	0.3878	914,582
2008	0	1,297,514	938,854	195,440		2,431,808	0.3624	881,399
2009	0	1,335,567	971,248	198,520		2,505,335	0.3387	848,644
2010	0	1,373,620	1,003,641	201,600		2,578,861	0.3166	816,401
2011	0	1,406,008	1,028,712	204,680		2,639,400	0.2959	780,903
2012	0	1,438,396	1,053,784	207,760		2,699,940	0.2765	746,556
2013	0	1,470,783	1,078,856	210,840		2,760,479	0.2584	713,360
2014	0	1,503,171	1,103,928	213,920		2,821,019	0.2415	681,313
2015	0	1,535,559	1,128,999	217,000		2,881,558	0.2257	650,406
2016	0	1,566,821	1,153,976	220,080		2,940,877	0.2109	620,369
2017	0	1,598,084	1,178,953	223,160		3,000,197	0.1971	591,479
2018	0	1,629,346	1,203,930	226,240		3,059,516	0.1842	563,713
2019	0	1,660,608	1,228,907	229,320		3,118,835	0.1722	537,049
2020	0	1,691,871	1,253,883	232,400		3,178,154	0.1609	511,462
2021	0	1,724,194	1,274,541	235,480		3,234,215	0.1504	486,433
2022	0	1,756,518	1,295,198	238,560		3,290,276	0.1406	462,490
2023	0	1,788,842	1,315,855	241,640		3,346,337	0.1314	439,599
2024	0	1,821,165	1,336,513	244,720		3,402,398	0.1228	417,723
2025	0	1,853,489	1,357,170	247,800		3,458,459	0.1147	396,827
2026	0	1,896,738	1,388,002	250,880		3,535,620	0.1072	379,141
2027	0	1,939,988	1,418,834	253,960		3,612,782	0.1002	362,071
2028	0	1,983,237	1,449,666	257,040		3,689,943	0.0937	345,611
2029	0	2,026,487	1,480,498	260,120		3,767,104	0.0875	329,755
2030	0	2,069,736	1,511,330	263,200		3,844,266	0.0818	314,495
2031	0	2,124,560	1,550,983	266,280		3,941,823	0.0765	301,379
2032	0	2,179,384	1,590,636	269,360		4,039,380	0.0715	288,634
2033	0	2,234,208	1,630,289	272,440		4,136,936	0.0668	276,266
2034	0	2,289,031	1,669,942	275,520		4,234,493	0.0624	264,281
2035	0	2,343,855	1,709,595	278,600		4,332,050	0.0583	252,682
2036	0	2,398,679	1,749,248	281,680		4,429,607	0.0545	241,470
2037	0	2,453,503	1,788,901	284,760		4,527,164	0.0509	230,643
2038	0	2,508,327	1,828,554	287,840		4,624,721	0.0476	220,199
2039	0	2,563,150	1,868,207	290,920		4,722,278	0.0445	210,135
2040	0	2,617,974	1,907,861	294,000	8,545,900	13,365,735	0.0416	555,847
TOTALS								
Discounted	68,110,086	11,943,941	8,697,816	1,735,715	355,402	90,842,960		90,842,960
Undiscounted	89,848,041	69,944,813	51,095,034	9,357,600	8,545,900	228,791,388		n.a.

Exhibit A-11

CORRIDOR PERSPECTIVE ECONOMIC IMPACT CALCULATIONS
ALTERNATE "A" – UPGRADED HIGHWAY
Excluding Construction Impacts
(1993 Dollars in Thousands)

Year	Economic Development Impacts (Undiscounted)						Present	Discounted to 1993
	Const.	Competitive Position	Other Efficiency	Addn1 Surplus	Residual Value	Total Impacts	Worth Factor	Total Impacts
1990								
1991								
1992								
1993						0	1.0000	0
1994						0	0.9346	0
1995		550,609	565,443	6,200		1,122,253	0.8734	980,219
1996		655,002	594,291	6,240		1,255,532	0.8163	1,024,888
1997		759,394	623,138	6,280		1,388,812	0.7629	1,059,518
1998		863,787	651,986	6,320		1,522,092	0.7130	1,085,231
1999		968,179	680,833	6,360		1,655,372	0.6663	1,103,044
2000		1,072,571	709,681	6,400		1,788,652	0.6227	1,113,883
2001		1,144,107	745,163	6,440		1,895,710	0.5820	1,103,320
2002		1,215,642	780,645	6,480		2,002,767	0.5439	1,089,373
2003		1,287,178	816,127	6,520		2,109,825	0.5083	1,072,528
2004		1,358,713	851,609	6,560		2,216,882	0.4751	1,053,225
2005		1,430,249	887,091	6,600		2,323,940	0.4440	1,031,857
2006		1,485,388	921,788	6,640		2,413,816	0.4150	1,001,648
2007		1,540,527	956,486	6,680		2,503,693	0.3878	970,975
2008		1,595,666	991,183	6,720		2,593,570	0.3624	940,029
2009		1,650,805	1,025,881	6,760		2,683,446	0.3387	908,976
2010		1,705,944	1,060,578	6,800		2,773,323	0.3166	877,963
2011		1,755,170	1,090,708	6,840		2,852,717	0.2959	844,016
2012		1,804,395	1,120,837	6,880		2,932,112	0.2765	810,753
2013		1,853,620	1,150,966	6,920		3,011,506	0.2584	778,230
2014		1,902,845	1,181,096	6,960		3,090,900	0.2415	746,493
2015		1,952,070	1,211,225	7,000		3,170,295	0.2257	715,577
2016		2,000,949	1,242,482	7,040		3,250,471	0.2109	685,677
2017		2,049,828	1,273,740	7,080		3,330,647	0.1971	656,626
2018		2,098,707	1,304,997	7,120		3,410,823	0.1842	628,441
2019		2,147,586	1,336,254	7,160		3,491,000	0.1722	601,134
2020		2,196,465	1,367,511	7,200		3,571,176	0.1609	574,711
2021		2,245,751	1,394,293	7,240		3,647,284	0.1504	548,560
2022		2,295,038	1,421,074	7,280		3,723,392	0.1406	523,370
2023		2,344,324	1,447,855	7,320		3,799,500	0.1314	499,129
2024		2,393,611	1,474,637	7,360		3,875,608	0.1228	475,820
2025		2,442,897	1,501,418	7,400		3,951,715	0.1147	453,424
2026		2,505,140	1,536,774	7,440		4,049,354	0.1072	434,231
2027		2,567,383	1,572,131	7,480		4,146,994	0.1002	415,609
2028		2,629,625	1,607,487	7,520		4,244,633	0.0937	397,565
2029		2,691,868	1,642,843	7,560		4,342,272	0.0875	380,103
2030		2,754,111	1,678,200	7,600		4,439,911	0.0818	363,224
2031		2,834,034	1,720,001	7,640		4,561,675	0.0765	348,771
2032		2,913,958	1,761,802	7,680		4,683,440	0.0715	334,655
2033		2,993,881	1,803,603	7,720		4,805,204	0.0668	320,893
2034		3,073,804	1,845,404	7,760		4,926,969	0.0624	307,500
2035		3,153,728	1,887,205	7,800		5,048,733	0.0583	294,485
2036		3,233,651	1,929,006	7,840		5,170,498	0.0545	281,858
2037		3,313,575	1,970,808	7,880		5,292,262	0.0509	269,622
2038		3,393,498	2,012,609	7,920		5,414,027	0.0476	257,781
2039		3,473,422	2,054,410	7,960		5,535,791	0.0445	246,335
2040		3,553,345	2,096,211	8,000	3,091,000	8,748,556	0.0416	363,830
TOTALS								
Discounted	0	18,596,199	12,165,066	85,290	128,547	30,975,102		30,975,102
Undiscounted	0	95,852,038	59,499,510	326,600	3,091,000	158,769,148		n.a.

Exhibit A–12

CORRIDOR PERSPECTIVE ECONOMIC IMPACT CALCULATIONS
ALTERNATE "B" – UPGRADED RAILWAY
Excluding Construction Impacts
(1993 Dollars in Thousands)

Year	Economic Development Impacts (Undiscounted)						Present Worth	Discounted to 1993
	Const.	Competitive Position	Other Efficiency	Addn'l Surplus	Residual Value	Total Impacts	Factor	Total Impacts
1990								
1991								
1992								
1993						0	1.0000	0
1994						0	0.9346	0
1995						0	0.8734	0
1996		438,234	205,237	50,560		694,031	0.8163	566,536
1997		516,279	216,099	51,820		784,198	0.7629	598,261
1998		594,323	226,962	53,080		874,365	0.7130	623,410
1999		672,367	237,825	54,340		964,532	0.6663	642,708
2000		750,412	248,688	55,600		1,054,699	0.6227	656,814
2001		811,965	262,896	56,860		1,131,721	0.5820	658,672
2002		873,518	277,104	58,120		1,208,742	0.5439	657,476
2003		935,071	291,312	59,380		1,285,763	0.5083	653,617
2004		996,624	305,521	60,640		1,362,785	0.4751	647,449
2005		1,058,177	319,729	61,900		1,439,806	0.4440	639,291
2006		1,110,781	332,686	63,160		1,506,627	0.4150	625,197
2007		1,163,385	345,643	64,420		1,573,448	0.3878	610,210
2008		1,215,988	358,601	65,680		1,640,269	0.3624	594,509
2009		1,268,592	371,558	66,940		1,707,090	0.3387	578,250
2010		1,321,196	384,515	68,200		1,773,911	0.3166	561,575
2011		1,370,639	394,752	69,460		1,834,851	0.2959	542,866
2012		1,420,082	404,990	70,720		1,895,791	0.2765	524,202
2013		1,469,525	415,227	71,980		1,956,732	0.2584	505,657
2014		1,518,968	425,464	73,240		2,017,672	0.2415	487,294
2015		1,568,411	435,702	74,500		2,078,612	0.2257	469,170
2016		1,618,292	447,218	75,760		2,141,270	0.2109	451,694
2017		1,668,173	458,735	77,020		2,203,928	0.1971	434,497
2018		1,718,055	470,251	78,280		2,266,586	0.1842	417,617
2019		1,767,936	481,768	79,540		2,329,243	0.1722	401,085
2020		1,817,817	493,284	80,800		2,391,901	0.1609	384,930
2021		1,867,699	500,640	82,060		2,450,399	0.1504	368,545
2022		1,917,580	507,996	83,320		2,508,896	0.1406	352,657
2023		1,967,461	515,352	84,580		2,567,393	0.1314	337,271
2024		2,017,342	522,708	85,840		2,625,890	0.1228	322,388
2025		2,067,224	530,064	87,100		2,684,387	0.1147	308,010
2026		2,127,934	543,554	88,360		2,759,847	0.1072	295,951
2027		2,188,643	557,044	89,620		2,835,308	0.1002	284,153
2028		2,249,353	570,535	90,880		2,910,768	0.0937	272,631
2029		2,310,063	584,025	92,140		2,986,228	0.0875	261,401
2030		2,370,772	597,516	93,400		3,061,688	0.0818	250,473
2031		2,446,063	613,383	94,660		3,154,106	0.0765	241,153
2032		2,521,354	629,249	95,920		3,246,524	0.0715	231,980
2033		2,596,646	645,116	97,180		3,338,942	0.0668	222,976
2034		2,671,937	660,983	98,440		3,431,360	0.0624	214,157
2035		2,747,228	676,850	99,700		3,523,778	0.0583	205,537
2036		2,822,519	692,717	100,960		3,616,196	0.0545	197,129
2037		2,897,810	708,584	102,220		3,708,613	0.0509	188,941
2038		2,973,101	724,450	103,480		3,801,031	0.0476	180,980
2039		3,048,392	740,317	104,740		3,893,449	0.0445	173,253
2040		3,123,683	756,184	106,000	4,934,000	8,919,867	0.0416	370,955
TOTALS								
Discounted	0	14,064,810	4,162,471	781,053	205,193	19,213,527		19,213,527
Undiscounted	0	78,597,611	21,089,031	3,522,600	4,934,000	108,143,242		n.a.

Exhibit A-13

CORRIDOR PERSPECTIVE ECONOMIC IMPACT CALCULATIONS
ALTERNATE "C" – THREE SUPER HIGHWAYS
Excluding of Construction Impacts
(1993 Dollars in Thousands)

Year	Economic Development Impacts (Undiscounted)						Present Worth	Discounted to 1993
	Const.	Competitive Position	Other Efficiency	Addn'l Surplus	Residual Value	Total Impacts	Worth Factor	Total Impacts
1990								
1991								
1992								
1993						0	1.0000	0
1994						0	0.9346	0
1995						0	0.8734	0
1996						0	0.8163	0
1997						0	0.7629	0
1998		647,644	1,981,108	1,123,320		3,752,072	0.7130	2,675,176
1999		735,328	2,066,769	1,138,860		3,940,956	0.6663	2,626,026
2000		823,011	2,152,430	1,154,400		4,129,841	0.6227	2,571,857
2001		895,080	2,247,448	1,169,940		4,312,467	0.5820	2,509,895
2002		967,148	2,342,465	1,185,480		4,495,094	0.5439	2,445,033
2003		1,039,217	2,437,483	1,201,020		4,677,720	0.5083	2,377,916
2004		1,111,286	2,532,501	1,216,560		4,860,347	0.4751	2,309,116
2005		1,183,355	2,627,519	1,232,100		5,042,973	0.4440	2,239,141
2006		1,246,505	2,742,786	1,247,640		5,236,931	0.4150	2,173,140
2007		1,309,655	2,858,053	1,263,180		5,430,888	0.3878	2,106,192
2008		1,372,805	2,973,321	1,278,720		5,624,846	0.3624	2,038,703
2009		1,435,955	3,088,588	1,294,260		5,818,803	0.3387	1,971,030
2010		1,499,105	3,203,855	1,309,800		6,012,760	0.3166	1,903,486
2011		1,559,031	3,319,402	1,325,340		6,203,772	0.2959	1,835,472
2012		1,618,956	3,434,948	1,340,880		6,394,784	0.2765	1,768,211
2013		1,678,881	3,550,495	1,356,420		6,585,796	0.2584	1,701,895
2014		1,738,806	3,666,042	1,371,960		6,776,808	0.2415	1,636,688
2015		1,798,732	3,781,588	1,387,500		6,967,820	0.2257	1,572,729
2016		1,859,911	3,901,641	1,403,040		7,164,592	0.2109	1,511,348
2017		1,921,089	4,021,695	1,418,580		7,361,364	0.1971	1,451,268
2018		1,982,268	4,141,748	1,434,120		7,558,136	0.1842	1,392,580
2019		2,043,447	4,261,801	1,449,660		7,754,908	0.1722	1,335,360
2020		2,104,626	4,381,855	1,465,200		7,951,681	0.1609	1,279,667
2021		2,165,177	4,501,877	1,480,740		8,147,794	0.1504	1,225,446
2022		2,225,727	4,621,900	1,496,280		8,343,907	0.1406	1,172,843
2023		2,286,278	4,741,923	1,511,820		8,540,021	0.1314	1,121,878
2024		2,346,829	4,861,945	1,527,360		8,736,134	0.1228	1,072,561
2025		2,407,380	4,981,968	1,542,900		8,932,247	0.1147	1,024,896
2026		2,480,387	5,111,970	1,558,440		9,150,797	0.1072	981,283
2027		2,553,394	5,241,973	1,573,980		9,369,346	0.1002	938,990
2028		2,626,401	5,371,975	1,589,520		9,587,896	0.0937	898,030
2029		2,699,408	5,501,977	1,605,060		9,806,445	0.0875	858,412
2030		2,772,415	5,631,980	1,620,600		10,024,994	0.0818	820,133
2031		2,862,446	5,783,798	1,636,140		10,282,384	0.0765	786,159
2032		2,952,477	5,935,616	1,651,680		10,539,773	0.0715	753,120
2033		3,042,509	6,087,434	1,667,220		10,797,163	0.0668	721,039
2034		3,132,540	6,239,252	1,682,760		11,054,553	0.0624	689,932
2035		3,222,572	6,391,070	1,698,300		11,311,942	0.0583	659,809
2036		3,312,603	6,542,889	1,713,840		11,569,332	0.0545	630,675
2037		3,402,635	6,694,707	1,729,380		11,826,721	0.0509	602,529
2038		3,492,666	6,846,525	1,744,920		12,084,111	0.0476	575,367
2039		3,582,697	6,998,343	1,760,460		12,341,500	0.0445	549,179
2040		3,672,729	7,150,161	1,776,000	9,794,000	22,392,890	0.0416	931,264
TOTALS								
Discounted	0	15,155,310	33,417,140	13,465,717	407,308	62,445,474		62,445,474
Undiscounted	0	89,811,108	186,954,824	62,335,380	9,794,000	348,895,312		n.a.

Exhibit A-14

CORRIDOR PERSPECTIVE ECONOMIC IMPACT CALCULATIONS
ALTERNATE "C" – ONE SUPER HIGHWAY
Excluding Construction Impacts
(1993 Dollars in Thousands)

Year	Economic Development Impacts (Undiscounted) Const.	Competitive Position	Other Efficiency	Addn'l Surplus	Residual Value	Total Impacts	Present Worth Factor	Discounted to 1993 Total Impacts
1990								
1991								
1992								
1993						0	1.0000	0
1994						0	0.9346	0
1995						0	0.8734	0
1996						0	0.8163	0
1997						0	0.7629	0
1998		1,080,839	3,012,219	1,887,960		5,981,018	0.7130	4,264,383
1999		1,228,011	3,146,692	1,914,080		6,288,784	0.6663	4,190,482
2000		1,375,184	3,281,166	1,940,200		6,596,550	0.6227	4,108,000
2001		1,497,665	3,437,608	1,966,320		6,901,593	0.5820	4,016,790
2002		1,620,145	3,594,051	1,992,440		7,206,637	0.5439	3,919,933
2003		1,742,626	3,750,494	2,018,560		7,511,680	0.5083	3,818,557
2004		1,865,107	3,906,937	2,044,680		7,816,724	0.4751	3,713,669
2005		1,987,588	4,063,380	2,070,800		8,121,768	0.4440	3,606,162
2006		2,092,106	4,249,768	2,096,920		8,438,793	0.4150	3,501,799
2007		2,196,623	4,436,155	2,123,040		8,755,819	0.3878	3,395,657
2008		2,301,141	4,622,543	2,149,160		9,072,844	0.3624	3,288,416
2009		2,405,659	4,808,930	2,175,280		9,389,870	0.3387	3,180,674
2010		2,510,177	4,995,318	2,201,400		9,706,895	0.3166	3,072,954
2011		2,611,599	5,187,527	2,227,520		10,026,646	0.2959	2,966,523
2012		2,713,020	5,379,737	2,253,640		10,346,397	0.2765	2,860,865
2013		2,814,441	5,571,946	2,279,760		10,666,147	0.2584	2,756,335
2014		2,915,862	5,764,155	2,305,880		10,985,898	0.2415	2,653,238
2015		3,017,284	5,956,365	2,332,000		11,305,648	0.2257	2,551,834
2016		3,120,428	6,154,962	2,358,120		11,633,510	0.2109	2,454,053
2017		3,223,571	6,353,560	2,384,240		11,961,372	0.1971	2,358,144
2018		3,326,715	6,552,158	2,410,360		12,289,233	0.1842	2,264,281
2019		3,429,859	6,750,756	2,436,480		12,617,095	0.1722	2,172,607
2020		3,533,003	6,949,353	2,462,600		12,944,956	0.1609	2,083,237
2021		3,634,455	7,146,787	2,488,720		13,269,962	0.1504	1,995,832
2022		3,735,907	7,344,221	2,514,840		13,594,968	0.1406	1,910,947
2023		3,837,359	7,541,655	2,540,960		13,919,974	0.1314	1,828,627
2024		3,938,811	7,739,089	2,567,080		14,244,980	0.1228	1,748,899
2025		4,040,263	7,936,522	2,593,200		14,569,986	0.1147	1,671,777
2026		4,163,716	8,150,763	2,619,320		14,933,798	0.1072	1,601,421
2027		4,287,168	8,365,003	2,645,440		15,297,611	0.1002	1,533,117
2028		4,410,620	8,579,244	2,671,560		15,661,424	0.0937	1,466,895
2029		4,534,072	8,793,484	2,697,680		16,025,236	0.0875	1,402,776
2030		4,657,525	9,007,724	2,723,800		16,389,049	0.0818	1,340,769
2031		4,805,197	9,255,135	2,749,920		16,810,252	0.0765	1,285,259
2032		4,952,870	9,502,545	2,776,040		17,231,454	0.0715	1,231,274
2033		5,100,542	9,749,955	2,802,160		17,652,657	0.0668	1,178,851
2034		5,248,215	9,997,365	2,828,280		18,073,859	0.0624	1,128,018
2035		5,395,888	10,244,775	2,854,400		18,495,062	0.0583	1,078,791
2036		5,543,560	10,492,185	2,880,520		18,916,265	0.0545	1,031,176
2037		5,691,233	10,739,595	2,906,640		19,337,467	0.0509	985,175
2038		5,838,905	10,987,005	2,932,760		19,758,670	0.0476	940,779
2039		5,986,578	11,234,415	2,958,880		20,179,872	0.0445	897,976
2040		6,134,250	11,481,825	2,985,000	9,794,000	30,395,075	0.0416	1,264,054
TOTALS								
Discounted	0	25,403,646	52,278,028	22,632,023	407,308	100,721,005		100,721,005
Undiscounted	0	150,545,790	296,215,069	104,768,640	9,794,000	561,323,498		n.a.

Exhibit A-15

CORRIDOR PERSPECTIVE ECONOMIC IMPACT CALCULATIONS
ALTERNATE "D" – HIGHWAY SPEED GUIDEWAY
Excluding Construction Impacts
(1993 Dollars in Thousands)

Year	Economic Development Impacts (Undiscounted)						Present	Discounted to 1993
	Const.	Competitive Position	Other Efficiency	Addn1 Surplus	Residual Value	Total Impacts	Worth Factor	Total Impacts
1990								
1991								
1992								
1993						0	1.0000	0
1994						0	0.9346	0
1995						0	0.8734	0
1996						0	0.8163	0
1997						0	0.7629	0
1998						0	0.7130	0
1999						0	0.6663	0
2000						0	0.6227	0
2001		970,058	704,330	173,880		1,848,268	0.5820	1,075,709
2002		1,023,382	738,666	176,960		1,939,008	0.5439	1,054,692
2003		1,076,706	773,002	180,040		2,029,749	0.5083	1,031,821
2004		1,130,030	807,339	183,120		2,120,489	0.4751	1,007,429
2005		1,183,355	841,675	186,200		2,211,230	0.4440	981,812
2006		1,221,408	874,068	189,280		2,284,756	0.4150	948,092
2007		1,259,461	906,461	192,360		2,358,282	0.3878	914,582
2008		1,297,514	938,854	195,440		2,431,808	0.3624	881,399
2009		1,335,567	971,248	198,520		2,505,335	0.3387	848,644
2010		1,373,620	1,003,641	201,600		2,578,861	0.3166	816,401
2011		1,406,008	1,028,712	204,680		2,639,400	0.2959	780,903
2012		1,438,396	1,053,784	207,760		2,699,940	0.2765	746,556
2013		1,470,783	1,078,856	210,840		2,760,479	0.2584	713,360
2014		1,503,171	1,103,928	213,920		2,821,019	0.2415	681,313
2015		1,535,559	1,128,999	217,000		2,881,558	0.2257	650,406
2016		1,566,821	1,153,976	220,080		2,940,877	0.2109	620,369
2017		1,598,084	1,178,953	223,160		3,000,197	0.1971	591,479
2018		1,629,346	1,203,930	226,240		3,059,516	0.1842	563,713
2019		1,660,608	1,228,907	229,320		3,118,835	0.1722	537,049
2020		1,691,871	1,253,883	232,400		3,178,154	0.1609	511,462
2021		1,724,194	1,274,541	235,480		3,234,215	0.1504	486,433
2022		1,756,518	1,295,198	238,560		3,290,276	0.1406	462,490
2023		1,788,842	1,315,855	241,640		3,346,337	0.1314	439,599
2024		1,821,165	1,336,513	244,720		3,402,398	0.1228	417,723
2025		1,853,489	1,357,170	247,800		3,458,459	0.1147	396,827
2026		1,896,738	1,388,002	250,880		3,535,620	0.1072	379,141
2027		1,939,988	1,418,834	253,960		3,612,782	0.1002	362,071
2028		1,983,237	1,449,666	257,040		3,689,943	0.0937	345,611
2029		2,026,487	1,480,498	260,120		3,767,104	0.0875	329,755
2030		2,069,736	1,511,330	263,200		3,844,266	0.0818	314,495
2031		2,124,560	1,550,983	266,280		3,941,823	0.0765	301,379
2032		2,179,384	1,590,636	269,360		4,039,380	0.0715	288,634
2033		2,234,208	1,630,289	272,440		4,136,936	0.0668	276,266
2034		2,289,031	1,669,942	275,520		4,234,493	0.0624	264,281
2035		2,343,855	1,709,595	278,600		4,332,050	0.0583	252,682
2036		2,398,679	1,749,248	281,680		4,429,607	0.0545	241,470
2037		2,453,503	1,788,901	284,760		4,527,164	0.0509	230,643
2038		2,508,327	1,828,554	287,840		4,624,721	0.0476	220,199
2039		2,563,150	1,868,207	290,920		4,722,278	0.0445	210,135
2040		2,617,974	1,907,861	294,000	8,545,900	13,365,735	0.0416	555,847
TOTALS								
Discounted	0	11,943,941	8,697,816	1,735,715	355,402	22,732,874		22,732,874
Undiscounted	0	69,944,813	51,095,034	9,357,600	8,545,900	138,943,347		n.a.

Exhibit B-1
Environmental Inventory
Analysis Corridor One

OPTION 1

Segment #	Natural Resources	Non-Attainment
63	——	Los Angeles, Extensive, South Coast Air Basin
60	1 river crossing Angeles National Forest and Scenic Route	Los Angeles, Extensive, South Coast Air Basin
55	2 river crossing (endangered species in Wash. Utah area)	Las Vegas, Moderate
52	Colorado River crossing (use US 89 bridge) Glen Canyon Recreational Area (Indian Burial Grounds likely)	——
44	4 river crossings Rio Grande National Forest Carson National Forest	——
42	——	——
38	1 river crossing	——
35	1 river crossing	——
31	3 river crossings	——
27	6 river crossings Mark Twain National Forest Ozark Natural Scenic Riverway	——
21	4 river crossings	——
19	3 river crossings	——
15	5 river crossings Daniel Boone National Forest	——
12	5 river crossings Daniel Boone National Forest	——
8	2 river crossings Jefferson National Forest George Washington National Forest	——
2	2 river crossings	——

Exhibit B-1
Analysis Corridor One Cont.

OPTION 2

Segment #	Natural Resources	Non-Attainment
63		Los Angeles, Extensive, South Coast Air Basin
60	1 river crossing Angeles National Forest and Scenic Route	Los Angeles, Extensive, South Coast Air Basin
55	2 river crossing (endangered species in Wash. Utah area)	Las Vegas, Moderate
52	Colorado River crossing (use US 89 bridge) Glen Canyon Recreational Area (Indian Burial Grounds likely)	——
44	4 river crossings Rio Grande National Forest Carson National Forest	——
42	——	——
38	1 river crossing	——
35	1 river crossing	——
31	3 river crossings	——
27	6 river crossings Mark Twain National Forest Ozark Natural Scenic Riverway	——
21	4 river crossings	——
19	3 river crossings	——
15	5 river crossings Daniel Boone National Forest	——
12	5 river crossings Daniel Boone National Forest	——
3	3 river crossings Jefferson National Forest	Norfolk, Marginal

Exhibit B-1
Analysis Corridor One con't

OPTION 3

Segment #	Natural Resources	Non-Attainment
63		Los Angeles, Extensive, South Coast Air Basin
60	1 river crossing Angeles National Forest and Scenic Route	Los Angeles, Extensive, South Coast Air Basin
55	2 river crossing (endangered species in Wash. Utah area)	Las Vegas, Moderate
52	Colorado River crossing (use US 89 bridge) Glen Canyon Recreational Area (Indian Burial Grounds likely)	——
44	4 river crossings Rio Grande National Forest Carson National Forest	——
40	1 river crossing	——
36	3 river crossings	——
28	1 river crossing 2 lake crossings	——
23	5 river crossings	——
21	4 river crossings	——
19	3 river crossings	——
15	5 river crossings Daniel Boone National Forest	——
12	5 river crossings Daniel Boone National Forest	——
8	2 river crossings Jefferson National Forest George Washington National Forest	——
2	2 river crossings Jefferson National Forest	——

Exhibit B-1
Analysis Corridor One Cont.

Option 4

Segment #	Natural Resources	Non-Attainment
63		Los Angeles, Extensive, South Coast Air Basin
60	1 river crossing Angeles National Forest and Scenic Route	Los Angeles, Extensive, South Coast Air Basin
55	2 river crossing (endangered species in Wash. Utah area)	Las Vegas, Moderate
52	Colorado River crossing (use US 89 bridge) Glen Canyon Recreational Area (Indian Burial Grounds likely)	——
44	4 river crossings Rio Grande National Forest Carson National Forest	——
40	1 river crossing	——
36	3 river crossings	——
28	1 river crossing 2 lake crossings	——
23	5 river crossings	——
21	4 river crossings	——
19	3 river crossings	——
15	5 river crossings Daniel Boone National Forest	——
12	5 river crossings Daniel Boone National Forest	——
3	3 river crossings Jefferson National Forest	Norfolk, Marginal

Exhibit B-2
Environmental Inventory
Analysis Corridor Two

OPTION 1

Segment #	Natural Resources	Non-Attainment
63		Los Angeles, Extensive, South Coast Air Basin
60	1 river crossing Angeles National Forest and Scenic Route	Los Angeles, Extensive, South Coast Air Basin
570	1 river crossing (endangered species in Wash. Utah area)	Las Vegas, Moderate
56	1 river crossing Havasu Natural Wildlife Refuge Kaibab National Forest	——
54	1 river crossing Coconino National Forest Petrified Forest National Park	Albuquerque, New Mexico, Moderate
45	2 river crossings Santa Fe National Forest	Albuquerque, New Mexico, Moderate
42	——	——
33	1 river crossing	——
29	1 river crossing	——
26	3 river crossings	St. Louis, Moderate
18	6 river crossings Hoosier National Forest	Louisville, Ky, Moderate
11	7 river crossings Daniel Boone National Forest	Louisville, Ky, Moderate Lexington, Ky Marginal
8	2 river crossings Jefferson National Forest George Washington National Forest	——
2	2 river crossings	——

Exhibit B-2
Analysis Corridor Two Cont.

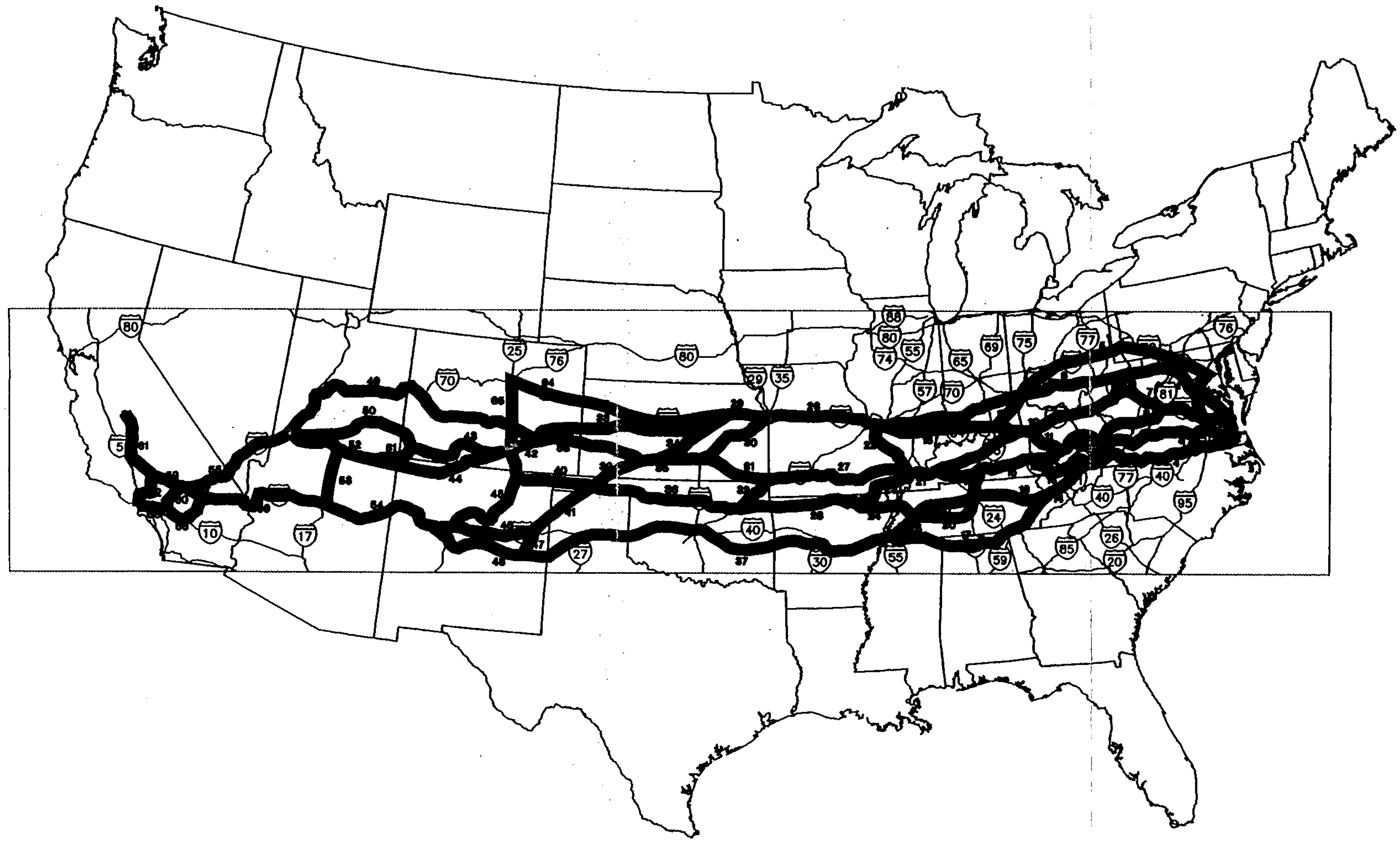
OPTION 2

Segment #	Natural Resources	Non-Attainment
63		Los Angeles, Extensive, South Coast Air Basin
60	1 river crossing Angeles National Forest and Scenic Route	Los Angeles, Extensive, South Coast Air Basin
57	1 river crossing (endangered species in Wash. Utah area)	Las Vegas, Moderate
56	1 river crossing Havasu Natural Wildlife Refuge Kaibab National Forest	——
54	1 river crossing Coconino National Forest Petrified Forest National Park	Albuquerque, New Mexico, Moderate
45	2 river crossings Santa Fe National Forest	Albuquerque, New Mexico, Moderate
42	——	——
33	1 river crossing	——
29	1 river crossing	——
26	3 river crossings	St. Louis, Moderate
18	6 river crossings Hoosier National Forest	Louisville, Ky, Moderate
11	7 river crossings Daniel Boone National Forest	Louisville, Ky, Moderate Lexington, Ky Marginal
3	3 river crossings Jefferson National Forest	Norfolk, Marginal

Exhibit B-3
Environmental Inventory
Analysis Corridor Three

Segment #	Natural Resources	Non-Attainment
63		Los Angeles, Extensive, South Coast Air Basin
60	1 river crossing Angeles National Forest and Scenic Route	Los Angeles, Extensive, South Coast Air Basin
55	2 river crossings (endangered species in Wash. Utah area)	Las Vegas, Moderate
52	Colorado River crossing (use US 89 bridge) Glen Canyon Recreational Area (Indian Burial Grounds likely)	—— ——
44	4 river crossings Rio Grande National Forest Carson National Forest	——
64	2 river crossings	Kansas City, Mo., submarginal
65	1 river crossing	Denver, Co., Moderate
26	3 river crossings	St. Louis, Moderate Colorado Springs, Moderate
18	6 river crossings Hoosier National Forest	St. Louis, Moderate Louisville, Ky, Moderate
5	5 river crossings Buchanan State Park	Washington, D.C., Moderate Columbus, OH., Marginal Pittsburgh, Pa., Moderate Cincinnati, Oh., Moderate Louisville, Ky., Moderate Norfolk, Va., Marginal

SEGMENT MAP



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Appendix C
INCOME REDISTRIBUTION IMPACTS

The equity of a proposed project is evaluated by comparing those who will pay for the project with those who will benefit from it. By means of the revenue instruments used to finance a project, and the distribution of benefits generated by the project, income is extracted from some people and provided to others. For the specific case of tolls levied on users, the persons providing the revenues and the persons receiving the benefits are one and the same. More generally, tax instruments raise revenues from various groups of people and economic activities, and redistribute the results as benefits to a different but overlapping group.

The process of tracing the flow from revenue sources to benefit recipients is difficult, and there are uncertainties at most of the many steps that occur along the way. Nonetheless, it is important in project evaluation to attempt to assess the equity consequences of a project. Equity impacts are distinct from efficiency impacts (whether the project generates positive net benefits overall), but it is necessarily the case that projects failing to yield positive net benefits produce at least some losers. For "good" projects, a rearrangement of the revenue instruments or expenditure categories may be able to eliminate most losers; for a "bad" project, no financing plan can prevent the creation of some losers.

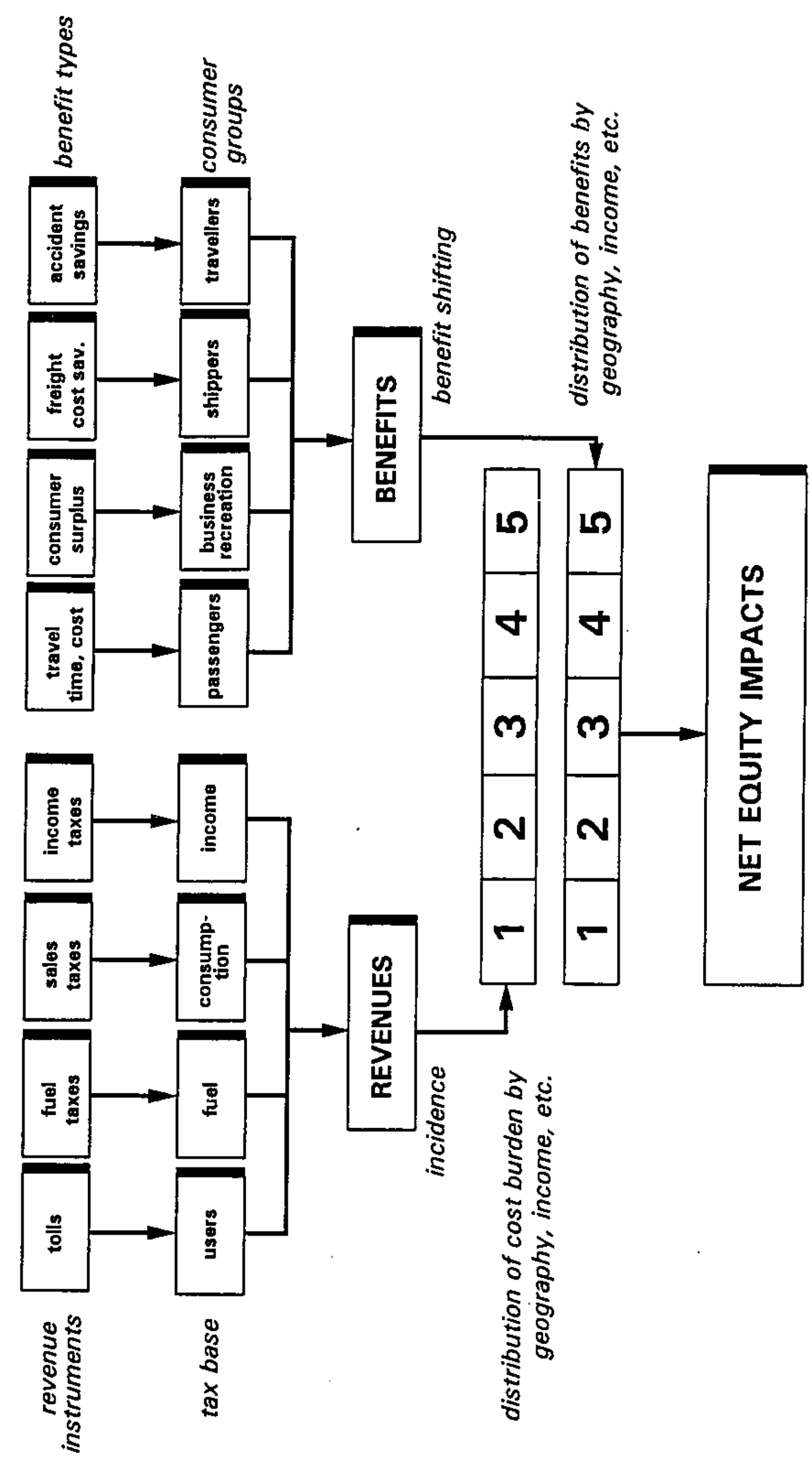
ANALYSIS FRAMEWORK

Any analysis of equity impacts requires a high level of aggregation, and within the groups studied it is impossible to declare specific individuals as winners or losers. The economic characteristics (e.g., income level, type of travel, geographic location) of gainers and losers can be described, but even individuals matching the descriptions may not be affected in the same degree that the group as a whole is affected. Within broad groups, however, it is often possible to predict whether they will be better or worse off as a result of the project. Exhibit C-1 provides a schematic outline of the equity analysis constructed for the TTC. Revenue

NOTE: As part of this TTC assessment, additional work, based on the consultant's financial and economic feasibility analyses, was conducted by the Volpe National Transportation Systems Center. This Appendix presents that work performed by the Volpe Center.

Exhibit C-1

SCHEMATIC OUTLINE OF EQUITY ANALYSIS



instruments and sources (on the left side) are analyzed separately from the benefit distribution (on the right), and the two are combined at the bottom to assess net equity impacts.

Revenues and benefits do not necessarily accrue to those directly paying the taxes, but are shifted forward or backward depending upon supply and demand characteristics. Absent substantial market inefficiency, the ultimate incidence of costs and benefits tends to fall on consumers and factors of production (e.g., capital and labor).

The numbers 1-5 on Exhibit C-1 represent income quintiles in the study here, but other geographic and demographic partitions of the population can also be used. A concern for impacts on the distribution of income is referred to as "vertical" equity, and the results are said to be "progressive" or "regressive." Distinctions with respect to geography or political jurisdictions (e.g., the TTC corridor versus the remainder of the U.S.) are referred to as "horizontal" equity concerns. Both types of equity impacts are quantified in this appendix.

REVENUE SOURCES

Revenue instruments and sources are derived from the financial plan for the project. Such a plan has only been sketched in rough outline for the TTC alternatives, so the specific instruments listed in Exhibit C-1 and Exhibit C-2 are illustrative. Each alternative should have its own financing plan, although different alternatives may have some revenue sources in common. Because Alternative C1 (One Super Highway) appears to come the closest to being a feasible project, that alternative is used in the equity impact analysis. Total revenue required of $4.05 billion per year is comprised of capital and operating costs taken from Chapter 6.

TTC Tolls

Tolls are charges levied on users of the TTC as a direct consequence of their use of the facility. A rate of 3.7 cents per VKmT (6 cents per VMT) is indicated, and 82 percent of the total travel is assumed to be by vehicles instrumented for high-speed automated travel at the owner's expense. An equivalent fuel tax would need to be over $1 per gallon to raise 3.7 cents per vehicle-km (6 cents per vehicle-mile). Annual vehicle travel for the TTC is taken as the average of 1990 and 2040 levels, including trucks.

Exhibit C-2
SOURCES OF REVENUE
ALTERNATIVE C1: SINGLE SUPER HIGHWAY

	TTC User Charges		Other State Revenues		Other Federal Funds		Total Revenue Required	Geographic Incidence	
	Tolls	Fuel and Excise Taxes	Non-TTC Highway Taxes	Other Taxes (Sales)	Non-TTC Fuel & Excise	Other Federal (Income)		Residents Inside TTC	Other US Residents
Capital Cost (\$million)							\$53,365		
Annual Operations and Maintenance (O&M) Cost (\$million)							\$154.4		
Total Revenue Needs (\$million)							\$4,052		
Revenues by Source:	\$926	\$23	\$1,259	\$1,066	\$343	\$495	\$4,052		
Tax Base Shares:	users	users	users	consumers	users	taxes			
Lowest 20% Income	10%	10%	10%	9%	10%	1%			
Next Lowest 20%	14%	14%	14%	12%	14%	5%			
Middle 20%	20%	20%	20%	17%	20%	12%			
Next Highest 20%	25%	25%	25%	24%	25%	23%			
Highest 20%	31%	31%	31%	38%	31%	60%			
Amounts Paid (\$million)									
Lowest 20% Income	\$92	\$2	\$124	\$89	\$34	\$3		\$114	\$230
Next Lowest 20%	131	3	178	124	49	23		164	345
Middle 20%	188	5	255	171	70	61		236	513
Next Highest 20%	232	6	316	237	86	112		300	688
Highest 20%	283	7	385	384	105	297		398	1,063
Totals								1,212	2,840
Total Revenue								4,052	

Parameters:

capital life (years)	47	annual TTC VKmT (bil) (VMT 15)	24.8
TTC toll rate/VKmT (6¢/VMT)	0.037	corridor states VKmT (bil) (VMT 1,079)	1,737
state TTC fuel tax rate/gal	0.02	US VKmT (2,240 VMT)	3,605
fed TTC fuel tax rate/gal	0.005	corridor length - km (3,000 miles)	4,828
km/g (16.9 mgp)	27.2	corridor width - km (50 miles)	80.5
state share of gen'l taxes	67%	discount rate	0.07

TTC Fuel and Excise Taxes

User taxes include excise taxes, registration fees, use fees, and other taxes borne primarily by highway users, whether levied at the local, state, or federal level. They apply to users of other facilities as well as the TTC, but only the TTC portion is covered here. This group of taxes is represented by a fuel tax (per gallon rate) equivalent. Included are federal apportionments from the Highway Trust Fund generated by TTC users. The magnitude of fuel tax equivalent added on for, or diverted to, the TTC is assumed to be 2 cents at the state level and half a cent at the federal level. Revenues generated are based on applicable vehicle travel estimates and an average fuel economy of 27.2 km\g (16.9 mpg). The latter includes both cars and trucks and is taken from the FHWA Highway Statistics 1992.

Non-TTC State Highway Taxes

Non-TTC state highway taxes comprise fuel, registration, and other state highway taxes that are paid by users of facilities other than the TTC. Apportionments from state road funds based on these levies are therefore covered, including matching shares on federal grants. The same 2-cent state tax applied to non-TTC users generates the revenue estimate for this entry.

Other State Taxes

Other state taxes used to fund the TTC would come from any non-highway source, and are represented here by a state sales tax of an unspecified rate and base. The number for this entry is an estimate of the share of the total TTC costs that would need to be borne by state-level revenues in addition to the highway user fees listed above. For financial planning purposes, it is assumed that 67 percent of the residual revenues (not raised from sources otherwise specified) would be derived from state sales taxes and the remainder from federal income taxes.

Non-TTC Federal Fuel and Excise Taxes

Non-TTC federal fuel and excise taxes are highway user fees from federal levies generated on facilities other than the TTC, but used to pay for its construction and upkeep. The figure of $343 million per year is based on applying the assumed half-cent tax rate to the gallons consumed for 3.4 trillion VKmT (2.24 trillion VMT).

Other Federal Funds

Other federal funds include any source of revenue other than taxes on highway users. An earmarked grant from Congress passed down to the applicable states would be an example, and it is assumed to be derived from the personal income tax.

REVENUE INCIDENCE

Depending upon the tax base, the revenues derived from a particular instrument are borne (after shifting) by a particular group of payers. Three types of payers are identified in this equity analysis: household quintiles grouped according to income; residence accounting to large urban versus rural and small urban; and residence inside or outside the 80-km (50-mile) wide TTC corridor.

Tax Base Shares

Four prototype distributions across income classes represent the vertical incidence of the relevant revenue instruments. "Users" are owners, operators, and passengers of vehicles using the TTC, and their distribution across income classes is represented by the U.S. distribution of expenditures on gasoline. Thus, 10 percent of total expenditures on gasoline are made by persons from the lowest income quintile, and 14 percent from the next quintile. Highway users are assumed to bear the costs of TTC tolls and fuel excise taxes. "Consumers" are assumed to be the bearers of sales tax burdens, and are represented by the distribution of total consumer expenditures. "Taxes" represent state and federal income taxpayers, who are assumed to bear the burden of federal income taxes. "Income" earners (not used in this table) reflect the distribution of after-tax money income plus both money and in-kind income transfers.

The distribution across income classes for each tax base is applied to the revenue requirements, to generate total amounts from each income class for each revenue source. For example, 10 percent of the $1.159 billion in tolls gives $115 million for the lowest income quintile. These revenues are allocated to residents inside or outside the TTC corridor, which is substantially smaller than the study area since the latter covers many possible facility alignments.

TTC user revenues are assumed to be paid by corridor residents in the same proportion as they capture benefits (90 percent, as taken from the Total Benefits line in Exhibit C-3). Non-TTC state highway user taxes are assumed to be paid by non-TTC (state) residents in the same 90 percent proportion (i.e., TTC residents pay 100-90 = 10 percent of state user fees on non-TTC highways). Sales and income taxes are paid by TTC residents in proportion to their state's share of the population of the entire U.S. The result is $1.2 billion paid by corridor residents and $2.8 billion paid by other U.S. residents.

Exhibit C-3
DISTRIBUTION OF BENEFITS
Alternative C1: Single Super Highway
(millions of dollars)

		TTC Geographic Income:								Inside TTC Corridor:							Other US:				
		TTC Local Share	TTC Geographic:		Benefit Distribution by Income Shares:					Benefits Received by:					TTC Geographic:		Benefits Received by:				
Annual Benefit	Amount		Urban	Rural	Low	Next Lo	Middle	Next Hi	High	Low	Next Lo	Middle	Next Hi	High	Urban	Rural	Low	Next Low	Middle	Next Hi	High
Passenger Benefits	865.3	0.9	0.83	0.17	10%	14%	20%	25%	31%	77	110	158	195	238	643	136	9	12	18	22	26
Auto Cost Savings	(676.3)								100%								auto users				
Other Mode Cost Savings	18.9																				
Auto Time Savings	1,209.6																				
Other Mode Time Savings	(18.0)																				
Induced Travel	58.0																				
Additional Consumer Surplus	2,443.8	0.9	0.83	0.17	5%	11%	17%	24%	44%	112	245	364	520	959	1,815	385	12	27	40	58	107
Comfort	--								100%								highway users				
Reliability	209.0																income				
Safety Perception	209.0																				
Sleep/Read/Work	425.0																				
1-Day Turnaround	480.0																				
1-Way in Single Day	355.0																				
Use Car at Trip End	--																				
Freight Benefits	93.9	0.9	0.83	0.17	9%	12%	17%	24%	38%	8	10	14	20	32	70	15	1	1	1	2	4
Truck Cost Savings	(336.1)								100%								shippers and consumers				
Rail Cost Savings																	expenditures				
Truck Time Savings	338.3																				
Freight Time Savings	62.3																				
Accident Savings	324.8	0.9	0.83	0.17	10%	14%	20%	25%	31%	29	41	59	73	89	241	51	3	5	7	8	10
									100%								auto users				
Total Annual Benefits	3,727.9	0.9								226	407	595	809	1,319	2,768	587	25	45	68	90	147
Implicit Present Value of Benefits	51,041													3,355		3,355					373
																					3,728

Parameters		
TTC large urban population90	18,241,878	70%
TTC small urban and rural pop	3,867,110	
Total TTC population90	22,108,989	
Total Impact Area Population(e)91	38,677,759	
Total 19 States Population91	117,503,000	
Total US Population 1991	252,157,000	
Area of the TTC	150,000	
Total US Population 1990	248,710,000	
Rural Population Density	25.8	
Benefit Cost Ratio	0.92	

BENEFIT DISTRIBUTION

Exhibit C-3 displays estimates of the distribution of benefits for Alternative C-1 across the 5 income groups. These estimates are based on the reasoning that 90 percent of the benefits of TTC will accrue to the 80-km (50-mile) wide band through which it passes. This figure is based on previous research that suggests a "benefit decay gradient" whereby the transportation cost savings associated with a major improvement have the greatest economic impact along the immediate corridor.

Input data for Exhibit C-3 are included in the first two columns of numbers, and all other numbers are derived from these data and parameters, as well as results from other exhibits. Benefits values are taken from the benefits estimates used in the feasibility evaluation (Chapter 9).

TTC Local Share

The TTC local share comprises the share of each category of benefit that is captured by the residents of the corridor, directly or indirectly. Only major categories (e.g., passenger benefits) are treated. The Local Share on the Total Benefits line is the weighted average for the four benefits categories above, and is used to allocate revenues to sources (above) as well as benefits to recipients.

Geographic Distribution

The TTC corridor is divided into two types of geographic areas: large urban centers (MSAs), on the one hand, and smaller urban areas and rural areas on the other. An arbitrary share (70 percent) of the urban population within the 19 states is assumed to be served by the TTC, whatever its actual alignment, and the remainder of the corridor is assumed to be populated at the average rural density for the 757-county Primary Impact Area. Thus 83 percent of the TTC corridor population resides within large urban areas, and the remainder is rural.

Income Shares

Benefits recipients are grouped into income classes in the same manner as revenue sources, using the same distributions. Beneficiaries such as truckers and shippers are assumed to pass on their costs and benefits to final consumers. Some user benefits will be captured by retail establishments in the corridor, but some activities such as hotel and eating establishments will lose business to the extent that faster travel times permit less time and days on the road.

Passenger benefits are assumed to be distributed in proportion to the income distribution of highway (auto) users. Additional consumer surplus benefits are believed to be distributed more like overall income, due to the business-related and generally more up-scale nature of the tourism benefits. Freight benefits are assumed to be passed on to consumers.

Inside TTC Corridor Benefits

Local share, geographic area, and income distributions are all assumed to apply independently of each other, so that any combination is a product of multiplying the three factors together. Thus low income passenger benefits are the result of total benefits times local share times low income share. Combinations for which the independence assumption is not plausible (e.g., low income urban, other U.S. rural) are not calculated. Using this method, benefits are mapped into residents inside and outside the corridor, by income or geographic area. The results are reported in the Total Benefits line in the table, and transferred to Exhibit C-4, which displays "Equity Impacts."

Benefits Parameters

All the dollar estimates in the above tables are stated in annual equivalents. In practice, the financial flows, capital expenditures, operating and maintenance expenditures, and flows of benefits would vary year by year. This additional detail is both unnecessary for and inappropriate to the aggregation and extensive assumptions embodied in the equity analysis. Thus key relationships are maintained while simplifying the time dimension.

The most fundamental of these relationships is the ratio of benefits to costs. For equity assessment, the efficiency result (net benefits) is an input. This is represented in the Benefits table as the benefit-cost ratio. The various totals for the major categories of benefits are scaled up or down to keep the benefit-cost ratio consistent, so that, for example, the sum of the items under Passenger Benefits does not exactly equal the group total at the top, but the proportions among the annual benefits are retained for the equity analysis.

NET EQUITY IMPACTS

Exhibit C-4 summarizes the results of the revenue and the benefit distributions. All numbers in the top two rows are copied directly from the previous tables except for the urban rural cost split, which is divided according to population. The table provides a comprehensive, if undetailed, view of which

Exhibit C-4
NET EQUITY IMPACTS
Alternative C1: Single Super Highway
(millions of dollars)

INSIDE TTC CORRIDOR:								
	Lowest	Next Low	Middle	Next High	Highest	Urban	Rural	Total
Benefits Received	226	407	595	809	1,319	2,768	587	3,355
Cost Burden	114	164	236	300	398	1,000	212	1,212
Net Equity	112	243	359	509	921	1,768	375	2,143

OTHER US:						
	Lowest	Next Low	Middle	Next High	Highest	Total
Benefits Received	25	45	66	90	147	373
Cost Burden	230	345	513	688	1,063	2,840
Net Equity	(205)	(299)	(447)	(599)	(917)	(2,467)
Total US Net Benefits	(94)	(57)	(88)	(90)	4	(324)

regions and income groups gain and which ones lose. For example, rural and small urban counties within the TTC gain a total of roughly $375 million per year, at the expense of almost $2.5 billion per year in losses spread over the rest of the U.S.

The information in Exhibit C-4 is represented graphically in Exhibit C-5. The unfilled bars above the axis show the net gains for each of the five income classes within the corridor. The highest income group gains by eight times as much as the lowest. The black bars below the axis show the corresponding amounts the taxpayers in the rest of the U.S. must donate each year in order to generate the benefits within the corridor. The shaded bars combine the two for the U.S. as a whole, and indicate that all income classes (except the highest) lose as a result of investment in this project.

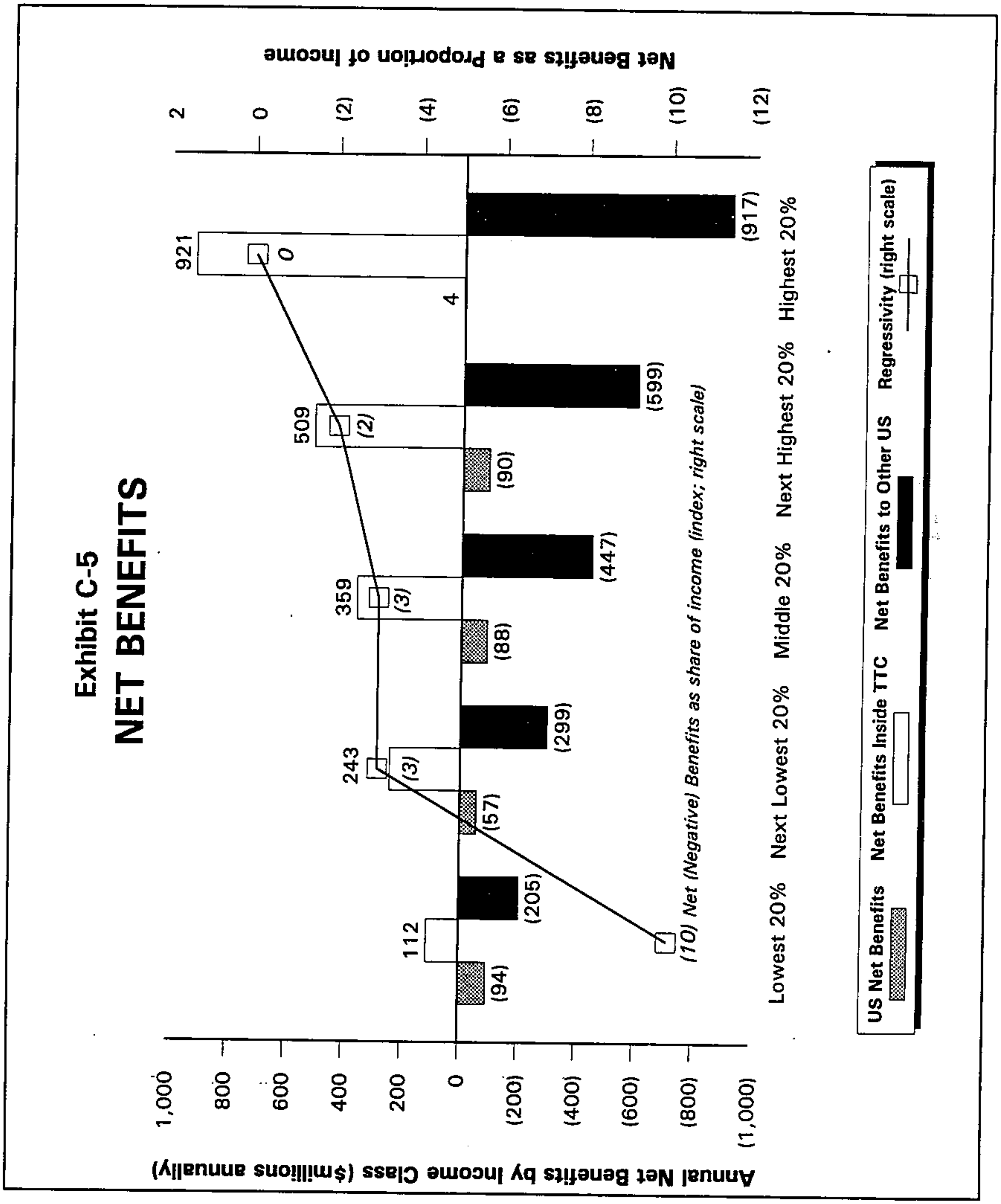


Exhibit C-5
NET BENEFITS
Annual Net Benefits by Income Class ($millions annually)
1,000
800
600
400
200
0
(200)
(400)
(600)
(800)
(1,000)
Net Benefits as a Proportion of Income
2
0
(2)
(4)
(6)
(8)
(10)
(12)
Lowest 20%
Next Lowest 20%
Middle 20%
Next Highest 20%
Highest 20%
112
(94)
(205)
243
(57)
(299)
359
(88)
(447)
509
(90)
(599)
921
4
(917)
(10) Net (Negative) Benefits as share of income (index; right scale)
(3)
(3)
(2)
0
US Net Benefits
Net Benefits Inside TTC
Net Benefits to Other US
Regressivity (right scale)

A fourth item is represented by the heavy line with small boxes. This line is read off the right-hand scale, and shows an index of net cost to each class. When viewed as a tax, the TTC Super Highway alternative has a regressive impact, in that it burdens the lowest class more heavily -- in relation to its ability to pay -- than the highest class. While making almost all income classes worse off nationally, the project would also serve to increase the disparity of incomes, meaning the difference between lowest and highest categories.

Only one TTC alternative has been subjected to a detailed equity analysis, but the others would produce similar results. To the extent that other alternatives generate fewer benefits in relation to their costs, they yield more and larger losers. Assuming they use similar financing mechanisms, the distributional impacts will be similar as well.

APPENDIX C FINDINGS

Based on the incidence of costs and benefits of Alternative C1, the Single Super Highway, all income groups within the TTC would be made better off. The lowest 20 percent of TTC residents, however, would gain much less than would those with higher incomes. For U.S. residents outside the corridor, net benefits to all but the highest income quintile would be negative, meaning that they would be made worse off. A simple index of proportionality relating these negative benefits to average income levels for the respective quintiles shows that those with the lowest incomes are impacted the worst. In short, the TTC would have a regressive income redistributive effect.

Any TTC alternative that fails to generate positive net benefits is likely to have similarly regressive equity impacts overall. The analyses presented in this chapter lead to the conclusion that the TTC cannot be justified on the basis of social equity or income redistribution.

The above analysis does not attempt to account for equity impacts arising from market imperfections in the economic transactions that would create the TTC. An example is the imperfect spatial and sectoral mobility of labor, meaning that some workers in some places would lose their jobs while others would gain them. Part of the difficulty in addressing these issues is conceptual (is a region better off if its unemployed workers leave?) and part is empirical (will the new jobs be filled by workers moving in from other regions or by the currently unemployed already located in the region?). If such an analysis were to be conducted, it would not affect the total costs and benefits, nor the distribution of revenues and benefits, but it would probably show additional gains to residents of the TTC and greater losses to those outside it.