Texas Triangle High Speed Rail Study

February, 1989

TEXAS TURNPIKE AUTHORITY

Lichliter/Jameson & Associates, Inc.
Consulting Engineers

Wilbur Smith Associates, Inc.
Consulting Engineers & Planners

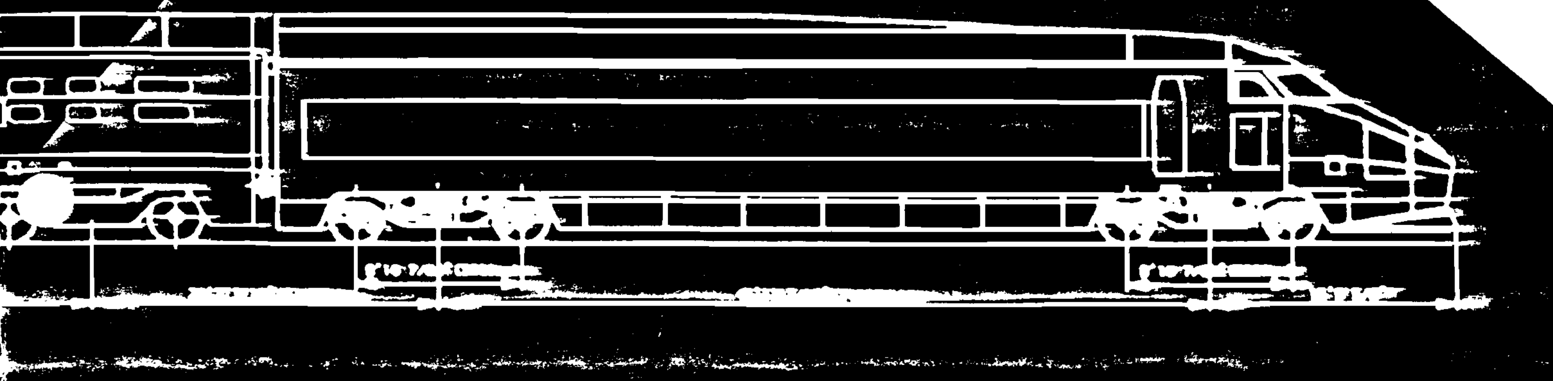
Morrison-Knudsen Engineers, Inc.
Consulting Railroad Engineers

M. Ray Perryman Consultants, Inc.
Economic Consultant

Underwood, Neuhaus & Co., Incorporated
Financial Consultant

Sylva Engineering Corporation
Consulting Engineers

Andrews & Kurth
Legal Advisors



ACKNOWLEDGEMENT

This study was performed by the Texas high speed rail feasibility study team under contract to and directed by the Texas Turnpike Authority. The Team was comprised of the firms listed below:

Project Management and System Planning

Lichliter/Jameson & Associates, Inc.
Eleven-One-Eleven Brooklet Drive, Suite 100
Houston, Texas 77099-3596
(713) 561-5190

In Association With

Ridership and Revenue

Wilbur Smith Associates, Inc.
908 Town and Country Blvd., Suite 400
Houston, Texas 77024
(713) 465-7800

Rail Technology

Morrison-Knudsen Engineers, Inc.
180 Howard Street
San Francisco, California 94105
(415) 442-7610

Economics

M. Ray Perryman Consultants, Inc.
P. O. Box 6028
Waco, Texas 76706-0028
(817) 755-3492

Financial

Underwood, Neuhaus & Co., Incorporated
909 Fannin
Houston, Texas 77010
(713) 853-2200

Technical Support

Sylva Engineering Corporation
1303-B Sherwood Forest
Houston, Texas 77043
(713) 973-7239

Legal

Andrews & Kurth
4200 Texas Commerce Tower
Houston, Texas 77002
(713) 220-4470

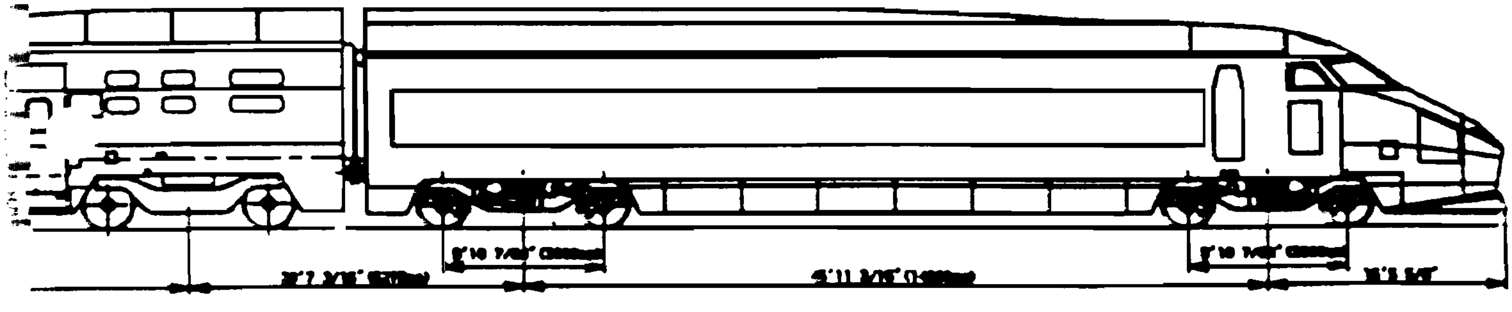
In addition, significant contributions and assistance to the study were made by the Texas Turnpike Authority Board of Directors, the Authority's Executive Director and Director, High Speed Rail Study. Representatives of the French National Railways and the German High Speed Consortium provided valuable information regarding their operating experience, as did a number of high speed rail industry representatives who furnished data concerning current technology. Appreciation is also extended to the railway companies operating within the study area, and the State Department of Highways and Public Transportation for their cooperation and assistance in providing data essential to this study.

The Texas high speed rail feasibility study was sponsored by and financed through the Texas Turnpike Authority, with partial financing provided by a grant furnished by the Federal Railroad Administration. This report is intended to assist the Texas Turnpike Authority, state officials, and members of the Texas Legislature in determining the future of high speed rail passenger service in Texas. The findings contained herein are the sole responsibility of the study team and do not necessarily reflect the positions of the Texas Turnpike Authority nor the Federal Railroad Administration.

Texas Triangle
High Speed
Rail Study

February, 1989

TEXAS TURNPIKE AUTHORITY



TEXAS HIGH SPEED RAIL FEASIBILITY STUDY TEAM MEMBERS

Key members of the study team are listed below. The team also included other members of the organizations shown whose efforts are sincerely appreciated:

Principal-in-Charge

William O. Jameson	Lichliter/Jameson & Associates, Inc.

Study Management Committee

Henry O. Johnson, Sr. (Chairman)	Lichliter/Jameson & Associates, Inc.
E. L. Walker, Jr.	Wilbur Smith Associates, Inc.
Anthony Daniels	Morrison-Knudsen Engineers, Inc.

Study Team

Phillip L. Wilson, Project Manager	Lichliter/Jameson & Associates, Inc.
Michael Long, Deputy Project Manager	Morrison-Knudsen Engineers, Inc.
M. E. Goolsby	Wilbur Smith Associates, Inc.
M. Ray Perryman	M. Ray Perryman Consultants, Inc.
Cesar Sylva	Sylva Engineering Corporation
Lawrence R. Catuzzi	Underwood, Neuhaus & Co., Incorporated
John Williford	Andrews & Kurth
Costas Georghiou	Lichliter/Jameson & Associates, Inc.

Texas Turnpike Authority

Richard J. Lindley, Chairman, Long Range Planning Committee
Bob Neely, Executive Director
Edward Kasparik, Director, High-Speed Rail Study

TABLE OF CONTENTS

I. INTRODUCTION **I - 1**

- A. The Study Area I - 1
- B. Purposes and Objectives of the Study I - 1
- C. Scope of the Study I - 2

II. RELEVANCY OF HIGH SPEED RAIL **II - 1**

- A. Existing and Planned High Speed Rail Systems II - 2
- B. Conclusions II - 5

III. RAIL TECHNOLOGY **III - 1**

- A. High Speed (80-125 MPH) III - 3
- B. Very High Speed (125-200 MPH) III - 5
- C. Ultra High Speed (Over 200 MPH) III - 6
- D. Tilt Vehicles III - 7
- E. Motive Power III - 8
  - 1. Electrification III - 8
  - 2. Diesel-Electric III - 8
  - 3. Turbine-Electric III - 8
- F. Track Electrification III - 9
- G. Train Control III - 9
  - 1. Signalization III - 9
  - 2. Supervisory Control and Data Acquisition (SCADA) System III - 11
  - 3. Communications III - 12
- H. Conclusions III - 13

IV. RIDERSHIP **IV - 1**

- A. Existing Travel Characteristics IV - 1
  - 1. Traffic Zones and Highway Network IV - 1
  - 2. Travel Demand IV - 1
    - a. Roadside Surveys IV - 1
    - b. Air Passenger Surveys IV - 3
    - c. Existing Travel Demand IV - 5
    - d. Trip Characteristics IV - 5
    - e. Focus Group Surveys IV - 6
- B. Ridership Analysis and Forecasts IV - 7
  - 1. Study Area Demographics IV - 7
  - 2. Model Development IV - 9
  - 3. Travel Forecasts IV - 9
  - 4. Station Location Sensitivity Tests IV - 9
  - 5. Potential Revenues from Fares IV - 10
  - 6. Sensitivity Analyses IV - 10
    - a. Travel Time and Fare Sensitivity IV - 11
    - b. Additional Sensitivity Tests IV - 13
    - c. Ridership for Selected Scenarios IV - 17
- C. Estimated Ridership IV - 18
- D. Potential Staging IV - 19
- E. Conclusion IV - 19

V. ALTERNATIVES TO CONSTRUCTING AN HSR SYSTEM V - 1

A. Impact on Airline System V - 1
B. Impact on the Street and Highway System V - 2
C. Importance of the High Speed Rail System V - 3
D. Conclusions V - 4

VI. ROUTES VI - 1

A. Design Assumptions VI - 1
  1. Horizontal Alignment Criteria VI - 1
  2. Double-Track Dedicated System VI - 1
  3. System Configuration VI - 1
B. Highway Routes VI - 2
C. Representational Routes VI - 2
  1. Representational Routes - Existing Alignment VI - 5
    a. Track Alignment VI - 7
    b. Safety VI - 7
    c. Construction Costs VI - 7
    d. Right-of-way Costs VI - 7
  2. Representational Routes - Independent Alignment VI - 8
  3. Route Comparisons VI - 9
D. Rail Stations VI - 10
  1. Austin VI - 10
  2. Dallas VI - 10
  3. Fort Worth VI - 10
  4. Dallas/Fort Worth - Mid-Cities Suburban VI - 10
  5. Houston VI - 13
    a. Memorial Drive VI - 13
    b. Union Station VI - 13
    c. North Main Street VI - 15
    d. Amtrak Station VI - 15
  6. Houston Suburban Stations VI - 15
  7. San Antonio VI - 15
E. Conclusions VI - 15

VII. SYSTEM OPERATIONS VII - 1

A. Rail Operations VII - 1
  1. Travel Times VII - 1
  2. Operating Criteria VII - 3
    a. Train Schedules and Fleet Sizes VII - 4
B. Vehicle Maintenance and Administration Facilities VII - 8
  1. Maintenance Shops VII - 8
  2. Ancillary Maintenance Facilities VII - 8
  3. Administration Facilities VII - 8

VIII. SYSTEM REVENUE AND COSTS **VIII - 1**

A. Revenues VIII - 1
  1. Revenues from Fares VIII - 1
  2. Supplemental Revenues VIII - 2
    a. Package Express VIII - 3
    b. Concessions/Rental (Station) VIII - 4
    c. Concessions/Rental (Trains) VIII - 5
    d. Rental Car VIII - 5
    e. Parking VIII - 5
  3. Summary of Revenues VIII - 6
B. Costs VIII - 6
  1. Basis of Costs VIII - 6
C. Capital Costs VIII - 10
D. Operations and Maintenance (O&M) Costs VIII - 14
E. Conclusions VIII - 18

IX. FINANCE **IX - 1**

A. Public Sector Financing IX - 1
  1. HR 4333 IX - 1
  2. Tax-Exempt Debt Structure IX - 2
    a. Note Issuance IX - 2
    b. Bond Issuance IX - 3
B. Private Sector Financing IX - 3
C. Financial Feasibility IX - 3
D. Staged Financing IX - 4
  1. General IX - 4
  2. Assumptions for Tax-Exempt Debt Issues IX - 5
  3. Summary of Findings IX - 6
E. Conclusions IX - 8

X. ECONOMIC IMPACTS **X - 1**

A. Texas' Present Economic Position X - 1
  1. Dallas X - 1
  2. Fort Worth X - 2
  3. Houston X - 2
  4. Austin X - 2
  5. San Antonio X - 3
B. Texas' Economic Outlook X - 3
C. Effect of High Speed Rail on the Triangle Economy X - 4
  1. Construction and Operation X - 5
  2. Tourism X - 6
  3. Economic Development X - 6
  4. Increased Tax Revenue X - 8
D. Conclusions X - 9

XI. ENVIRONMENTAL CONSIDERATIONS XI - 1

- A. Impact Considerations XI - 1
  - 1. Air Quality XI - 1
  - 2. Biological Resources (Threatened or Endangered Species) XI - 2
  - 3. Cultural Resources XI - 2
  - 4. Electromagnetic Interference XI - 3
  - 5. Farmland XI - 3
  - 6. Harzardous Waste Sites XI - 3
  - 7. Land Use XI - 4
  - 8. Noise and Vibration XI - 4
  - 9. Relocation and Acquisition XI - 5
  - 10. Visual XI - 5
  - 11. Water Resources XI - 5
    - a. Floodplains XI - 5
    - b. Navigable Waters XI - 6
    - c. Water Quality XI - 6
    - d. Wetlands XI - 7
    - e. Wild and Scenic Rivers XI - 7
    - f. Other Considerations XI - 7
- B. Conclusions XI - 8

XII. IMPLEMENTATION XII - 1

- A. Ridership Refinements XII - 1
- B. Engineering Analysis XII - 2
- C. Environmental Analysis XII - 4
- D. Construction XII - 5
- E. Procurement of Rolling Stock XII - 5
- F. Financial and Joint Development Plan XII - 7
- G. Public Involvement and Marketing XII - 8
  - 1. Immediate Activities XII - 8
  - 2. Future Activities XII - 9
- H. Schedule of System Development XII - 10
  - 1. Implementation Schedule XII - 11
- I. Legislative Actions XII - 14
  - 1. Designation of a Responsible State Agency XII - 15
    - a. Creation of a New State Agency XII - 15
  - 2. Interim Responsible Agency XII - 15
  - 3. Legislative Appropriations XII - 17
- J. Conclusions XII - 19

XIII. SUMMARY OF FINDINGS AND RECOMMENDATIONS XIII - 1

- A. Findings XIII - 1
  - 1. Previous High Speed Rail Studies XIII - 1
  - 2. Available Technology XIII - 1
  - 3. Alternatives to High Speed Rail XIII - 2
  - 4. Ridership Forecasts XIII - 2
  - 5. Routes XIII - 2
  - 6. The Texas HSR System XIII - 3
  - 7. Revenue Forecasts and System Costs XIII - 3
  - 8. Economic Impacts XIII - 3
  - 9. Project Finance XIII - 4
  - 10. Environmental Considerations XIII - 4
  - 11. Project Implementation XIII - 5
- B. Recommendations XIII - 5

INDEX OF TABLES

IV-1 Estimated 1988 Annual Inter-City Origin and Desination Person Trips IV - 3
IV-2 Summary of Annual Origin-Destination Airline Passengers Between Study Cities IV - 4
IV-3 Summary of Annual Origin-Destinations Between Airport Pairs IV - 5
IV-4 Typical Trip Characteristics of Travelers in the Texas Triangle IV - 6
IV-5 Primary Demographic Data for 1988 IV - 7
IV-6 Primary Demographic Data for 1998 and 2015 IV - 8
IV-7 Station Location Sensitivity - Fort Worth - Dallas - Houston Corridor IV - 10
IV-8 Annual Ridership and Revenues for Variations in Travel Time and Fare - Total HSR System IV - 11
IV-9 Annual Ridership and Revenues for Variations in Travel Time and Fare - Dallas/Fort Worth - Houston Corridor IV - 12
IV-10 System Time and Fare Sensitivity by Trip Purpose IV - 12
IV-11 Time and Fare Sensitivity by Trip Purpose - Dallas/Fort Worth - Houston Corridor IV - 13
IV-12 Summary of Sensitivity Tests - Total System IV - 15
IV-13 Summary of Sensitivity Tests - Dallas/Fort Worth - Houston Corridor IV - 16
IV-14 Ridership and Revenues for VHS Technology - 1998 IV - 18
IV-15 Ridership for VHS Technology - 2015 IV - 18
IV-16 Potential Staging Plan IV - 19
VII-1 One Way Trip Time - VHS Technology (Hrs:Min) VII - 2
VII-2 Dwell Times VII - 2
VII-3 Rolling Stock Fleet Determinations - Stand-Alone Scenarios - VHS Technology VII - 5
VII-4 Rolling Stock Fleet Requirements - Stand-Alone Scenarios - VHS Technology VII - 6
VII-5 Rolling Stock Fleet Determinations - Staging Scenarios - VHS Technology VII - 7
VIII-1 Estimated Fare Revenue VIII - 2
VIII-2 Estimated Supplemental Revenue VIII - 2
VIII-3 Summary of Total Revenue VIII - 6
VIII-4 High Speed Rail, Unit Price Summary VIII - 10
VIII-5 Independent Alignment: VHS Option - Cost Summary VIII - 11
VIII-6 Existing Alignment: VHS Option - Cost Summary VIII - 12
VIII-7 Staging - Independent Alignment: VHS Option VIII - 13
VIII-8 Staging - Existing Alignment: VHS Option VIII - 13
VIII-9 Estimated Capital Costs VIII - 14
VIII-10 Cost Estimate, Independent Alignment, VHS Technology Operations and Maintenance Costs - Fixed Costs VIII - 15
VIII-11 Cost Estimate, Existing Alignment, VHS Technology Operations and Maintenance Costs - Fixed Costs VIII - 16
VIII-12 Cost Estimate, Independent Alignment, VHS Technology Operations and Maintenance Costs - Variable Costs VIII - 17
VIII-13 Cost Estimate, Existing Alignment, VHS Technology Operations and Maintenance Costs - Variable Costs VIII - 17
IX-1 Comparative Analyses of Each Corridor and Each Technology (1988 Dollars) IX - 4
X-1 Two Scenarios for Job Creation in Texas as a Result of the Potential Economic Development Associated with the Texas HSR X - 7
XII-1 Estimated Needed Legslation Appropriations XII - 18

INDEX OF FIGURES

I-1 Texas Triangle I - 1
IV-1 Station Location Sensitivity IV - 9
IV-2 System Revenues with Variations in Time and Fare IV - 10
IV-3 Revenues with Variations in Time and Fare, Fort Worth - Dallas - Houston Corridor IV - 10
IV-4 System Time and Fare Sensitivity IV - 11
IV-5 Time and Fare Sensitivity, Fort Worth - Dallas - Houston Corridor IV - 11
IV-6 Travel Mode Congestion and Energy Cost Sensitivity IV - 14
IV-7 Travel Mode Cost Sensitivity IV - 14
IV-8 Estimated HSR Ridership, Fort Worth - Dallas - Houston IV - 17
IV-9 Most Probable HSR Ridership IV - 18
IV-10 Potential Staging, Stage 1 IV - 19
IV-11 Potential Staging, Stage 2 IV - 19
IV-12 Potential Staging, Stage 3 IV - 19
V-1 Total Population V - 1
V-2 Inter-City Travel Demand V - 1
VI-1 Existing and New Alignment VI - 3
VI-2 Minimum Median Requirements for HSR VI - 4
VI-3 Rail Stations - Austin, San Antonio VI - 11
VI-4 Rail Stations - Dallas, Fort Worth VI - 12
VI-5 Rail Stations - Houston VI - 14
VIII-1 Projected Annual HSR Revenues VIII - 1
VIII-2 Typical Sections VIII - 7
VIII-3 Estimated Capital Costs - (1988 Dollars) VIII - 10
X-1 New Expenditures as a Result of the Texas HSR X - 5
X-2 Job Creation as a Result of the Texas HSR X - 6
X-3 New Earnings as a Result of the Texas HSR X - 7
X-4 Anticipated Annual Tax Revenues Related to HSR X - 8
XII-1 Staged Implementation of HSR System XII - 11
XII-2 Texas High Speed Rail Development Flow Chart Fort Worth - Dallas - Houston XII - 13

APPENDICES

APPENDIX A - GLOSSARY OF TERMS A - 1

APPENDIX B - SELECTED REFERENCES B - 1

APPENDIX C - RIDERSHIP AND REVENUE C - 1

Tables:

C-1 Manual Vehicle Classification Count on I.H. 45, Northbound C - 1
C-2 Manual Vehicle Classification Count on I.H. 45, Southbound C - 2
C-3 Manual Vehicle Classification Count on I.H. 10, Westbound C - 3
C-4 Manual Vehicle Classification Count on I.H. 10, Eastbound C - 4
C-5 Manual Vehicle Classification Count on I.H. 35, Southbound C - 5
C-6 Manual Vehicle Classification Count on I.H. 35, Northbound C - 6
C-7 Origin-Destination Patterns of Annual Automobile Travel on I.H. 45, North of Fairfield C - 7
C-8 Origin-Destination Patterns of Annual Automobile Travel on I.H. 10, East of Columbus C - 8
C-9 Origin-Destination Patterns of Annual Automobile Travel on I.H. 35, North of Georgetown C - 9
C-10 Important Service Characteristics for a Business Trip C - 10
C-11 Best Mode of Transportation for a Business Trip C - 11
C-12 Important Service Characteristics for a Pleasure Trip C - 12
C-13 Best Mode of Transportation for a Pleasure Trip C - 13
C-14 System Time and Fare Sensitivity by Trip Purpose C - 14
C-15 Time and Fare Sensitivity by Trip Purpose - Dallas/Fort Worth to Houston Corridor C - 15
C-16 Time and Fare Sensitivity - System C - 16
C-17 Time and Fare Sensitivity - Dallas/Fort Worth to Houston Corridor C - 17

Figures:

C-1 Station Location Sensitivity C - 18
C-2 System Revenues With Variations In Time and Fare C - 19
C-3 Revenues With Variations In Time and Fare C - 20
C-4 System Time and Fare Sensitivity C - 21
C-5 Dallas/Fort Worth - Houston Corridor - Time and Fare Sensitivity C - 22
C-6 Travel Mode Congestion and Energy Cost Sensitivity C - 23
C-7 Travel Mode Cost Sensitivity C - 24
C-8 Estimated HSR Ridership for Dallas/Fort Worth - Houston Corridor C - 25
C-9 Potential System Staging Plan C - 26

APPENDIX D - SYSTEM OPERATIONS D - 1

Tables:

Trip Times Technology: HS D - 1
Trip Times Technology: VHS D - 1
Trip Times Technology: UHS D - 2
Schedule Times D - 3
Rolling Stock Fleet Determinations - Stand-Alone Scenarios D - 4
Rolling Stock Requirements - Stand-Alone Scenarios D - 4
Rolling Stock Fleet Determinations - Staging Scenario - VHS Technology D - 5
Rolling Stock Requirements D - 5

APPENDIX E - CAPITAL AND O&M COSTS E - 1

Tables:

E-1 Independent Alignment: HS Option, Cost Summary by Segment E - 1
E-2 Existing Alignment: HS Option, Cost Summary by Segment E - 2
E-3 Independent Alignment: VHS Option, Cost Summary by Segment E - 3
E-4 Existing Alignment: VHS Option, Cost Summary by Segment E - 4
E-5 Independent Alignment: UHS Option, Cost Summary by Segment E - 5
E-6 Existing Alignment: UHS Option, Cost Summary by Segment E - 6
E-7 Independent Alignment: HS Option, Stand-Alone Scenario E - 7
E-8 Existing Alignment: HS Option, Stand-Alone Scenario E - 7
E-9 Independent Alignment: VHS Option, Stand-Alone Scenario E - 8
E-10 Existing Alignment: VHS Option, Stand-Alone Scenario E - 8
E-11 Independent Alignment: UHS Option, Stand-Alone Scenario E - 9
E-12 Existing Alignment: UHS Option, Stand-Alone Scenario E - 9
E-13 Independent Alignment Technology: HS - Cost Per Year - Stand-Alone Scenario E - 10
E-14 Independent Alignment Technology: VHS - Cost Per Year - Stand-Alone Scenario E - 11
E-15 Independent Alignment Technology: UHS - Cost Per Year - Stand-Alone Scenario E - 12
E-16 Independent Alignment - Cost Per Year - Stand-Alone Scenario E - 13
E-17 Existing Alignment Technology: HS - Cost Per Year - Stand-Alone Scenario E - 14
E-18 Existing Alignment Technology: VHS - Cost Per Year - Stand-Alone Scenario E - 15
E-19 Existing Alignment Technology: UHS - Cost Per Year - Stand-Alone Scenario E - 16

APPENDIX F - ENVIRONMENTAL **F - 1**

Tables:

F-1 Federal Environmental Regulations F - 1
F-2 State Environmental Regulations F - 3

APPENDIX G - FINANCIAL **G - 1**

Preliminary Financinal Analysis G - 1
Summary of Staging Scenario - Total System VHS G - 2
Staging Scenario - Stage 1 - Fort Worth - Dallas - Houston Segment - VHS G - 7
Staging Scenario - Stage 2 - Houston - San Antonio - Austin Segment - VHS G - 14
Staging Scenario - Stage 3 - Fort Worth - Austin - San Antonio Segment - VHS G - 25

APPENDIX H - LEGAL PROVISIONS (OTHER STATES) **H - 1**

SUMMARY OF CONCLUSIONS & RECOMMENDATIONS

- The population of the five city areas of the Texas Triangle is projected to grow from 9.7 million in 1988 to 11.8 million in 1998 and to 15.5 million in 2015.

- In 1988, there were more than 19 million inter-city trips between the Texas Triangle cities. It is projected that this travel demand will increase to 30 million in 1998 and nearly 60 million by 2015.

- Based on a specific set of current conditions and assumptions, high speed rail service on all legs of the Texas Triangle is a feasible and attractive option to accommodate future travel demands between the five principal cities of the Texas Triangle.

- Very High Speed (VHS) rail technology (125-200 mph) is recommended as the preferred technology due to a high ratio of revenues to capital cost relative to the other technologies. This technology currently qualifies for tax-exempt revenue bond funding. VHS technology is new to North America but has been in scheduled service in Japan and Europe, and is currently available or under development in Germany, France, Italy, and Japan.

- The HSR system should be constructed on an independent right-of-way dedicated for the exclusive use of HSR service. The track would be grade-separated and fenced. In urban areas the alignment may parallel existing rail corridors.

- Financial analysis indicates that completion of the total high speed rail system or implementing the system in stages would produce increased operating efficiency in comparison to any "stand-alone" corridor of the system.

- Construction of the entire system should be implemented in three stages with service on the first stage; Fort Worth - Dallas - Houston, available in 1998; the second stage, Houston - San Antonio - Austin, available in 2003; and the third stage, San Antonio - Austin - Dallas - Fort Worth, available by 2005.

- The project could represent a significant infusion of resources into the Texas economy. The construction phase alone could produce new spending in excess of $7 billion, and generate 111,000 person years of employment. After this initial stimulus, the impact of an ongoing operation could mean a permanent increase of over $500 million annually.

- Ongoing operations of the system could lead to 9,000 new permanent positions. Texas payrolls could expand permanently by over 15,000 workers when the positions derived from ongoing operations are combined with jobs created as a result of increased tourist activity.

- The potential impact of economic development as a result of high speed rail in Texas indicates, at a minimum, an additional 3,600 jobs could be created. If a "high growth" scenario occurs, the Texas employment base could increase by over 18,000 permanent additional workers.

- As a result of construction of Stage 1 (Fort Worth - Dallas - Houston), nearly 56,000 person years of new employment and $3.479 billion in new expenditures could be realized by 1998.

- Construction cost for the HSR system (in 1988 dollars), including right-of-way and rolling stock, was estimated as follows:

Stage 1	Fort Worth - Dallas - Houston	$2,022,774,000
Stage 2	Houston - San Antonio - Austin	1,411,440,000
Stage 3	San Antonio - Austin - Dallas - Fort Worth	958,386,000
	Total	**$4,392,600,000**

- Tax-exempt revenue bond financing under the Technical and Miscellaneous Revenue Act of 1988 (HR 4333) could provide financing for over 70 percent of the capital required to construct the HSR system.

- In addition to the bond financing, the Fort Worth - Dallas - Houston corridor would require a financial advance of approximately $100 million to cover preconstruction costs from 1991 through 1993. The Houston - San Antonio -Austin corridor would require an advance of approximately $15 million to cover preconstruction costs. The San Antonio - Austin - Dallas - Fort Worth corridor would require no advance.

- All financial advances would be re-paid after completion and placing into revenue service of the last corridor (San Antonio - Austin - Dallas - Fort Worth). Repayment would be from revenues generated in excess of funds required for debt service, operation and maintenance, and franchisee return on investment.

- Private sector funding assistance would be required from contractors or franchisees involved in developing and equipping the project, along with entities who would receive a direct benefit from high speed train operations.

- The results of this study conclude that high speed rail service on all legs of the Texas Triangle is an economically sound and recommended option to accommodate future travel demands between the five major Texas cities. It is, therefore, recommended that the following specific actions be taken to proceed with HSR development in Texas:

  1. **That the 71st Texas Legislature, acting in Regular Session, issue such directives and enact necessary legislation to recognize the importance of high speed rail to the State as an alternate transportation mode;**

  2. **That the 71st Texas Legislature, acting in Regular Session, designate the Texas Turnpike Authority as the "interim" executing agency for the HSR project until such time as a Texas high speed rail authority is created which would be responsible for financing, constructing, managing, and operating the system;**

SECTION I

INTRODUCTION

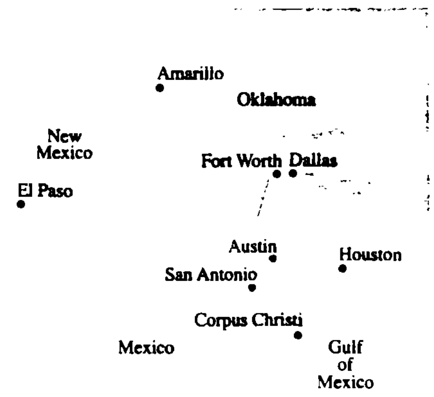
The potential of a high speed rail system connecting the major cities of Texas has been discussed since the early 1970's. With the rapid population growth and the continuing increase in commercial and industrial activity, it has become apparent that provisions will ultimately have to be made to accommodate increasing travel demands within the State. Recognizing these needs, the 70th Regular Session of the Texas Legislature directed that a study be made of the economic and financial feasibility of constructing and operating a high speed rail system in Texas. House Bill 1678 directed the Texas Turnpike Authority (TTA) to manage the study and file a report with the Governor, the Lieutenant Governor, and the Speaker of the House of Representatives prior to the convening of the Regular Session of the Legislature in January, 1989. On March 10, 1988, TTA retained the project team headed by Lichliter/Jameson & Associates, Inc. to perform the feasibility study.

The five cities of the Texas Triangle contain more than 50 percent of the State's population and include the principal governmental, business, and recreational activity in the State.

A. THE STUDY AREA

The legislature designated a portion of the State, referred to as the Texas Triangle, as the study area. The Texas Triangle is formed by the cities of Fort Worth, Dallas, Houston, San Antonio, and Austin, which approximate a geographic triangle in the central part of the State, as shown in **Figure I-1.** The five cities of the Texas Triangle contain more than 50 percent of the State's population and include the principal governmental, business, and recreational activity in the State. This concentration of activity in the Triangle cities generates a significant amount of travel between the cities as they interact with each other. The interstate highway system connecting the cities provides major transportation linkages for the movement of people and goods between the cities. In addition, a significant portion of travel demand is carried by commercial airlines, particularly between Dallas/Fort Worth and Houston.

Figure I-1
Texas Triangle



Source: Lichliter/Jameson & Associates, Inc.

B. PURPOSES AND OBJECTIVES OF THE STUDY

The purpose of the study was to investigate the economic and financial feasibility of constructing and operating a high speed rail system in Texas. To accomplish this, objectives were established to provide answers to the following questions:

- What is high speed rail? Is it in use in the United States and other countries? Have other states studied its application to their transportation system?
- What technology is available?
- What is the estimated ridership for high speed rail in the Texas Triangle? Will the Triangle or any corridor of the Triangle generate sufficient ridership to justify a high speed rail facility?
- What are the costs, revenues, and financing options for various high speed rail alternatives?

- When would construction and operation be feasible?

- What direct and indirect public benefits could be expected in the form of travel efficiency, multiplier economic benefits, and the future growth of jobs as a result of high speed rail?

- What are the possibilities for privatization of the system and what options exist for joint public/private development and operation?

- What actions by the Texas Legislature will be necessary to further development of a high speed rail system and how should it be implemented?

- What conclusions can be derived from the previous studies by the German High Speed Consortium for Fort Worth - Dallas - Houston service?

This report presents the findings developed by the project team to address these questions.

C. SCOPE OF THE STUDY

The scope of this study included a systematic planning and engineering analysis of factors relating to potential development of a high speed rail system between the study cities. The study included the following primary areas of investigation:

- Data Collection and Analysis
- Conceptual Design/Ridership Forecast
- Environmental Considerations
- Financial Analysis
- Economic Impacts
- Institutional and Legislative Needs

A high speed rail system linking any or all of the Triangle cities would introduce a completely new, modern mode of inter-city ground transportation that would compliment existing ground and air transportation systems.

To aid in identifying the impacts and issues to be investigated, several factors were considered.

- A high speed rail system linking any or all of the Triangle cities would introduce a completely new, modern mode of inter-city ground transportation that would compliment existing ground and air transportation systems;

- The five largest cities in Texas were involved in the study. Their population, together with the surrounding areas which comprise their standard metropolitan statistical areas, constituted nearly 52 percent of the State's population in 1986. In addition, 22 other counties in the mid-section of the State, containing six percent of the State's population, could also be impacted by a fully developed high speed rail system;

Texas Triangle cities constituted nearly 52 percent of the State's population in 1986.

- The identification and analysis of travel demand involved examination of airline and automobile travel within the corridors linking the major cities and, to a lesser extent, bus and existing passenger rail modes;

- The selection of representational existing rail routes involved an inventory of all possible existing rail lines and, through a process of elimination, the selection of the routes considered most applicable for detailed analysis. Approximately 1,750 miles of existing railroad corridors were inventoried prior to selection of representational study routes;

Approximately 1,750 miles of existing railroad corridors were inventoried prior to selection of representational study routes.

- The selection of representational independent rail routes (new alignment) entailed an identification of possible independent corridors, including cross-country electrical transmission lines, and narrowing the alternatives to those routes considered most applicable to high speed rail;

- Each of the alternative representational routes, either following existing rail lines or on new alignment, required order of magnitude cost estimating, ridership forecasting, revenue estimation, and financial plans for a system comprising over 600 miles of new, double-track rail lines; and

- Each alignment comprising the Texas Triangle, either along existing rail or on new location, included examination of three types of technology: high speed, very high speed, and ultra high speed.

This report presents the analyses, conclusions, and recommendations developed in the study. Supporting information and analyses are provided in the compendium of technical memorandums published in two separate volumes.

SECTION II
RELEVANCY OF HIGH SPEED RAIL

High speed rail is a proven and continuously evolving technology which was originally developed in Japan following World War II. The technology utilizes fast, lightweight vehicles which operate at speeds in excess of 80 mph and is primarily utilized in Japan and Europe for connecting large metropolitan areas.

HSR is not expected to replace automobile and airline travel, but would complement those modes. Each mode of transportation (automobile, HSR, and air) is generally best suited to particular trip lengths. The private automobile is considered the logical and preferred mode for trips of up to 150 miles. Air transportation is generally considered the logical mode of travel for trips in excess of about 300 miles. This leaves a trip length "gap" between 150 and 300 miles, which high speed rail service can logically fill.The trend to smaller automobiles and lower speed limits is contributing to less comfortable and more time consuming automobile trips for distances greater than about 150 miles. For air trips of less than 300 miles, more time is often consumed in travel to and from the airport than is spent in actual flying time. In addition, actual air travel time is uncertain due to more congested highway access, air terminals and air space, and unpredictable weather conditions.

High speed rail is a proven and continuously evolving technology which ~~was originally~~ developed in Japan following World War II.

?

1964

HSR is not expected to replace automobile and airline travel, but would complement those modes.

Focus group surveys have shown that the inter-city traveler is more interested in the "journey time," from origin to destination, than the maximum travel speed during any portion of the trip. These surveys further indicated that the business traveler's other major concerns include departure frequency, schedule reliability, and the need for ground transportation at the final destination. High speed rail systems have successfully met these needs in other areas of the world and, as a result, similar systems to those operations in Japan and Europe are under active consideration for various locations in North America.

High speed rail is a logical mode of travel for trips between 150 and 300 miles.

A. EXISTING AND PLANNED HIGH SPEED RAIL SYSTEMS

Several areas throughout the United States and Canada are actively considering implementation of high speed rail systems as a means of satisfying existing and future travel demands without overburdening any one mode or requiring massive airline infrastructure expansion.

HSR Systems are currently under consideration in a number of other states.

Although high speed rail is a general term describing the particular mode, three generic classes of high speed rail have been categorized for this study:

Three generic classes of high speed rail were studied based on operating speed ranges.

- **High Speed (HS)**, operating at speeds between 80 mph and 125 mph
- **Very High Speed (VHS)**, operating at speeds between 125 mph and 200 mph
- **Ultra High Speed (UHS)**, operating at speeds over 200 mph

[illegible]

Within the generic classification of high speed rail, the Northeast Corridor system operating between New York and Washington, D.C., and the Amtrak System operating between New York City and Albany represent the only systems operational in the United States. These systems share trackage rights with freight service and operate at average speeds of around 85 mph. Both systems are considered to be highly successful.

Very high speed rail systems are currently in operation in a number of foreign countries, some of which are:

- **Japan** - The Japanese were the first to initiate commercial high speed rail service on dedicated track. In 1964, the Shinkansen "Bullet Train" Series "O" began operating between Tokyo, Osaka, and Hakata at an operating speed of 136 mph. In 1982, an advanced series of the Shinkansen was placed in operation between Omiya and Morioka with an operating speed of 162 mph.

France is continuously expanding their HSR system on a country-wide basis.

- **France** - The French TGV (Train a' Grande Vitesse) was placed in operational service between Paris and Lyon in 1981. The train operates on a dedicated track with operating speeds of approximately 165 mph. In 1985, the Paris-Lyon line carried a total of more than 16 million passengers. The 264-mile trip between Paris and Lyon is made in two hours with an average fare of $38.00. The French National Railways started construction of a second 177-mile line in 1985 to the southwestern region of France. This line, referred to as the Atlantique TGV, will have advanced equipment with operating speeds of 186 mph. Before the year 2000, French National Railways expects to have high speed rail service to every region of the country.

- **Italy** - The first Italian high speed rail route, between Rome and Milan, was placed in operation in 1988. Trains on this line operate at a speed of approximately 155 mph. The Italian government plans to provide additional high speed rail service within the country utilizing the new ETR 500 high speed train by 1991.

Texas has considered HSR since the early 1970's.

In addition to the systems which are currently in operation, the countries of West Germany, Sweden, and England have very high speed rail systems under consideration or in the planning stage.

The popularity and success of the high speed rail systems operating in Japan and Europe have generated a positive interest in implementing similar systems in the United States. This interest has been focused on projects which would connect major population centers with travel times of approximately three hours or less. Some of these states are:

- **Texas** - Texas has considered HSR service connecting Dallas, Houston, and San Antonio since the early 1970's. This system, referred to as the "Texas Triangle," has been evaluated by a variety of organizations including:

- Texas Transportation Institute (TTI)
- Federal Railroad Administration - 1977
- German High Speed Consortium - 1985 and 1987
- Japanese Railway Technology Corporation (Fort Worth - Dallas)

Studies by TTI covered a wide range of issues that were primarily focused on the reinitiation of conventional passenger rail service operating over existing freight lines. The Federal Railroad Administration report of 1977 also focused on the joint usage of existing freight trackage. This report utilized a triangle configuration connecting San Antonio, Temple, and Rosenberg with common route trackage connecting Rosenberg to Houston and Temple to Fort Worth and Dallas. The German High Speed Consortium in 1985 and 1987 studied a high speed rail line between Fort Worth, Dallas, and Houston. This study recommended utilization of the Burlington Northern Railway right-of-way and the operation of VHS trains.

- **Florida** - A feasibility study completed in 1984 recommended an HSR system connecting Miami, Orlando, and Tampa for a system length of approximately 320 miles. Capital costs for the system ranged between $2.2 and $4.3 billion depending upon rail technology. In 1984, the State created a Florida High Speed Rail Transportation Commission responsible for implementing the HSR program. The Commission has recently received proposals from private industry for the turnkey development of a system with private capital. A unique concept of the Florida system would provide that increased property appreciation values, stimulated by the HSR system, would be a major factor in supporting the capital cost of the system. Proposals for implementation of the Florida HSR system are currently under review by the Florida High Speed Rail Commission.

Proposals for implementation of the Florida HSR system are currently under review by the Florida High Speed Rail Commission.

- **Nevada/California** - A study supported by the City of Las Vegas in 1987 recommended a new 230-mile dedicated HSR line connecting Las Vegas and Los Angeles. Both VHS and UHS technology are currently under consideration.
- **Ohio** - In 1978, Ohio completed a study for a 250-mile system connecting Cleveland, Columbus, and Cincinnati. The study recommended a system utilizing VHS equipment. In 1982, a referendum was defeated by the voters which would have provided that the system be financed by a state-wide increase in state sales tax.

- **Pennsylvania** - In 1985, a feasibility study was made for a high speed rail system connecting Philadelphia and Pittsburgh. The study evaluated speeds ranging from 180 mph to 250 mph with a cost of between $7 billion and $10 billion. Because of the high cost, a recent study has recommended that a system be constructed by upgrading existing rail lines which decreases the project cost to about $3 billion.

Florida and Las Vegas - Los Angeles systems appear to be closest to implementation.

While the Florida and Las Vegas-Los Angeles systems appear to be the closest to implementation, studies have been completed, or are in progress, for the following corridors in the United States and Canada: San Diego-Los Angeles, Montreal-Toronto, Montreal-New York, Detroit-Chicago, Santa Fe-Albuquerque, New York City-Albany, and Vancouver B.C.-Portland.

Most of the studies performed to date have been deferred or postponed by lack of financial support. Some of the potential corridors were not able to generate sufficient projected revenues to cover operating and maintenance cost. Financial support from the Federal government is currently not available for funding of high speed rail projects.

In 1982, Amtrak issued a report entitled "Rail Corridor Development: An Update." This report, commenting on the Texas Triangle route, stated: "The Texas Triangle has limited Amtrak service and would incur substantial capital costs to permit conventional speed rail corridor operation. Far more promising in this corridor may be the construction of an ultra high speed rail service." The report also set forth several "...conditions (which) must be present to make the introduction of ultra high speed rail service a financially viable prospect in the United States." Two of those significant conditions are:

- "Strong support from federal, state, and local leaders in order to help address permit acquisition, licensing, taxing, and a myriad of other problems which inevitably arise with any project of this magnitude and complexity."

- "Heightened understanding in the American financial community of the factors which distinguish the economics of ultra high speed trains from other kinds of railroad financing projects."

Passage of the Technical and Miscellaneous Revenue Act of 1988 permits tax-exempt revenue bond financing for HSR projects.

Recent passage of the Technical and Miscellaneous Revenue Act of 1988 (HR 4333) which permits tax-exempt revenue bond financing for HSR projects should bring about a resurgence of interest in some projects which have been temporarily postponed.

B. CONCLUSIONS

Japan and several European countries have had HSR in commercial operation for some time. It has proven to be a viable alternative to other transportation modes, to the extent that new, faster systems are being planned in West Germany, France, and Italy.

High speed rail has been the subject of numerous studies elsewhere in the United States and Texas during the past decade. Each of the studies concluded that HSR is a relevant alternate to established transportation systems, with Florida, California, Ohio, and Pennsylvania being the states who have shown the greatest interest in adding HSR to their transportation system. Previous Texas studies have indicated that some form of high speed rail would warrant serious consideration.

SECTION III
RAIL TECHNOLOGY

The selection of the appropriate rail technology is directly related to ridership and capital cost. Since travel time is a significant factor of business-orientated travel, higher train speeds generate higher revenues. Similarly, construction costs also increase significantly since trackwork designed for higher speeds requires construction to finer tolerances. The horizontal curvature of the alignment increases significantly from **HS** to **UHS** technology. The economic feasibility of the appropriate rail technology is a function of the generated revenues divided by the amortized construction cost for that technology.

The survey of equipment technologies concentrated on a comparison of technical features such as vehicle dimensions and performance characteristics, type of propulsion, characteristics of track and related infrastructure, and equipment costs. The survey of operating systems reviewed such aspects as system alignment relative to cities served, operating speeds, train technology, and construction and operation costs.

Rail technology is in a constant state of evolution comparable to that of the automobile and the air space industries. Every aspect of rail technology, which includes motive power, passenger coaches, signalization, trackwork, rail construction, maintenance, and communications, is in a constant state of refinement and improvement. Continuous advancements in the electronic industry result in improvements to train controls, signalization, communication, and "fail safe" equipment. Advancements in the field of metallurgy are providing stronger, lighter, more durable, and maintenance-free metals for rails, power units, and coaches. New, less labor-intensive construction and track maintenance equipment provides for faster and more accurate construction and maintenance procedures.

Rail technology is in a constant state of evolution comparable to that of the automobile and the air space industries.

The single aspect of rail technology that has not changed is that standard gauge rail track is still 4 feet 8-½ inches (inside edge of rail to inside edge of rail). Although some special systems operate on guideways, such as magnetic levitation and monorail, most major railroads throughout the world operate over standard gauge tracks. While railroad ties are changing from wood to concrete and steel, and, while continuous welded case hardened steel is replacing conventional bolt jointed rail, the rail gauge itself has remained unchanged for steel-wheel-on-steel-rail technology.

Japan and Europe are the leaders in development of passenger rail technology.

The most dramatic changes in rail technology have been most apparent in the operating equipment -- the basic characteristic which differentiates high speed rail from conventional rail. Since rail passenger service has been the predominant means of public transportation in Japan and Europe, it is understandable that those areas have provided most advancements in high speed passenger rail technology.

Of all the technological issues, the rolling stock is the portion of the system that leads the "state-of-the-art" in new developments; whereas, track, structures, and signaling and communications are considered tried and proven technologies. The exception to this is, of course, the Mag-lev system in which the vehicles and guideways, combined, are promising technological advancements which are still in the developmental stage.

It is essential that the system and the rolling stock for HSR reflect the latest technological advances to carry this transportation system into the 21st century.

Since a significant portion of patronage would be from the business community, many amenities would be directed to attracting business travelers. Such features could include:

High speed rail would offer travelers numerous amenities.

- Streamlined and continuous appearance
- Superior ride quality (both a function of suspension and track quality)
- Low interior noise
- Ease of communications such as on-board telephones or link-up with computers and facsimile machines. These features could be located at the individual's seat
- Possible conference rooms for business purposes
- Restaurant and/or lounge bar - may be any of a variety of configurations from full dining car/bar lounge to casual snack bar
- Catered meals at each seat
- Entertainment such as television, on-board movies, or audio recordings
- Coach design to accommodate elderly and handicapped travelers
- Large view windows
- On-board secretarial services
- Convenient luggage facilities - overhead and separate compartment for large items
- First class or business class seating with added space and comfort

- Check-through baggage capability
- On-board service for booking car rental, hotels, or other modes of transportation
- Passenger station conveniences such as automated fare vending machines, rental car conveniences, and communications for hotel pickup

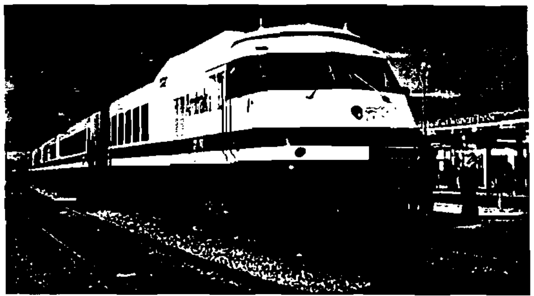
Technological features in present use or scheduled for the near future could include:

- Integrated braking systems utilizing regenerative (or dynamic, if not electrified) braking, eddy current, and disc brakes
- Safety features such as fire-resistant materials, escape windows in each car, automatic doors with safety features to open when closed on an obstacle, and fire fighting equipment
- High voltage commercial frequency electrification
- Crashworthy design
- Thyristor-controlled, three-phase a.c. electric propulsion, with sufficient high power to accelerate to and maintain high speeds
- Aerodynamically advanced design (streamlining)
- Improved track design and suspension with high speed stability
- State-of-the-art "fail-safe" train control system
- On-board microprocessors for monitoring and trouble-shooting for safe operation and ease of maintenance

A. HIGH SPEED (80-125 MPH)

Inter-city rail service at the lower end of this speed range (up to 100 mph) is common in most industrialized countries, generally having been developed by progressive upgrading of vehicles and infrastructure on existing lines. The equipment technology varies, therefore, no attempt was made to extensively inventory the technologies in this speed range.

Amtrak–RTL Turboliner (HS)



courtesy of "Progressive Railroading"

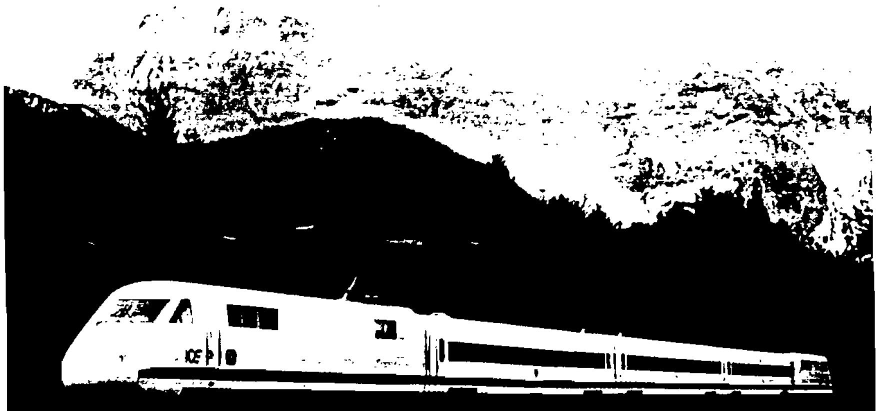
In the upper speed range (100-125 mph), development has been more systematic, therefore, data for these technologies is available. Operations at maximum speeds in this range are now common in at least a dozen countries, and are in the process of implementation in several others.

The technologies in this category all operate as conventional steel-wheel-on-steel-rail systems, with either diesel or electric propulsion, or with gas turbine propulsion. Some of the vehicles in this speed range, notably the Canadian LRC and the Spanish Talgo Pendular, include tilt-body features, which permit higher speeds on curved track, thereby facilitating operation of high speed service on existing lines.

A HS train set would be made up of three types of vehicles. At each end would be a powered locomotive with operating cab. Passenger coaches were assumed to hold an average of 60 passengers but could vary depending on whether first class or coach class seating were utilized. Each train consist would have a restaurant/lounge car. The maximum train consist was assumed to be two locomotives and ten trailing cars, including a restaurant/lounge car, with all cars similar in appearance. All trains have conventional railroad couplers and bellows between coaches that permit passengers to walk between cars.

French-TGV (VHS)

German-ICE (VHS)



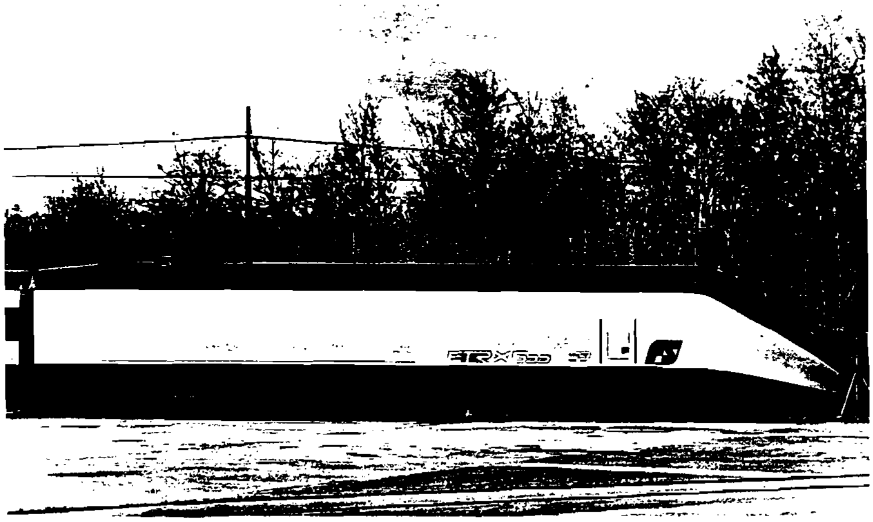
B. VERY HIGH SPEED (125-200 MPH)

Train operation in this speed range is a relatively recent development and only a few countries have significant operating experience at these speeds. Principal among these are Japan, whose first Shinkansen "Bullet Train" commenced operation in 1964 and runs at a top speed of 136 mph; and France, whose TGV (Train a' Grande Vitesse) commenced operation on the Southeast (Sud-Est) Line between Paris and Lyons in 1981, running at speeds up to 168 mph. Both of these systems have been extended to other new lines in their national networks.

Several other European countries are now developing and constructing similar systems and expect to have them in commercial operation within the next five years.

The technologies in this speed range are also steel-wheel-on-steel-rail and nearly all use electric traction with overhead catenary power distribution. Turbo-powered propulsion, although not currently used on any existing VHS system, was used for TGV001, the first train set built in the French TGV series, and has been proposed by the TGV Company for use on the Florida high speed line. Several systems now under development incorporate tilt-body equipment: the ETR 450 and ETR 500 (Italy); the X2 (Sweden); and the APT (United Kingdom - development currently suspended).

Italian–ETR-500 (VHS)



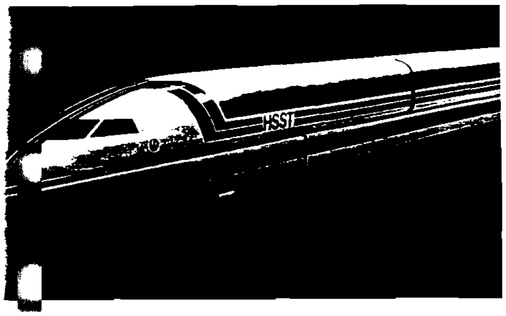
Japanese–Shinkansen "Bullet Train" (VHS)

Rail operations at these speeds generally require a dedicated grade-separated guideway and are, therefore, developed as an integrated system, i.e., entirely new vehicles and new or substantially upgraded right-of-way and infrastructure.

The French TGV has attained a maximum speed of 236 mph and the West German ICE a speed of 256 mph. These speed ranges represent a "break through" for steel-wheel-on-steel-rail technology.

As with the **HS** category, a **VHS** train set would consists of three types of rolling stock. At each end would be an electric powered locomotive equipped with pantograph with streamlined operating cab. Passenger coaches were assumed to hold an average of 60 passengers. Each train consist would have a restaurant/lounge car. The maximum consist was assumed to be two locomotives and 10 trailing cars, including a restaurant/lounge car. All cars would have a similar appearance.

Japanese–HSST (UHS)



C. ULTRA HIGH SPEED (OVER 200 MPH)

Most technologies being developed for speeds over 200 mph incorporate magnetic levitation (Mag-lev) equipment. The vehicles are magnetically levitated away from the guideway, either by electromagnetic attraction or electrodynamic repulsion, and are propelled by linear induction. The guideway itself is a completely dedicated facility, generally built on an elevated structure or otherwise physically separated from surrounding land.

No magnetic levitation systems are yet in high speed commercial operation, although specific plans have been announced to install the West German Transrapid Mag-lev system between Hamburg and Hannover for initial operation in 1998.

The **UHS** train was assumed to consist of a maximum of six cars. Each car would be self-propelled and would have an operating cab and hold 100 passengers. It was assumed that one car would be a combination restaurant/coach car, carrying about 50 seated passengers. This concept would result in an average of 90 passengers per car for fleet determination purposes. All cars would have a similar appearance. It was assumed that Mag-lev trains would be assembled into unit trains under shop conditions.

The Mag-lev system requires power for levitation, guidance, and propulsion. Levitation and guidance forces are generated by electromagnets supplied with power from an on-board set of batteries maintained at charge by linear generators. Propulsion of the train is provided by a long-stator, linear, synchronous motor with the levitation magnets in the car generating the field excitation for the synchronous motor. Three-phase, iron-cored windings for the propagating field are placed symmetrically on both sides of the guideway and fed with three-phase current of varying frequency directly from the track. In this way, they generate a traveling field that propels the train in the desired direction. The linear motor serves as the standard braking system by decelerating the train electrically without any frictional contact between the train and the guideway. By varying the voltage, frequency, and polarization, a converter controls the driving force of the linear motor to provide the requisite propulsion or braking force.

The power supply scheme considered for Mag-lev was based on the system developed for the Transrapid 06 (TR06) in West Germany. Each substation would be equipped with 138 kV switching equipment, main transformer, rectifier transformers, d.c. circuit breakers, inverters, and a set of output circuit breakers. Output of the station would be a variable voltage of 0 to 2,027 volts at a variable frequency of 0 to 215 Hz at a maximum current of 1,200 Amps.

D. TILT VEHICLES

The basic principle of the tilt-body suspension system is to artificially lean the car body into a curve so that the resultant lateral acceleration of the passengers does not exceed a pre-set criteria based on passenger comfort. This is possible because the speed at which passengers become uncomfortable is much lower than the speed above which a derailment might occur. Thus, tilting the body allows the train to run through curves at speeds higher than normally acceptable.

The tilt-body concept adds complexity, cost, and maintenance to the rolling stock; however, it permits the upgrading of existing lines to higher speeds with a lesser capital investment for reconstructing fixed installations. The maximum operating speed of tilt-body trains in commercial service is 125 mph, with scheduled operation on two new systems at speeds of 150 mph. Tilt-body technology has met with mixed success as car maintenance is higher, offsetting some of the capital cost savings in alignment/track. Savings in track improvement in areas with a high degree of curvature would be particularly advantageous. Without a detailed study, however, this technology was not considered in this study.

E. MOTIVE POWER

A number of types of alternative motive power lend themselves to consideration over the multiple alignments considered for the Texas Triangle corridors. Examples of these are: electrification, diesel electric vehicles, and turbo-electric vehicles. Certain alternative technical features were generally considered in selecting the generic technologies.

1. Electrification

The primary advantage of electrification is that higher power levels can be achieved than with diesel-powered equipment, allowing higher speeds and acceleration rates to be achieved. Electrified operation also has environmental and operating cost advantages over diesel operation. However, electrification necessitates high capital expenditures for power transmission facilities. Electrification is the primary source of motive power for the VHS and UHS technologies.

2. Diesel-Electric

The diesel-electric propulsion mode is well known and highly reliable. Typically, for modern high speed locomotive application, a diesel engine drives a three phase alternating current generator. The electric power is converted to direct current through a rectifier and is fed to the traction motors. To provide the required power level, several locomotives may be needed, working in a consist. Diesel-electric motive power was assumed for the HS technology.

3. Turbine-Electric

Similar to the diesel-electric, turbine-powered train sets have on-board equipment to generate power for traction and auxiliary services. Typical train sets include one power car at each end and six or eight passenger coaches. Each power car includes two main turbines. Each turbine, which is similar to a jet engine, drives a three-phase alternating current generator whose output is then rectified to direct current and delivered to direct current traction motors. An auxiliary turbine in each power car provides electric power for auxiliary services.

The primary advantage of turbine over diesel is the weight of the power plant. The power-to-weight ratio of a turbine can be up to 10 times better than that of a diesel. This results in fewer driving axles and lower axle loads, thereby delivering higher permissible speeds for equivalent weight. Although speeds in excess of 125 mph are attainable with this technology, it was assumed that turbine electric would be an option for the HS technology rather than the VHS technology.

F. TRACK ELECTRIFICATION

Most modern, high speed passenger rail systems are electrified.

The majority of modern, high speed passenger rail systems are electrified. Instead of generating electricity on board the locomotive (as with diesel-electric or turbine-electric locomotives), the electric power is drawn from a power network of the region. For the purposes of this study, the **HS** category of technology examined the use of on-board generation type technology since it was the lowest speed category under consideration and would ensure a low range of economic feasibility analysis where ridership might not justify a higher speed system. **VHS** and **UHS** systems were evaluated utilizing the more expensive forms of electrification supply. **VHS** electrification systems are comprised of high voltage transmission lines linking the system to the existing high voltage utility system; traction substations which convert the high voltage power to a voltage that can be utilized directly by the electric locomotives; and an Overhead Contact System (OCS) which permits the transfer of traction power to the locomotive by means of a sliding contact with a pantograph on the train. **UHS** (Mag-lev) utilizes electric power taken from the utility network and delivered to traction substations where it is converted to a special power form (variable voltage magnitude and frequency), then distributed along the concrete guideway by cables and coupled to the vehicle by means of a magnetic field through an air gap. Both the **VHS** and **UHS** electrification systems would be controlled remotely from a central command center.

A side effect of electrification is Electro-Magnetic Interference (EMI), which is an electrical influence on other metallic objects in proximity due to electrical induction, such as electrical and electronic equipment, and, in particular, electrical conductors physically running in parallel with the electrified line. EMI can adversely impact existing freight railroads on which signaling and communications circuits are mounted on telegraph poles along the alignment. In such cases, the signaling and communication systems must be converted to shield cable or fiber optic systems which are generally buried along the track. Where the **VHS** system was based on being located on a common right-of-way with an existing railroad, the costs for this conversion were included in the estimated costs.

G. TRAIN CONTROL

1. Signalization

Signals control the movement of trains by detecting the presence of other trains on the track, open switches, and broken rails. Federal regulations require that trains traveling at speeds in excess of 80 mph be equipped with a system that will automatically stop a train if it exceeds a pre-set speed.

Railroad signaling on United States railroads usually consists of Automatic Block Signals (ABS). The track is divided into a series of segments (blocks) which vary in length according to the characteristics of the route geometry and the amount of train traffic. The minimum block length is a function of safe stopping distance of a train, which is typically several miles for freight trains. Each block is protected by a wayside signal which consists of a display of lights, called aspects, mounted on a pole by the side of the track or on an overhead bridge. The aspects indicate the action that the operator of the train approaching the block is supposed to take.

Automatic block signaling is a method of maintaining a safe distance between train sets to prevent collisions. The signals do not serve as authorization for train movement, which must be done by other means. A Centralized Traffic Control (CTC) system combines the two functions. CTC also relays information on the occupancy of signal blocks to a central dispatch office so that the status and locations of all trains can be monitored. The central dispatch office could be located in either Dallas or Houston, along with the administrative offices.

Cab signaling, in its basic form, consists of the display of the signal aspect of the block being approached inside the locomotive cab so that the train operator continuously knows the status of the signal. Cab signals generally supplement, rather than displace, wayside signals. The signal aspect is relayed to the locomotive cab through electronic track circuits. The locomotive picks up the cab signal from the rails. Continuous display of the signal aspect in the cab permits faster speeds and closer train spacing in inclement weather when visibility is limited.

Automatic block signals and central train control do not physically "control" the movement or speed of the trains, but only indicate the actions required of the train operator. Cab signaling allows the incorporation of systems that can electronically control the movement of the train, either its maximum speed or causing it to stop if a speed is exceeded or a stop signal is passed. The HS or VHS categories would have, as a minimum requirement, a cab signaling system with automatic train control features.

Train control for the HS and VHS train sets would be modeled after the most recent developments for high speed rail systems. The train control system sets the train speed and the traction motors are controlled and/or the brakes are applied accordingly. The speed of the train is controlled from the train itself, based on data received from the wayside transmitters or electronic circuits in the rails.

In the UHS system, train speed is controlled by varying voltage and frequency of the power supply, either automatically by a computer system at the control center, or manually from the control room, or from the control cabin of the train. Allowable maximum speed, which is a function of track curvature and switch positions ahead of the vehicle, is monitored against actual speed by an independent system. If the critical velocity is exceeded, the mechanical emergency braking system is actuated. Comparison is made by a double-channel computer system aboard the vehicle, which uses scanning of passive markers in the guideway to determine speed and position of the vehicle.

Data transfer between the control center and the vehicle is made via a slotted wave guide mounted along the guideway. Couplers dipping into the slot of the wave guide provide the data link to the vehicle. Traffic control and the switch points are controlled from the control center by optical fiber cables.

2. Supervisory Control and Data Acquisition (SCADA) System

A real time computer SCADA system would be used to monitor and control train movement and system operations for all technologies. Basic functions for the SCADA system are:

- Manage centralized traffic control
- Supervise electric traction control of substations and auto-transformers (VHS and UHS)
- Direct control of train speed and position
- Management information system
- Maintenance scheduling and planning
- Test and training simulation

The SCADA system would collect data and control breakers and other equipment through the use of microprocessor-based Remote Terminal Units (RTUs) located at traction substations, auto-transformer stations (for the VHS system), and signal system interface points. Data communications to the RTUs would be through single-mode, fiber optic cable, which would also carry dedicated telephone service. The use of fiber optics would economically minimize electrical interference problems and provide substantial future channel expansion capacity.

The SCADA master computer would be located at the central control center in the headquarters building.

3. Communications

Since continuous advancements are occurring in the electronics and communications fields, it is clear that today's systems are likely to be obsolete and replaced by the time the project is nearing implementation. It was assumed, therefore, that the communications systems herein described were concepts for costing purposes and that a modern equivalent would be substituted to carry into the 21st century.

The communications system backbone would be dual, six-fiber cables buried along each side of the right-of-way to provide redundant wide-band channel capacity for all communications functions. Other communications systems features are described as follows:

- SCADA System - The link between the control center and each wayside RTU would be fiber optic and the link from the RTU to the vehicles would be radio.

- Train Operations - Communications between the train operator and the dispatcher and the maintenance center would be via separate dedicated radio channels using transmitter/receivers located along the right-of-way. The links from the transmitter/receivers to the central locations would be via the fiber optic cables.

- Train Control - Although railroad signaling has traditionally been via hard-wired signaling circuits, it is anticipated that the use of redundant fiber optic cables would be used for implementation of the HSR system.

- Conventional Telephone - An Electronic Public Automatic Branch Exchange (EPABX) would be used for handling telephone switching at the headquarters and at each passenger station. The fiber optic cables would be used for links to each RTU and other wayside locations. The EPABX would handle both passenger/station-attendant communications and maintenance communications.

- Closed Circuit Television (CCTV) - The CCTV system would provide centralized monitoring of all stations from the headquarters, as well as local station-attendant monitoring of the public access areas at passenger stations.

- Passenger Communications - On-board communications that the passengers may choose could include intercom service to the train operator, as well as credit card access to cellular telephone service for both voice and data (i.e., facsimile).

- Public Address - Communications for passenger information would include public address via speakers and variable message display units in the vehicles, as well as loudspeakers and variable message display units at each passenger station.

- Passenger Entertainment - Communications for entertainment would include audio programs, as well as optional television programs via video disk, in the vehicles.

H. CONCLUSIONS

Three generally identified categories of technology were considered for analysis by the study team (HS, VHS, and UHS), of which two (HS and VHS) are in commercial operating service. UHS is presently in the development stage.

SECTION IV
RIDERSHIP

This section presents information on existing travel characteristics in the Texas Triangle and estimates future HSR ridership.

A. EXISTING TRAVEL CHARACTERISTICS

Inter-city travel within the Texas Triangle is presently by automobiles, airlines, buses, and limited Amtrak passenger train service. The number of persons currently traveling between the study cities provides a measure of the travel market from which riders of high speed rail would be drawn. Accordingly, travel surveys were conducted and secondary information sources were used to determine existing travel demand between the study cities.

Travel surveys and secondary information were used to determine existing travel between triangle cities.

1. Traffic Zones and Highway Network

Traffic zones were established in order to determine existing inter-city travel patterns, make area forecasts of demographic characteristics, and develop and apply inter-city travel forecast models. The traffic zone system included each of the study cities and adjacent counties, providing a broader study area than only the cities themselves. A more detailed level of zone definition was provided in the urbanized areas. Data from the travel surveys were coded using these zones for trip origins and destinations. Existing and future population, employment, and other demographic characteristics were also developed using the traffic zone.

In addition to zone development, a highway network of major facilities was established within and linking the study cities. This network provided the basis for modeling the highway travel component, for each mode, between the study cities.

2. Travel Demand

An important element of the study was the determination of the magnitude and mode of existing travel between the study cities. This travel is distributed among four modes: airplane, automobile, inter-city bus, and passenger rail. Initial inquiry indicated that existing inter-city bus and passenger rail (Amtrak) travel was negligible compared to air and automobile travel, and further investigation of those modes was deemed unnecessary. Highway and air passenger travel was surveyed to estimate the magnitude and characteristics of inter-city travel.

a. Roadside Surveys

Roadside surveys served as the foundation to develop and analyze a comprehensive database suitable for existing travel characteristics of roadway users in the respective inter-city corridors. Travel surveys were set up on Interstate Highway 45 (IH 45), north of Fairfield and on Interstate Highway 10 (IH 10), east of Columbus. Information on Interstate Highway 35 (IH 35) was obtained from similar surveys conducted in July, 1987, by the Texas Transportation Institute, north of Georgetown and south of Austin.

As a part of the data collection in the IH 45, IH 10, and IH 35 corridors, manual vehicle classification counts were conducted at the survey stations. The counts took place over a 12 hour period from 7:00 a.m. to 7:00 p.m., coinciding with the hours of operation of the survey station. The counts provided a basis for estimating daily traffic and provided a breakdown of vehicle types in the traffic stream. This vehicle classification identified the proportion of passenger vehicles whose occupants can be considered a potential market for high speed rail. Examples of the manual classification counts are found in **Tables C-1** through **C-6** in **Appendix C**. The IH 45 and IH 10 surveys were conducted in May on a Thursday, Friday, and a Saturday. Those particular three days were chosen since they represented the travel expected over a seven-day period. Thursday figures were representative of the typical weekday (Monday-Thursday) travel. Friday was representative of pre-weekend/post-weekend travel on Friday and Sunday. Saturday figures were representative of typical weekend travel. An analysis of the origin and destination data from the surveys indicated the amount of travel between the study cities. The number of annual passenger vehicle trips was derived from the survey data and are shown in **Tables C-7** through **C-9** in **Appendix C**, representing the inter-city movements.

A step-wise process was used to expand the travel survey data to estimate annual travel in each of the corridors and to determine annual trips with both origins and destinations in the study cities. The following procedure was used to develop annual trip estimates:

1. The State Department of Highways and Public Transportation traffic count data at permanent count stations in each corridor was used for hourly, daily, and monthly trends.

2. Twelve-hour manual counts were related to permanent count station trends for Thursday, Friday, and Saturday traffic to estimate daily traffic at the survey location.

3. Traffic volumes were adjusted to average annual, based on the monthly factor for the appropriate permanent count station.

4. The proportion of passenger vehicle traffic in the traffic stream (from manual classification counts) was applied to daily traffic volumes to determine daily passenger vehicle traffic.

5. Passenger vehicle traffic was related to weekly traffic, based on the relationship of days of the week for the selected permanent count station to survey days.

6. Daily factors derived were applied to develop day of week and total weekly passenger vehicles.

7. Weekly passenger vehicle traffic was expanded to annual traffic by multiplying by 52 weeks per year.

An important element of the roadside survey was the determination of origin-destination patterns of passenger vehicle traffic in the IH 45, IH 10, and IH 35 corridors, and, more specifically, to quantify the passenger traffic between the study cities. The annual origin-destination patterns for passenger vehicles passing through the survey stations are summarized in Table IV-1.

Origin-destination of travelers was an important element.

TABLE IV-1

Estimated 1988 Annual Inter-City Origin and Destination Person Trips

City Pair					**Person - Trips by Mode**
	Airline[1]	**Automobile**	**Amtrak[4]**	**Bus[5]**	**Total**
	6,000+daily	8,000+daily			15,000 Daily
Houston - Dallas/Fort Worth	2,194,600	2,969,500[2]	N/A	21,900	5,185,900
Houston - San Antonio	454,700	3,177,600[2]	1,500	29,200	3,662,900
Houston - Austin	413,600	2,954,800[2]	N/A	73,000	3,441,400
Dallas/Fort Worth - Austin	725,400	1,074,300[3]	1,400	29,200	1,830,300
Dallas/Fort Worth - San Antonio	888,200	627,800[3]	600	29,200	1,545,900
San Antonio - Austin	N/A	3,581,600[3]	1,300	58,400	3,641,300
	= 4,676,500	14,385,600			19,307,700
	or 14,171/day	or 43,593/day			or 58,508/day

[1] Boeing Computer Services, based on U.S. DOT 10% Survey

[2] Wilbur Smith Associates roadside surveys on IH 10 and IH 45

[3] Developed from roadside surveys conducted on IH 35 by Texas Transportation Institute

[4] Ridership data received from Amtrak

[5] Estimated from inter-city bus service schedules

N/A Not Applicable

Source: Wilbur Smith Associates, Inc.

b. Air Passenger Surveys

A survey of enplaning passengers was made at each of the six air carrier airports located in the study cities. The airports were Dallas/Fort Worth International (DFW), Dallas Love Field (DAL), Houston Intercontinental (IAH), Houston Hobby (HOU), San Antonio International (SAT), and Austin Robert Mueller (AUS). Surveyors were positioned in public areas near the security stations leading to the departure lounges. Passengers were asked if their destination was another Texas Triangle city. If the response was "yes," a mail back questionnaire was given to them.

Passenger travel information was obtained from the U.S. Department of Transportation (DOT) and from the Texas Aeronautics Commission (TAC). The DOT information included the continuous 10 percent ticket sample compiled by the Research and Special Programs Administration of the DOT. That information was obtained from two commercial database services: I. P. Sharpe & Associates and Boeing Computer Services. The I. P. Sharpe information is directly from the DOT database, whereas, Boeing Computer Services conducts additional analysis and refines the basic DOT data based on other inter-city airline travel data. Selected origin-destination data were available from the TAC. These data are primarily from information submitted by Southwest Airlines to the TAC and consist of the number of enplaned passengers, their origin, and destination.

Inter-city airline travel data from Boeing Computer Services was considered the most accurate estimate of travel between study cities. Annual origin-destination passenger travel between the Triangle cities is summarized in Tables IV-2 and IV-3.

TABLE IV-2

Summary of Annual Origin-Destination Airline Passengers Between Study Cities

City Pair	Annual Air Passenger Trips
Houston - Dallas/Fort Worth	2,194,580
Houston - San Antonio	454,680
Houston - Austin	413,640
Dallas/Fort Worth - Austin	725,400
Dallas/Fort Worth - San Antonio	888,180
TOTAL	4,676,480

Source: Boeing Computer Services based on U.S. Department of Transportation, Research and Special Programs Administration passenger origin-destination survey. Period is 4th Quarter 1986 through 3rd Quarter 1987.

TABLE IV-3

Summary of Annual Airline Origin-Destination Passengers Between Airport Pairs

Airport Pair	O-D Passengers
Austin - Dallas	455,940
Austin - Dallas/Fort Worth	269,460
Austin - Houston	340,380
Austin - Intercontinental	73,260
Dallas - Houston	1,173,240
Dallas - Intercontinental	212,940
Dallas - San Antonio	511,560
Dallas/Fort Worth - Houston	78,120[1]
Dallas/Fort Worth - Intercontinental	730,280[1]
Dallas/Fort Worth - San Antonio	376,620
Houston - San Antonio	347,940
Intercontinental - San Antonio	106,740
Total	**4,676,480**

[1] Passenger O-D traffic between DFW-Houston and DFW-IAH is not reported separately by some airlines, resulting in over-reporting of IAH and under-reporting for HOU.

Source: Boeing Computer Services based on U.S. Department of Transportation, Research and Special Programs Administration passenger origin-destination survey. Period is 4th Quarter 1986 through 3rd Quarter 1987.

c. Existing Travel Demand

The primary data surveys and secondary information sources provided information on existing travel demand between the study cities. The number of persons currently traveling between the Triangle cities provided an indication of potential riders of high speed rail. Inter-city bus and passenger rail service were found to comprise a negligible portion of inter-city travel. Aircraft and automobiles are the primary means of transportation between the study cities and are thus the most likely sources of potential high speed rail ridership. The estimated annual inter-city person origin and destination person trips between the city pairs in 1988 are summarized in **Table IV-1**.

d. Trip Characteristics

Trip characteristics also play an important role in determining the potential ridership of high speed rail. Trip characteristics include descriptions of the traveler, such as age, sex, and income; and of the trip made, such as duration, purpose, and frequency. The following **Table IV-4** characterizes the typical traveler in both the air and automobile modes in the Triangle:

Aircraft and automobiles are the primary means of transportation between Triangle cities.

TABLE IV-4

Typical Trip Characteristics of Travelers in the Texas Triangle

Characteristic	Air	Automobile
Age	35 to 44	45 to 64
Sex	Male	Male
Employed?	Yes	Yes
Family Income	$60,000+	$40,000+
Trip Begins	At home, arriving at airport by personal automobile	At home
Purpose of Trip	Business	Personal, visit relative or acquaintance
Who Pays for Trip?	Employer	Himself
Frequency of Trip	Occasionally	Occasionally
Duration of Trip	Less than three days	Less than three days
End of Trip	At home	At home

e. Focus Group Surveys

A focus group is a small, selected group from which specific information is obtained in an in-depth survey. The purpose of the focus group surveys was to focus on potential riders of high speed rail and solicit information on their travel patterns, as well as obtain their opinions and attitudes concerning travel service characteristics and the potential of high speed rail in Texas. Focus group participants were selected from Chamber of Commerce membership rosters in each study city. A qualification survey was conducted by calling potential participants and inquiring about recent trips they had made. If these trips were to any of the study cities, participants were invited to attend a focus group meeting. Once a group of twenty individuals had been identified, the qualification survey ceased. At each meeting, a multi-part questionnaire was administered which inquired about recent trip characteristics and opinions on the use of high speed rail for such trips. The dates and locations of the focus group surveys follow:

August 2, 1988	Houston Chamber of Commerce	Houston
August 3, 1988	Houston HL&P Energy Information Center	Houston
August 4, 1988	Central Dallas Association	Dallas
August 5, 1988	North Dallas Chamber of Commerce	Dallas
August 10, 1988	Fort Worth Chamber of Commerce	Fort Worth
August 11, 1988	San Antonio Greater Chamber of Commerce	San Antonio
August 12, 1988	Austin Chamber of Commerce	Austin
August 16, 1988	Fort Bend County Chamber of Commerce	Sugar Land

The focus group surveys provided attitudinal information as well as trip characteristic information that was used in estimating travel demand. A portion of the attitudinal information obtained from the focus groups is in **Tables C-10 through C-13 in Appendix C.**

B. RIDERSHIP ANALYSIS AND FORECASTS

Estimated changes in human behavior and demographic, social, political, and economic conditions create inherent uncertainties in ridership forecasting. In recognition of the uncertainties in forecasting, low, base (most probable), and high ranges of population were used in forecasting both ridership and revenues. The methodologies used in this study reduce these uncertainties to a level which yields results that can be considered realistic estimates. The low, base, and high forecasts reflect ranges of growth in the economy, housing, population, employment, and income of the analysis zones utilized in the study area. The low forecast represents a conservative estimate of growth, the base estimate represents those conditions most likely to occur, and the high estimate represents those conditions favorable to optimistic growth.

Ridership forecasts were made through use of mathematical models which followed the procedures outlined in the "Standard Guidelines of Revenue and Ridership Forecasting," published by the High Speed Rail Association. Information concerning existing travel demand, trip characteristics, socioeconomic conditions, and demographics was developed and forecasts made to future years. The information was related to individual traffic analysis zones in the study area and this zonal data was the working base for the development and application of the mathematical models utilized. Calibration tests were made to examine how closely the estimated values resembled observed values and adjustments were made in the models to reflect actual travel demand. Sensitivity tests were then conducted to determine how model results would fluctuate if the variables were changed.

1. Study Area Demographics

Study area demographics, on a zonal basis, were estimated for the base year (1988) for a number of data elements, including population, number of households, labor force, employment, income, hotel/motel units, and college enrollment. Key demographic data for 1988 for the study cities' urbanized areas are summarized in the following Table IV-5.

TABLE IV-5

Primary Demographic Data for 1988

Urbanized Area	Population	Households	Labor Force	Employment
Dallas/Fort Worth	3,783,500	1,414,600	1,908,600	1,788,900
Houston	3,700,400	1,356,500	1,628,600	1,482,400
Austin	849,500	315,900	420,200	353,100
San Antonio	1,408,100	482,400	593,800	546,900
Total	9,741,500	3,569,400	4,551,200	4,171,300

Source: M. Ray Perryman Consultants, Inc.

Once current year estimates were determined, low, base (most probable), and high forecasts were made for the years 1998 and 2015. These forecasts were then used in the mathematical model to develop ranges of estimated HSR ridership for 1998 and 2015. The key demographic data forecasts for these years are summarized in the following **Table IV-6.**

TABLE IV-6

Primary Demographic Data for 1998 and 2015

Urbanized Area	Year	Population	Households	Labor Force	Employment
Dallas/Fort Worth	1998				
	Low	4,421,600	1,708,200	2,288,700	2,161,900
	Base	4,529,300	1,749,700	2,355,700	2,218,100
	High	4,668,200	1,803,300	2,409,400	2,281,900
	2015				
	Low	5,521,700	2,227,900	2,978,600	2,832,200
	Base	5,932,200	2,393,300	3,195,000	3,048,400
	High	6,291,900	2,538,200	3,392,500	3,267,900
Houston	1998				
	Low	4,345,900	1,646,400	1,887,500	1,718,300
	Base	4,459,100	1,689,200	1,932,300	1,759,900
	High	4,611,200	1,746,800	1,968,100	1,793,100
	2015				
	Low	5,276,500	2,087,700	2,338,700	2,124,200
	Base	5,782,900	2,287,900	2,475,000	2,251,700
	High	6,343,300	2,509,400	2,598,800	2,370,300
Austin	1998				
	Low	1,006,500	386,600	510,800	435,700
	Base	1,034,600	397,300	526,900	450,500
	High	1,064,500	408,800	539,800	462,400
	2015				
	Low	1,262,900	506,500	678,400	595,400
	Base	1,351,500	542,000	731,400	647,600
	High	1,445,200	579,500	780,100	696,100
San Antonio	1998				
	Low	1,724,400	610,800	710,800	660,500
	Base	1,782,900	631,500	731,400	681,900
	High	1,812,800	642,100	747,900	697,000
	2015				
	Low	2,241,700	829,600	922,800	870,800
	Base	2,400,900	888,600	989,000	939,900
	High	2,520,200	932,800	1,049,500	1,000,800
Totals	1998				
	Low	11,498,400	4,351,900	5,397,700	4,976,400
	Base	11,806,000	4,467,800	5,546,200	5,110,500
	High	12,156,700	4,601,000	5,665,100	5,234,500
	2015				
	Low	14,302,800	5,651,700	6,918,400	6,422,600
	Base	15,467,600	6,111,800	7,390,400	6,887,700
	High	16,600,600	6,559,900	7,821,000	7,335,000

Source: M. Ray Perryman Consultants, Inc.

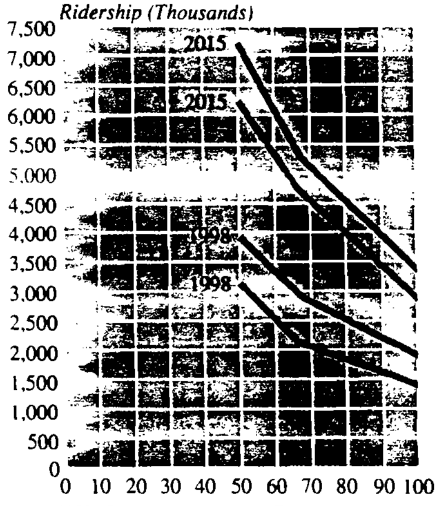
2. Model Development

Utilizing the demographic data set forth in **Tables IV-5** and **IV-6**, in conjunction with travel characteristics data, a series of models was developed to estimate total travel demand in the Texas Triangle and to determine the share of travel that could be expected to use a high speed rail system. The process consisted of a series of steps as follows:

- Estimate city to city travel demand;
- Disaggregate city to city demand into traffic analysis zone to traffic analysis zone movements;
- On a zone to zone basis, determine the combined air and HSR (high speed travel) share of total travel;
- Estimate the share of "high speed" travel by HSR; and
- Adjust the HSR forecasts to account for induced travel and the special attractiveness of HSR.

Major highways, within and between the cities, were included in the base network as were existing airports with their points of connection to the highway system. The network was updated for future year forecasts to include major highway additions, the location of a new Austin airport, and the candidate HSR systems and station locations. Data from the air and highway surveys were analyzed to identify the major market segments making up travel in the corridors. This analysis led to the stratification of travel into two components: business and non-business travel. Individual models were then developed for each of these major travel purposes.

Figure IV-1
Station Location Sensitivity
Texas High Speed Rail Feasibility Study



Source: Wilbur Smith Associates, Inc.

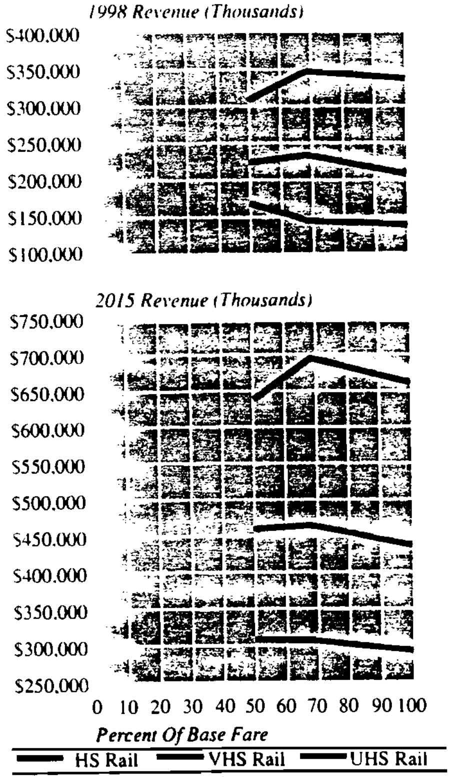
3. Travel Forecasts

The travel forecasts models yielded the travel demand for the three primary modes -- air, automobile, and high speed rail -- for each city pair. Due to the importance of the Fort Worth - Dallas - Houston corridor and its high travel demand, travel estimates for this corridor are shown separately. Several analyses were conducted using the travel forecast models. Each analysis, or sensitivity test, helped to determine what the change in ridership would be based on possible changes in conditions. The analyses functioned as a refining process resulting in realistic estimated ridership.

4. Station Location Sensitivity Tests

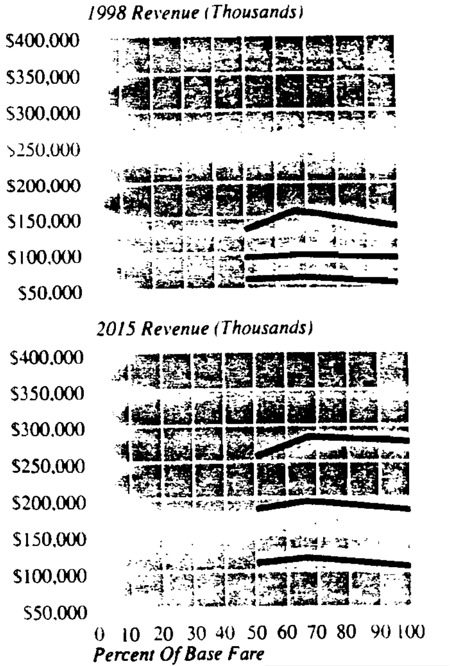
The generalized locations of HSR stations were tested to determine impact on ridership. Using VHS as the comparison technology, two tests were run: one, assuming only central business district (CBD) stations; and, another, assuming CBD stations with suburban stations in Houston and mid-point between Dallas and Fort Worth. Results of this comparison are shown in **Table IV-7** and **Figure IV-1** for the Fort Worth - Dallas - Houston corridor. By including the suburban stations, a 14 to 17 percent increase in ridership can be realized. As a result, the remaining sensitivity tests that were conducted included suburban stations.

Figure IV - 2
System Revenues With Variations in Time and Fare



Source: Wilbur Smith Associates, Inc.

Figure IV - 3
Revenues With Variations in Time and Fare
Fort Worth - Dallas - Houston Corridor



Source: Wilbur Smith Associates, Inc.

TABLE IV-7

Station Location Sensitivity
Fort Worth - Dallas - Houston Corridor

	Ridership by Mode	
Test	**1998**	**2015**
HSR fare 100% of air fare - CBD stations	1,485,700	2,966,600
HSR fare 67% of air fare - CBD stations	2,446,300	4,738,800
HSR fare 50% of air fare - CBD stations	3,204,400	6,223,100
HSR fare 100% of air fare - CBD and suburban stations	1,807,100	3,448,400
HSR fare 67% of air fare - CBD and suburban stations	2,853,200	5,499,100
HSR fare 50% of air fare - CBD and suburban stations	3,644,000	7,041,000
Additional riders using suburban stations for HSR fares 100% of air fares	321,400	481,800
Additional riders using suburban stations for HSR fares 67% of air fares	406,900	760,300
Additional riders using suburban stations for HSR fares 50% of air fares	439,600	817,900

Note: Suburban stations are assumed for mid-cities area (Dallas/Fort Worth) and at Beltway 8 (Houston). Technology is VHS. Induced trips included in ridership estimates.

Source: Wilbur Smith Associates, Inc.

5. Potential Revenue from Fares

Estimated passenger revenues were derived from estimates of ridership and assumed fares. The base average fare used for calculations was $52.00 for all corridors except the Austin - San Antonio corridor, for which $27.00 was used. The base HSR fare was considered equal with average air fares for the same corridors. The ridership estimates for each technology were multiplied by these fares and then reduced to 67 percent and 50 percent of the base fare, consistent with the fare sensitivity ridership estimates. The time/fare/revenue sensitivities are shown in **Table IV-8** for the entire HSR system (including all legs of the Triangle) and in **Table IV-9** for the Dallas - Fort Worth - Houston corridor. These riderships are depicted graphically in **Figures IV-2 and IV-3**.

6. Sensitivity Analyses

A series of sensitivity tests were conducted using the forecast models to determine the impact on ridership if changes were made to the variables. The variables of time, station location, and travel costs were varied to represent a range of conditions. The following describes the different sensitivity tests that were performed.

a. Travel Time and Fare Sensitivity

Travel time sensitivity was tested by using the relative speed differences of the candidate rail technologies: **High Speed (HS), Very High Speed (VHS), and Ultra High Speed (UHS)**. Fare sensitivity was tested by reducing the cost of HSR fare in relation to air fare and holding automobile costs constant. This test indicated how ridership varied with different time and fare scenarios. Results of fare sensitivity tests for the three rail technologies are shown in **Tables IV-10** and **IV-11** for the entire system and the Fort Worth - Dallas - Houston corridor. Results of these sensitivity tests for total trips on the system and the Fort Worth - Dallas - Houston corridor are graphically shown in **Figures IV-4** and **IV-5**. The results of this testing showed that UHS generates the highest ridership of the three technologies at every fare structure. The analysis showed that the greater the fare reduction, the greater the HSR ridership. Business related trips are more sensitive to time than cost, while cost reductions yield an even greater increase for non-business trips.

Additional analysis of the HSR ridership were made as shown in **Tables C-14** and **C-15** in **Appendix C**. These tables show the changes in automobile and air ridership as well as HSR ridership. The number of HSR induced trips was calculated for the three technologies and three fare relationships. Induced travel and travel related to the special attractiveness of the HSR mode were estimated to increase ridership by 20 percent. Induced trips are additional trips that would not otherwise have occurred if the HSR were not available.

TABLE IV-8

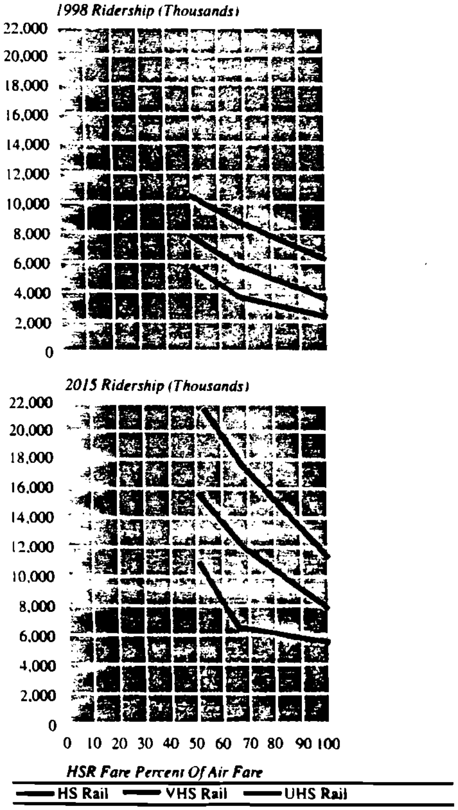
Annual Ridership and Revenues for Variations in Travel Time and Fare
Total HSR System

		1998		2015
	Estimated Riders	**Estimated Revenues**	**Estimated Riders**	**Estimated Revenues**
1. HS, Fare, 100% of Air	3,216,400	$145,429,500	6,623,900	$296,171,100
VHS, Fare, 100% of Air	4,605,200	$217,646,400	9,359,000	$433,532,300
UHS, Fare 100% of Air	6,754,100	$328,266,100	13,595,400	$656,148,000
2. HS, Fare, 67% of Air	4,734,000	$147,944,600	9,738,400	$301,641,100
VHS, Fare, 67% of Air	7,127,600	$231,723,600	14,497,000	$468,199,200
UHS, Fare, 67% of Air	10,438,700	$346,579,500	21,088,000	$696,566,200
3. HS, Fare, 50% of Air	6,983,600	$167,108,800	12,849,700	$302,160,700
VHS, Fare, 50% of Air	9,154,100	$223,543,100	18,873,800	$458,774,900
UHS, Fare, 50% of Air	12,987,600	$322,352,200	26,276,000	$649,280,000

NOTE: Revenues are in 1988 constant dollars. Estimated ridership includes induced trips. CBD and suburban stations assumed. Base demographic forecasts used.

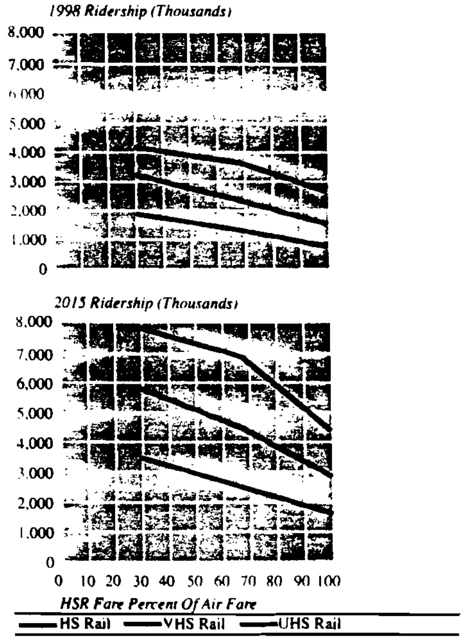
Source: Wilbur Smith Associates, Inc.

Figure IV - 4
System Time and Fare Sensitivity
Texas High Speed Rail Feasibility Study



Source: Wilbur Smith Associates, Inc.

Figure IV - 5
Time and Fare Sensitivity
Fort Worth - Dallas - Houston Corridor



Source: Wilbur Smith Associates, Inc.

TABLE IV-9

Annual Ridership and Revenues for Variations in Travel Time and Fare
Dallas/Fort Worth - Houston Corridor

		1998		2015	
		Estimated Riders	**Estimated Revenues**	**Estimated Riders**	**Estimated Revenues**
1.	HS, HSR 100% of Air	1,075,100	$55,905,200	2,058,700	$107,052,400
	VHS, HSR 100% of Air	1,807,100	$93,969,200	3,448,400	$179,316,800
	UHS, HSR 100% of Air	2,779,800	$144,549,600	5,408,400	$281,236,800
2.	HS, HSR 67% of Air	1,652,200	$56,882,000	3,128,900	$109,511,500
	VHS, HSR 67% of Air	2,853,200	$99,862,000	5,499,100	$192,468,500
	UHS, HSR 67% of Air	4,445,500	$155,592,500	8,108,800	$283,808,000
3.	HS, HSR 50% of Air	2,172,500	$56,485,000	4,247,500	$110,435,000
	VHS, HSR 50% of Air	3,644,000	$94,744,000	7,046,600	$183,211,600
	UHS, HSR 50% of Air	5,044,100	$131,146,600	9,705,800	$252,350,800

NOTE: Revenues are in 1988 constant dollars. Estimated ridership includes induced trips. CBD and suburban stations assumed. Base demographic forecasts used.

Source: Wilbur Smith Associates, Inc.

TABLE IV-10

System Time and Fare Sensitivity by Trip Purpose

Rail Mode	HSR Fare % of Air Fare	RIDERSHIP 1998[1]			RIDERSHIP 2015[1]		
		Business	**Non-Bus**	**Total**	**Business**	**Non-Bus**	**Total**
HS	100	1,808,900	871,400	2,680,300	3,674,000	1,845,900	5,519,900
	67	1,903,100	2,041,900	3,945,000	3,859,900	4,255,400	8,115,300
	50	1,957,000	3,253,200	5,819,700	3,967,200	6,740,900	10,708,100
VHS	100	2,566,500	1,271,200	3,837,700	5,140,100	2,659,100	7,799,200
	67	2,704,300	3,235,400	5,939,700	5,409,900	6,670,900	12,080,800
	50	2,685,200	4,943,200	7,628,400	5,565,100	10,163,100	15,728,200
UHS	100	3,684,800	1,943,600	5,628,400	7,296,200	4,033,300	11,329,500
	67	3,876,300	4,822,600	8,698,900	7,657,200	9,916,100	17,573,300
	50	3,981,500	6,841,500	10,823,000	7,876,000	14,029,700	21,896,700

[1] Ridership estimates do not include induced trips.

Source: Wilbur Smith Associates, Inc.

TABLE IV-11

Time and Fare Sensitivity by Trip Purpose
Dallas/Fort Worth - Houston Corridor

	HSR						
Rail	**Fare % of**		**RIDERSHIP 1998[1]**			**RIDERSHIP 2015[1]**	
Mode	**Air Fare**	**Business**	**Non-Bus**	**Total**	**Business**	**Non-Bus**	**Total**
HS	100	581,100	314,800	895,900	1,086,500	629,100	1,715,600
	67	614,500	734,000	1,348,500	1,149,000	1,452,300	2,601,300
	50	633,000	1,190,200	1,823,200	1,184,200	2,351,300	3,535,500
VHS	100	987,600	518,300	1,505,900	1,845,500	1,028,200	2,873,700
	67	1,039,400	1,338,300	2,377,700	1,940,300	2,642,300	4,582,600
	50	1,069,900	1,966,800	3,036,700	1,995,000	3,872,500	5,867,500
UHS	100	1,481,500	829,900	2,311,400	2,756,300	1,642,800	4,399,100
	67	1,550,000	1,965,300	3,515,300	2,882,500	3,871,000	6,753.500
	50	1,588,000	2,611,600	4,199,600	2,953,900	4,930,000	7,883,900

[1] Ridership estimates do not include induced trips.

Source: Wilbur Smith Associates, Inc.

The VHS technology was selected as the basis of comparison in the remaining sensitivity tests since it is the most advanced technology in revenue service and represents a mid-range for cost of implementation.

As fares decrease, ridership increases. Revenues, however, increase when fares are reduced to 67 percent of base fares but decrease when fares are reduced to 50 percent, in spite of increases in ridership. Thus, a 50 percent decrease in fares increases ridership but decreases revenues. Therefore, a pricing strategy of setting HSR fares at approximately two-thirds of current air fares, would maximize revenues.

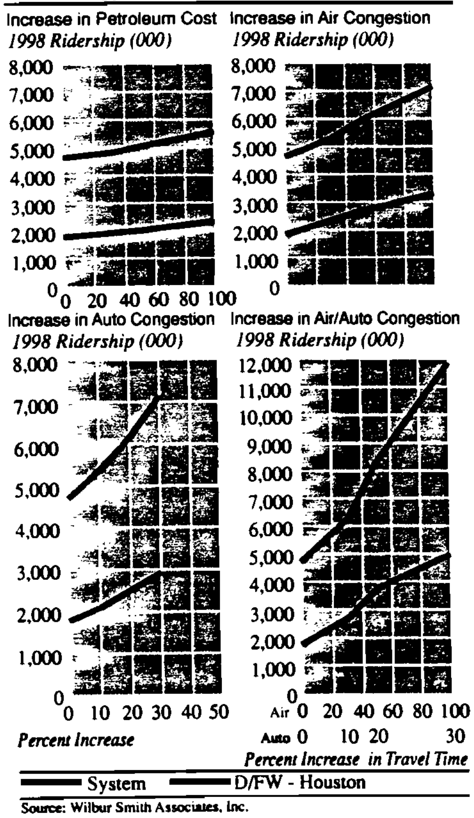
b. Additional Sensitivity Tests

A battery of sensitivity tests were conducted assuming suburban and CBD stations and the VHS technology. Eight additional tests were conducted with two to three levels run under each major test group. These additional sensitivity tests were as follows:

- **Air/HSR Fares** - A decrease in the cost of both HSR fares and air fares with automobile costs remaining constant. The HSR and air fares were tested at 100 percent, 67 percent, and 50 percent of the base.

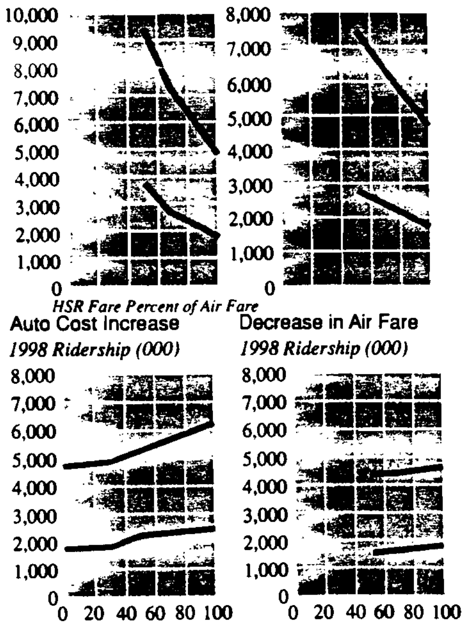
- **Automobile Costs** - An increase in automobile costs with HSR and air fares remaining constant. The automobile costs were tested at 30 percent, 50 percent, and 100 percent increases.

Figure IV-6
Travel Mode Congestion and Energy Cost Sensitivity



Source: Wilbur Smith Associates, Inc.

Figure IV-7
Travel Mode Cost Sensitivity



Source: Wilbur Smith Associates, Inc.

- **Air Fare** - A decrease in air fares with HSR fares and automobile costs remaining constant. Air fares were tested at 100 percent of HSR fares, 67 percent of HSR fares, and 50 percent of HSR fares.

- **Petroleum Cost** - An increase in petroleum costs impacting air fares and automobile costs. Increases in petroleum costs were tested at a 30 percent increase, 50 percent increase, and 100 percent increase. A decrease of 10 percent was also tested.

- **Air Congestion** - An increase in air congestion (gate-to-gate travel times) with no change in HSR or automobile (highway) congestion. Increases were tested at 30 percent, 50 percent, and 100 percent.

- **Automobile Congestion** - An increase in automobile congestion (travel time) with no change in HSR or air congestion. Increases were tested at 10 percent, 20 percent, and 30 percent increases in automobile travel time.

- **Air and Automobile Congestion** - A joint increase in automobile congestion and air congestion with no change in HSR. The increases were jointly tested at 10 percent, 20 percent, and 30 percent increases in automobile travel time and 30 percent, 50 percent, and 100 percent increases in air travel time.

Each of these tests were run using the 1998 base demographic forecast, VHS technology and suburban stations. Results of these sensitivity tests are summarized in **Tables IV-12** and **IV-13**, while **Figures IV-6** and **IV-7** graphically depict the eight tests conducted. The changes in different variables reflect potential scenarios that could affect HSR ridership. A decrease in HSR fares in relation to air fares yields a significant change in ridership with an increase in the Fort Worth - Dallas - Houston corridor, as well as the entire system. Other variables showed significant impact on ridership, as well. Ridership on HSR can be significantly affected by decreasing both air and HSR fares or by increasing air and automobile travel times. The highest increase in HSR ridership occurred when both air and automobile congestion were assumed.

The eight sensitivity tests indicated some of the realistic scenarios that could impact HSR ridership. Changes in variables could have a significant effect on HSR ridership. Therefore, ridership forecasts should be based on the best estimate of which scenarios are the most reasonable, given the current and expected conditions. Any ridership forecasts should reflect a range of likely ridership based on the most realistic selection of variables, while recognizing the inherent uncertainties of the forecasts.

TABLE IV-12

Summary of Sensitivity Tests-Total System

		1998 RIDERSHIP BY MODE	
Test	**Automobile**	**Air**	**HSR**
HSR Fare			
HSR fare 100% of air fare (base)	21,766,000	4,338,500	4,605,200
HSR fare 67% of air fare	19,929,200	4,082,500	7,127,600
HSR fare 50% of air fare	18,262,500	3,958,200	9,154,100
Air/HSR Fare			
Air/HSR fare 67% of base	18,871,200	5,929,100	6,248,600
Air/HSR fare 50% of base	16,965,600	6,903,300	7,310,200
Automobile Cost			
Automobile cost increase of 30%	21,025,600	4,757,700	4,994,400
Automobile cost increase of 50%	20,484,200	5,061,000	5,277,600
Automobile cost increase of 100%	19,029,500	5,872,000	6,066,000
Air Fare			
Air fare 67% of HSR fare	19,359,800	6,871,300	4,460,600
Air fare 50% of HSR fare	17,707,400	8,658,200	4,301,300
Petroleum Cost			
10% decrease in petroleum cost	21,782,700	4,379,300	4,534,400
30% increase in petroleum cost	21,601,400	4,319,600	4,892,900
50% increase in petroleum cost	21,515,400	4,258,500	5,002,000
100% increase in petroleum cost	21,161,100	4,184,600	5,519,500
Air Congestion (Travel Time)			
30% increase in air congestion	22,964,600	2,649,200	5,353,000
50% increase in air congestion	23,079,600	1,912,300	5,938,400
100% increase in air congestion	23,158,600	798,800	7,162,300
Automobile Congestion (Travel Time)			
10% increase in automobile congestion	20,345,000	5,145,500	5,339,600
20% increase in automobile congestion	18,796,600	6,000,000	6,180,800
30% increase in automobile congestion	17,268,200	6,824,300	7,023,100
Air and Automobile Congestion			
Increase of 30% air and 10% auto. congestion	21,456,900	3,234,900	6,307,300
Increase of 50% air and 20% auto. congestion	20,198,000	2,853,700	8,275,700
Increase of 100% air and 30% auto. congestion	18,784,200	1,474,500	11,617,800

Note: Revenues are in 1988 constant dollars. Estimated ridership includes induced trips. CBD and suburban stations assumed. Base demographic forecasts used.

Source: Wilbur Smith Associates

TABLE IV-13

Summary of Sensitivity Tests - Dallas/Fort Worth - Houston Corridor

		1998 RIDERSHIP BY MODE	
Test	**Automobile**	**Air**	**HSR**
HSR Fare			
HSR fare 100% of air fare (base)	4,444,800	1,875,400	1,807,100
HSR fare 67% of air fare	3,686,500	1,764,500	2,853,200
HSR fare 50% of air fare	3,107,600	1,683,300	3,644,000
Air/HSR Fare			
Air/HSR fare 67% of base	3,348,900	2,476,100	2,403,700
Air/HSR fare 50% of base	2,757,400	2,797,300	2,729,600
Automobile Cost			
Automobile cost increase of 30%	4,111,100	2,061,500	1,988,900
Automobile cost increase of 50%	3,865,400	2,195,000	2,120,000
Automobile cost increase of 100%	3,222,700	2,547,400	2,470,300
Air Fare			
Air fare 67% of HSR fare	3,465,900	2,929,700	1,719,700
Air fare 50% of HSR fare	2,877,400	3,504,400	1,615,800
Petroleum Cost			
10% decrease in petroleum cost	4,456,900	1,890,600	1,774,100
30% increase in petroleum cost	4,362,100	1,872,400	1,913,800
50% increase in petroleum cost	4,311,500	1,851,300	1,997,300
100% increase in petroleum cost	4,117,000	1,832,100	2,254,400
Air Congestion (Travel Time)			
30% increase in air congestion	4,834,000	1,155,100	2,204,400
50% increase in air congestion	4,866,100	852,600	2,527,000
100% increase in air congestion	4,866,100	352,200	3,121,000
Automobile Congesetion (Travel Time)			
10% increase in automobile congestion	3,864,400	2,196,100	2,119,600
20% increase in automobile congestion	3,237,900	2,533,000	2,469,600
30% increase in automobile congestion	2,647,400	2,843,300	2,799,200
Air and Automobile Congestion			
Increase of 30% air and 10% auto. congestion	4,256,800	1,389,500	2,620,200
Increase of 50% air and 20% auto. congestion	3,668,700	1,221,000	3,527,000
Increase of 100% air and 30% auto. congestion	3,064,600	606,600	4,983,700

Note: Estimated ridership includes induced trips. Estimates include VHS technology, CBD and suburban stations, and base demographic forecasts.

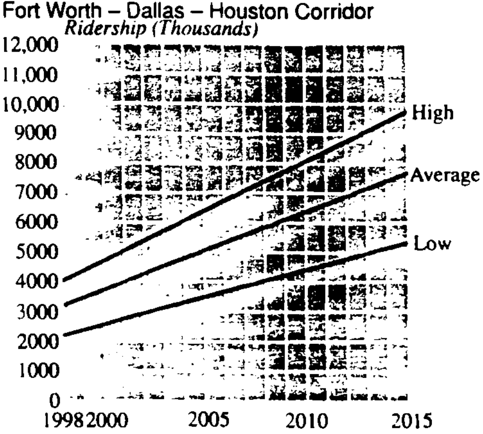
Source: Wilbur Smith Associates

c. Ridership for Selected Scenarios

Although the sensitivity analyses treated different variables singularly, it is more likely that variables will change in combinations. On this basis, three conditions were considered to be realistic future scenarios. These scenarios were based on assumptions concerning HSR fare, future automobile congestion, and future air congestion. The three scenarios were as follows:

- Scenario 1:
  - HSR fare is 67 percent of air fare
  - Air congestion increases 30 percent
  - Automobile congestion increases 10 percent in 1998 and 30 percent in 2015
- Scenario 2:
  - HSR fare is 67 percent of air fare
  - No Increase in air or automobile congestion
- Scenario 3:
  - HSR fare is the same as air fare
  - Automobile congestion increases 10 percent in 1998 and 30 percent in 2015

Figure IV-8
Estimated HSR Ridership
Fort Worth – Dallas – Houston Corridor



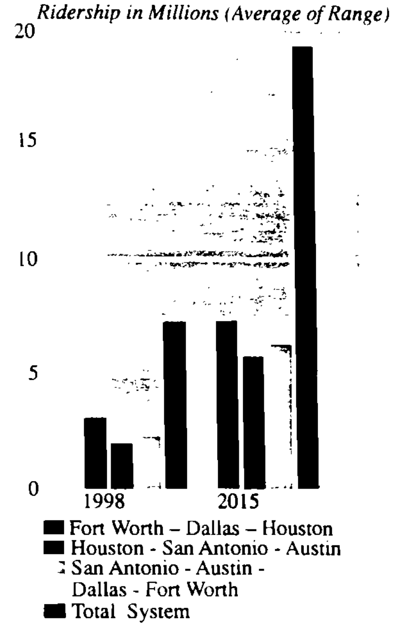
Source: Wilbur Smith Associates, Inc.

Scenario 1 was considered a high estimate of ridership since air and automobile congestion were increased thereby making HSR more attractive as a travel mode. Scenario 2 was considered more realistic since air and automobile travel would compensate for congestion and HSR could realistically compete by maintaining fares at 67 percent of air travel costs. Scenario 3 was considered a low estimate due to air fares equalling HSR fares with moderate increases only in automobile travel.

The range of HSR ridership represented by these scenarios is illustrated for the Fort Worth - Dallas - Houston corridor in **Figure IV-8**.

The fare relationship of HSR to air was one important element in defining the scenarios analyzed. Although potential fare competition with the airlines could be a factor, the optimum HSR fare (which maximizes revenue) was found to be 65-70 percent of air fare. A fare pricing policy of maintaining HSR fares at approximately 65-70 percent of air fare is important in attracting riders and maximizing operating revenues.

Figure IV-9
Most Probable HSR Ridership



Source: Wilbur Smith Associates, Inc.

C. ESTIMATED RIDERSHIP

Based on the foregoing analysis, the three scenarios were considered realistic estimates of a range of ridership to be applied in further analyzing the feasibility of high speed rail. In the Fort Worth - Dallas - Houston corridor, for the VHS technology, the range of estimated 1998 HSR ridership, using base demographics, was 2,119,000 to 4,008,000 passengers per year with a mid-point of 3,063,600. Estimated 2015 ridership ranged from 5,334,800 to 9,804,600 riders per year with a mid-point of 7,569,700.

Estimated ridership represented by the three scenarios was considered a realistic potential. The middle of this range was considered the most probable and was used as the estimate for ridership. Accordingly, the estimated ridership shown in **Tables IV-14** and **IV-15** and **Figure IV-9** was developed for the middle range for VHS and was used in evaluating the HSR system for years 1998 and 2015, respectively.

TABLE IV-14

Ridership and Revenues for VHS Technology - 1998

City Pair/Technology	Estimated Ridership	Estimated Revenues
Fort Worth - Dallas - Houston	3,063,000	$107,226,000
Houston - Austin	1,050,500	36,767,500
Houston - San Antonio	1,039,900	36,396,500
Fort Worth - Dallas - San Antonio	671,6007	2 3,506,000
Fort Worth - Dallas - Austin	591,400	20,699,000
San Antonio - Austin	1,112,200	20,019,600

Assumptions used are base demographics, HSR fare 67% of air fare, induced travel, VHS Technology, and use of suburban stations.

Source: Wilbur Smith Associates, Inc.

TABLE IV-15

Ridership for VHS Technology - 2015

City Pair/Technology	Estimated Ridership	Estimated Revenues
Fort Worth - Dallas - Houston	7,569,700	264,939,500
Houston - Austin	2,848,300	99,690,500
Houston - San Antonio	2,901,900	101,566,500
Fort Worth - Dallas - San Antonio	1,679,300	58,775,500
Fort Worth - Dallas - Austin	1,421,400	49,749,000
San Antonio - Austin	3,129,100	56,323,800

Estimates are based on base demographics, HSR fare 67% of air fare, induced travel, VHS Technology, and use of suburban stations.

Source: Wilbur Smith Associates, Inc.

D. POTENTIAL STAGING

Accepting the Fort Worth - Dallas - Houston corridor as the first to be implemented, a potential staging option for development of a total HSR system is shown schematically in **Figures IV-10, IV-11, and IV-12**. Estimated 1998 ridership (assuming the VHS mode) for the option is summarized in **Table IV-16**. The analysis indicated highest ridership for the Fort Worth - Dallas - Houston corridor, with the other corridors showing potential for later implementation.

TABLE IV-16

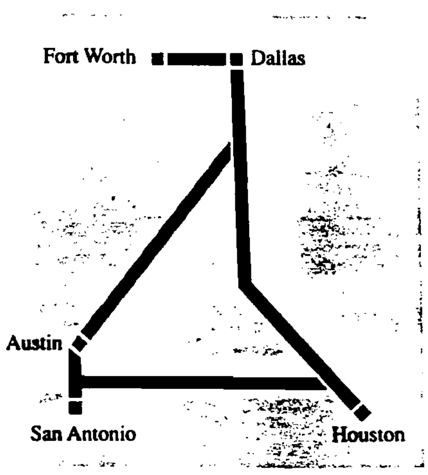
Potential Staging Plan

Segment	1998 Annual Passengers
Stage 1 Fort Worth - Dallas - Houston	3,063,600
Stage 2 Houston - San Antonio - Austin	2,090,400
Stage 3 San Antonio - Austin - Dallas - Fort Worth	2,375,200
Total	7,529,200

E. CONCLUSION

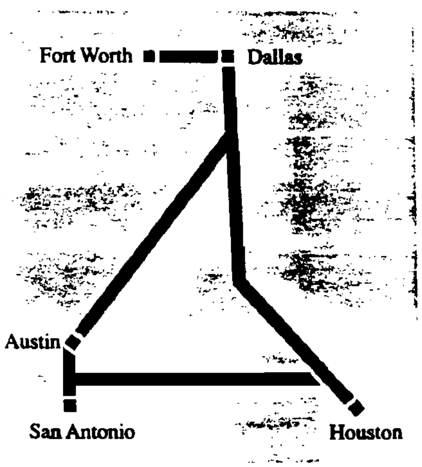
Estimated future ridership has been developed for HSR travel for each segment of the Texas Triangle. The high speed rail system is estimated to carry one-fourth of inter-city travelers in the year 1998, increasing to one-third by the year 2015. A staged development plan is recommended, with the first stage consisting of the Fort Worth - Dallas - Houston segment. Estimated annual ridership for Stage 1 was three million passengers in 1998 and 7.5 million passengers in 2015.

Figure IV-10
Stage 1



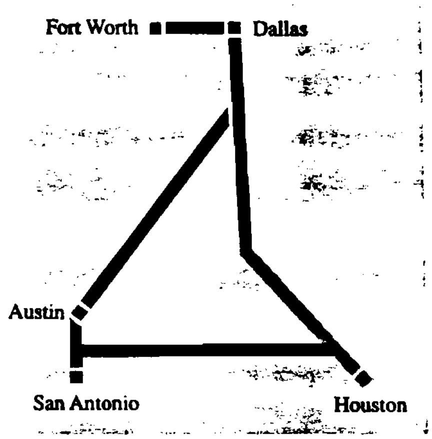
Source: Wilbur Smith Associates, Inc.

Figure IV-11
Stage 2



Source: Wilbur Smith Associates, Inc.

Figure IV-12
Stage 3



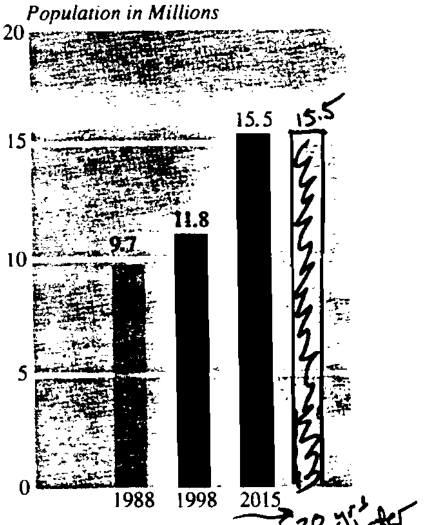
Source: Wilbur Smith Associates, Inc.

SECTION V
ALTERNATIVES TO CONSTRUCTING AN HSR SYSTEM

In 1988, the population of the four urbanized areas of Austin, Dallas/Fort Worth, Houston, and San Antonio totaled about 9,750,000. Within the next decade, this population is projected to increase by approximately 20 percent, to about 11,800,000 residents. By the year 2015, the population of the four urbanized areas is expected to be approximately 15,500,000 or almost 60 percent greater than today (see **Figure V-1**). Inter-city travel between these metropolitan areas amounted to approximately 19 million trips in 1988. By 1998, it is projected to increase to 30 million annual trips and to 60 million by year 2015 (see **Figure V-2**). Trip increases of 50 percent in the next decade and a further doubling by 2015 will require considerable expansion of the State's transportation network to safely and adequately serve the traveling public.

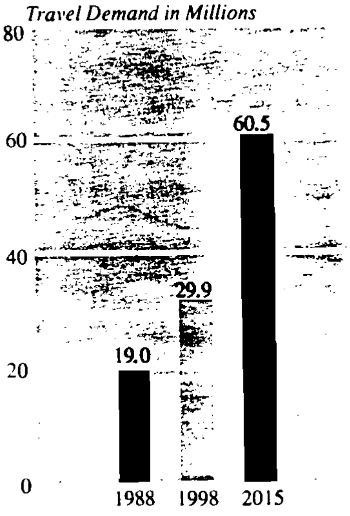
Inter-city travel between these metropolitan areas amounted to approximately 19 million trips in 1988. By 1998, it is projected to increase to 30 million annual trips and to 60 million by year 2015.

Figure V-1
Total Population



Source: M. Ray Perryman Consultants, Inc.

Figure V-2
Inter - City Travel Demand



Source: Wilbur Smith Associates, Inc.

Texas' economy and lifestyle are dependent upon mobility. The major cities each have unique characteristics which make them attractive areas in which to work and reside. They are, however, being drawn ever closer together by their economies which are becoming more dependent upon each other. Industries or goods in one city are economically linked to markets in other cities. These economic ties are discussed in greater detail in **Section X**. The cultural and recreational attractions offered by each city further strengthen the ties between them, as do friends and families. As these inter-city dependencies increase, so will the need for expanded transportation systems to serve growing travel demands.

A. IMPACT ON THE AIRLINE SYSTEM

The State's airport system and airline industry are being challenged to serve today's volume of travelers who seek a faster, more convenient alternative to driving a personal automobile between Triangle cities. The reduced highway speed limits and advent of smaller automobiles have made highway driving less attractive than it once was. The accelerated pace of business has also contributed to the increased volume of air travelers. The airline industry has responded with larger, faster airplanes and attractive cost-saving air fares. However, the burden of increased patronage has created problems, many of which are becoming more pervasive:

- Airline Safety - The increased number of flights to serve more passengers has placed a greater burden on air traffic control personnel and facilities. In addition, the major air terminals have had to periodically expand their facilities (runways, gate areas, etc.) to accommodate this increased patronage. With more and more flights arriving and departing, questions are being asked regarding the capability of airports to safely handle such increased airline traffic.

- Adherence to Schedules - The arrival and departure of increasing numbers of airliners, the inability of airports to routinely accommodate increased air traffic, inclement weather, and equipment malfunctions have all contributed to airlines being unable to consistently maintain published schedules. Some airports are subject to criticism from surrounding communities if flights that are scheduled to arrive earlier in the evening actually arrive much later, and either annoy nearby residents or awaken them late at night.

Increased passenger demands are challenging both the State's airport system and the airline industry to safely and efficiently meet travel needs.

- Inadequate Ground Facilities - Few major new airports have been constructed in the nation during the past several decades. In Texas, only Dallas/Fort Worth International and Houston Intercontinental have been developed. Houston Hobby, Dallas Love Field, Austin Robert Mueller, and San Antonio International have expanded their facilities in recent years; however, the burden of inter-city Texas flights appears to be increasingly directed to these facilities, rather than the two regional airports. Only Austin has embarked on a program to develop an entirely new facility to replace the over-burdened Robert Mueller airport serving the Capital City.

- Environmental Impacts - Both airports and airline operators are increasingly exposed to complaints by environmentalists and nearby residents that airliners are noisy, polluting intruders that portray a "poor neighbor" image.

In trying to accommodate the increase in passengers, the airline industry's resources have been strained. Many of today's airliners offer reduced seating space compared to that formerly furnished to passengers. Not all airlines serving Texas Triangle routes offer passengers the amenities, such as free cocktails or meal service, that made air travel attractive in earlier years. Airport terminals, gate areas, and planes are congested during peak periods, on weekends, and during holiday seasons. The airline industry and local airports are aware of these problems and are attempting to meet the challenge; however, it will take time and money to alleviate the problems. With the difficulties being faced by the airline industry today, the problems inherent in a doubling or tripling of passenger volumes in the next several decades poses an even greater challenge.

A related problem is increasingly congested access to many airports and the limited areas for drop-off or pick-up of passengers adjacent to terminals. Satisfying the demand for parking of automobiles is becoming more difficult and costly.

Highway capacity problems are becoming critical within the urban and suburban areas of the Triangle cities.

B. IMPACT ON THE STREET AND HIGHWAY SYSTEM

The major highways linking the Triangle cities presently have sufficient capacity in most rural areas to accommodate increased traffic volumes. The principal exception is IH 35 linking Austin and San Antonio, which is one of the most heavily traveled rural highways in the State. Planning is well advanced, however, to provide additional capacity within that corridor. Other rural highways in the Triangle generally have wide enough center medians to accommodate added lanes.

The urban and suburban areas of the Triangle cities are where capacity problems are becoming critical. The State Department of Highways and Public Transportation has embarked on a program to expand major facilities by: (l) developing High Occupancy Vehicle (HOV) lanes for buses, vanpools, and carpools; (2) assisting local transit authorities in expanding and modernizing public transit operations to provide an alternative to commuter driving; and (3) expanding existing freeways by adding more freeway lanes and/or modernizing traffic flow by instituting ramp-metering or other improvements to facilitate traffic flow. However, it appears that these improvements will, at best, only keep pace with the normal growth in transportation demand.

Local governments, unlike the State, have not had the resources to expand their street and road system. Most improvements to streets and roads are funded from local government's general fund accounts or bond issues. As a result, many local streets need capacity improvements, but they must compete for funds with other critical public service needs of the urban area.

C. IMPORTANCE OF THE HIGH SPEED RAIL SYSTEM

A high speed rail system would serve millions of trips that would, otherwise, impact air and surface transportation.

The development of a Texas HSR system could help to alleviate the increasing travel demand which would otherwise fall upon the State's airline industry, highway system, and local roads and streets. Constructing the HSR system would offer the following benefits in future years:

- Airline demand would be reduced by millions of annual trips that could be expected to use HSR in preference to air travel. A saving of local, state, and federal funds could be realized, due to a reduction in the need for expanded terminals, runways, gate areas, and parking. The airline industry could also avoid making sizeable investments in additional equipment and facilities to handle short distance travelers that could otherwise use HSR.

- Urban streets, roads, and highways would also benefit, since a portion of travel demand could be accommodated on HSR.

Constructing a high speed rail system would require a large expenditure of funds - both public and private. However, through revenues generated by fares and other services, the public's investment could be returned, in time, by the retirement of bonds and repayment of governmental advances expended in its development. Once the loans and bonds have been repaid, HSR would be a self-sustaining transportation mode, paid for by users, that would add to the State's total transportation system and offer travelers an alternative they do not presently enjoy.

D. CONCLUSIONS

If a Texas high speed rail system is not developed, the alternative is to serve Texas' growing travel demand on existing transportation systems, i.e., by air and highway modes. These systems, which are already approaching capacity, will be further burdened by future increases in trip demand between the Texas Triangle cities. Requiring the present modes to absorb these volumes of travelers will necessitate considerable expansion of their capabilities at a substantial cost to the public and private sector.

SECTION VI
ROUTES

An almost unlimited number of potential routes for high speed rail exist between the Texas Triangle cities. Forty-one individual segments of eight different railroads presently provide freight rail service between the five cities. Seven major highways and many lesser highway routes directly connect the cities. In addition, numerous high-voltage transmission line rights-of-way exist within the Texas Triangle.

The system configurations of routes considered in this study were of a preliminary nature and were developed for purposes of preparing order of magnitude estimates of construction, operation, and maintenance costs. All alignments must be considered and evaluated in greater detail prior to final selection of the desirable system configuration.

A. DESIGN ASSUMPTIONS

In order to develop comparative order of magnitude estimates of construction costs, the following basic assumptions were made:

1. Horizontal Alignment Criteria

It was assumed the horizontal alignment criteria would be as required for VHS (125-200 mph) service. Curves for the VHS alignment would require minimum radii of 13,000 feet. The selection of this criteria was made since it is applicable to both HS (80-125 mph) and UHS (Mag-lev) operations.

2. Double-Track Dedicated System

Ridership projections indicate the frequency of HSR service on all lines would require a double-track system. Operations and safety problems in combining 45-60 mph freight service with 185 mph HSR service preclude the joint use of existing tracks by both freight and high speed passenger rail service.

3. System Configuration

It was assumed the HSR system would ultimately serve all cities in the Triangle, rather than any "stand alone" corridor. For example, a route between Houston and Dallas, on a stand alone basis, would logically locate the alignment near Interstate Highway 45 to provide the shortest route possible between these cities. However, when considering HSR on a "system" basis, the optimum configuration would be to arrange the routes in order to reduce system track mileage while not sacrificing trip travel times. In this way, capital, operational and maintenance costs for the system would be optimized. Principal passenger terminals in all five Triangle cities would be located within or in close proximity to central business districts.

B. HIGHWAY ROUTES

The configuration of the Texas Triangle is encompassed by major arterial highway routes consisting of IH 10, IH 30, IH 35, and IH 45, and State Highway 71 (see **Figure VI-1**). All these highways are freeways except SH 71, which is, or will be, a freeway in certain urban areas and a divided multi-lane highway within rural areas. Although highways appear to offer logical opportunities for joint use of existing right-of-way, the differences in design standards for highways, as compared to HSR facilities, are substantial. High speeds associated with HSR require substantially flatter horizontal and vertical alignments than exist on most highways or freeways.

The use of existing highway medians for HSR is not practical.

A minimum median width of approximately 70 feet would be required to accommodate the HSR lines, a dimension which most highways do not offer (see **Figure VI-2**). Locating HSR in outer separations or adjacent utility areas would interfere with ramps and access driveways. In addition, the existence of center piers in medians at most highway underpasses would require considerable reconstruction to provide the required clearance envelope for the rail system.

The use of existing highway medians is impractical for high speed rail operations and was not considered an acceptable alternative.

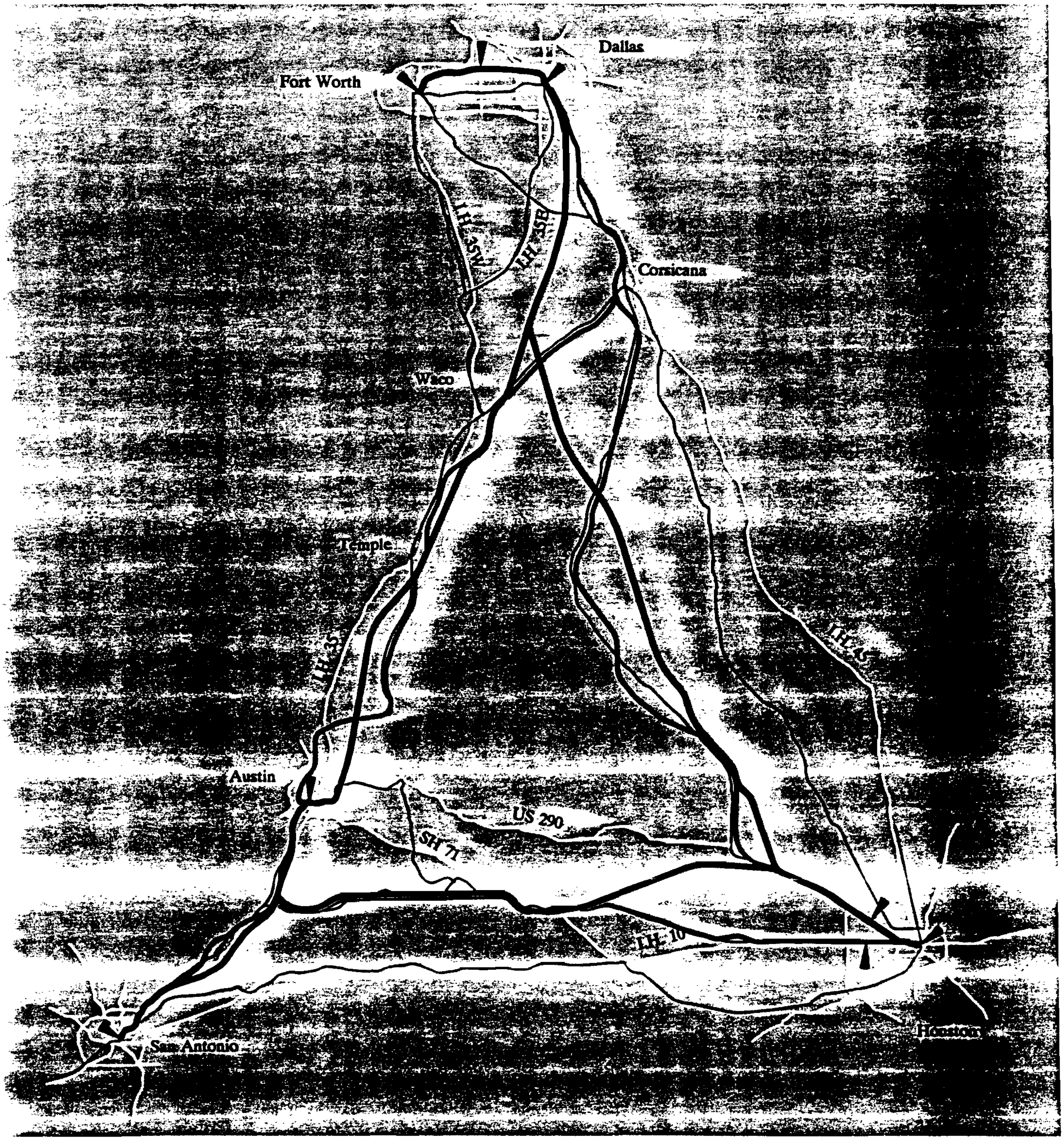
C. REPRESENTATIONAL ROUTES

Two system configurations were analyzed - existing rail corridor alignments and new, independent alignments.

Two representational routes concepts were developed. Both concepts would accommodate **HS**, **VHS**, and **UHS** technology.

In the first concept, the route would parallel existing freight line tracks, to the maximum extent possible. The alignments in rural areas would provide for a double main line track, designed to accommodate maximum operating speeds of **HS**, **VHS**, and **UHS** technology. A minimum right-of-way of 50 feet and a desirable width of 100 feet would be provided with the right-of-way fully fenced and grade separated. This concept is referred to as **Representational Route - Existing Alignment**. Within urban areas, where operating speeds would be restricted to 45 to 60 mph, maximum utilization would be made of existing rail corridors.

The second concept would locate the tracks on a new, independent, and fully grade separated alignment in rural areas. A right-of-way width of 100 feet would be provided, except in urban areas where right-of-way could be within the corridors of existing rail facilities. This route is referred to as **Representational Route - Independent Alignment**.



▬ Existing Highways

▬ Existing Railroads

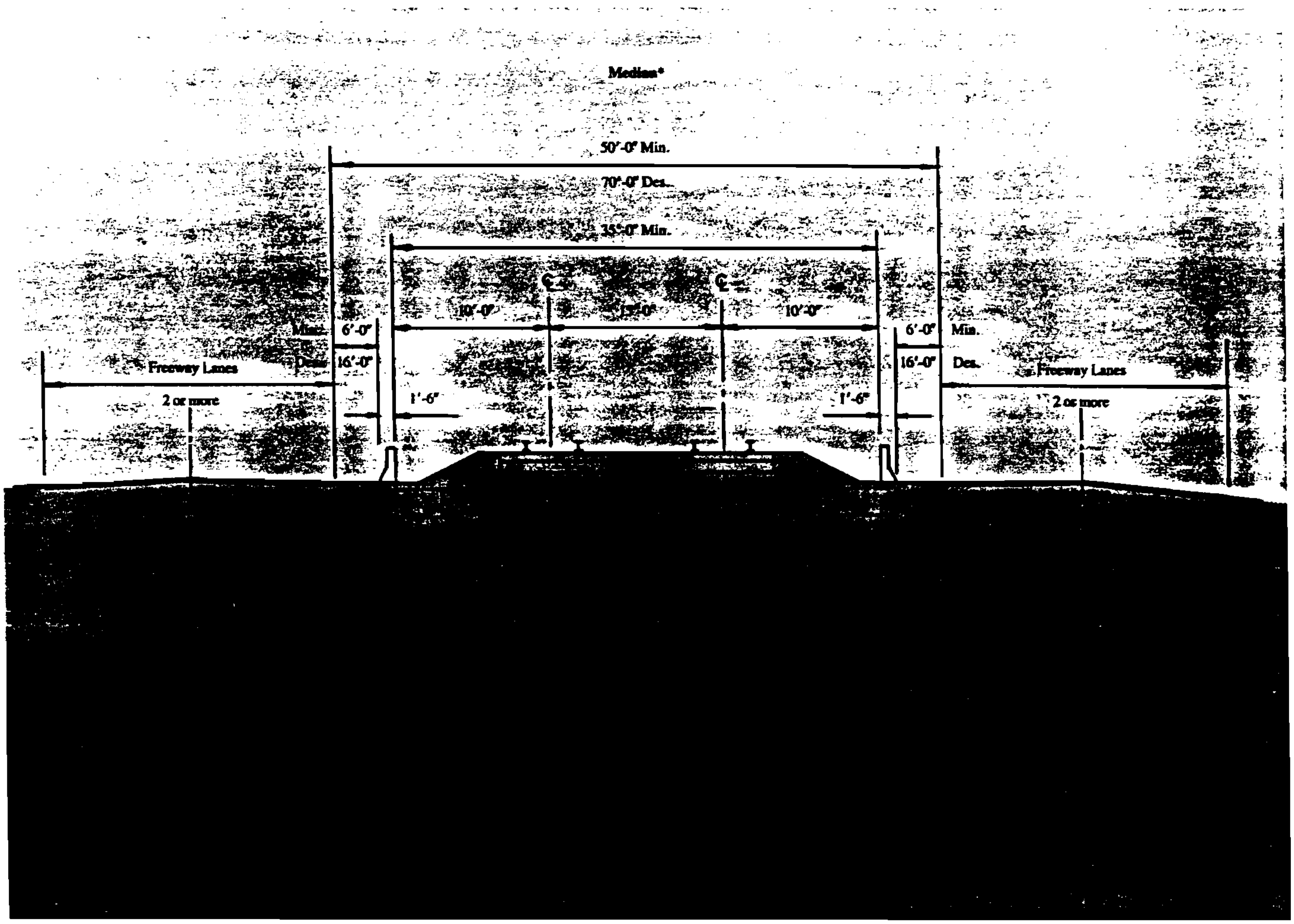
▬ HSR Existing Rail Alignment

▬ HSR Independent Alignment

▶ ▶ HSR Stations

Figure VI-1
Existing and New Alignment

Source: Lichliter/Jameson & Associates, Inc.



Source: Lichliter/Jameson & Associates, Inc.

Figure VI-2
Minimum Median Requirements for HSR

1. Representational Route - Existing Alignment

The study team analyzed different combinations of the existing railroad segments. An evaluation system was developed which compared each combination of segments against other combinations by "weighting" certain major indicators common to each route. The indicators included:

- Route length
- Alignment (curvature)
- Number and type of road and water crossings
- Availability of electrical power (number of transmission line crossings)
- Length of the route in double track
- Existing freight traffic
- Available right-of-way
- Railroad companies' position regarding joint use of right-of-way

Values for all factors were determined for each alternative route. The routes selected for detailed analysis for each leg of the triangle were the ones which achieved the highest score in the weighting process.

Previous studies, including those by the German High Speed Consortium, have assumed joint use of existing railroad right-of-way. Most of the existing railroad rights-of-way in rural areas have an overall width of about 100 feet which could provide adequate space for two dedicated high speed rail lines, plus a single-track freight line. To accommodate HSR rail lines, the existing freight lines, which are generally located on the right-of-way centerline, could be relocated to one side of the right-of-way. Because of the necessity of providing uninterrupted freight service, this relocation would essentially require the construction of a new freight line while maintaining service on the existing line. The double track HSR lines would then be constructed adjacent to the new relocated freight line.

The route configuration shown on **Figure VI-1** would make maximum utilization of the existing railroad rights-of-way within the Texas Triangle. The existing rail alignments were revised to flatten all horizontal curvatures, grade separate, or close all existing highways/local road crossings and provide bypasses for all en-route communities where no stops were planned. The right-of-way would be completely fenced and exclusive tracks would be provided for HSR operation. The existing alignment routing between the Triangle cities is generally described as follows:

- **Dallas - Fort Worth** - This route would be on the former Chicago, Rock Island and Pacific Railroad (Rock Island) now owned by RAILTRAN. Freight trains of the Missouri, Kansas, and Texas (MKT) and Burlington Northern (BN) operate over this alignment through agreement with RAILTRAN. No bypasses would be anticipated within any en-route cities.

- **Dallas - Houston** - This route would essentially follow the Southern Pacific (SP) railroad right-of-way from Dallas to Houston. Bypasses would be provided at Ennis, Corsicana, Mexia, Hearne, Bryan, College Station, Navasota, and Hempstead. Amtrak service currently operates over this line. In Houston, the alignment would continue along the SP to the entrance of the central business district. An optional alignment in Houston would be along the MKT right-of-way from inside the IH 610 Loop to the central business district.

- **Dallas - Austin - San Antonio** - From Dallas to Corsicana, the alignment would be along the SP right-of-way and common with the Dallas-Houston alignment. South of Corsicana, the alignment would follow the St. Louis Southwestern Railway (Cotton Belt) right-of-way bypassing Hubbard. The alignment would bypass Waco and generally follow the MKT right-of-way to Taylor, bypassing Temple. At Taylor, it would follow the Missouri Pacific (MP) to Round Rock, through Austin, to San Marcos. From San Marcos to San Antonio, the alignment would generally follow the MKT railroad.

- **Houston - Austin - San Antonio** - Although previous studies have indicated utilization of the Southern Pacific (SP) line (currently used by Amtrak) as the southern leg of the triangle, it was determined that both the Houston -San Antonio and the Houston - Austin services could be provided by a single alignment between Houston and San Marcos. Use of this common alignment would substantially reduce costs. Direct service would be provided between Houston and Austin, as well as Houston and San Antonio, with no stops or transfers at San Marcos. The alignment would follow the MKT right-of-way from the IH 610 Loop in Houston to San Marcos. Bypasses would be provided at Sealy, Fayetteville, LaGrange, Smithville, and Lockhart. The availability of right-of-way parallel to IH 10 in Houston is questionable due to the State Department of Highways and Public Transportation's plans for the ultimate widening of IH 10 in that area.

Concerns in the joint use of existing railroad rights-of-way are:

a. Track Alignment

The existing alignments of freight lines were designed for low to moderate rail speeds with minimum horizontal radii of about 2,000 feet. A high speed rail line would require minimum horizontal radius of at least 13,000 feet. For example, the Southern Pacific line between Dallas and Houston would require realignment of approximately 50 percent of its total length. In urban areas, where operating speeds would vary between 45 and 60 mph and where new right-of-way costs would be costly, the use of existing rail right-of-way is an appropriate consideration.

b. Safety

The potential derailment of freight trains operating in close proximity, on parallel tracks, would be a continuous safety concern. This concern would be magnified by the potential derailment of rail cars transporting hazardous materials.

c. Construction Costs

Sharing the right-of-way with an existing freight line would result in some additional construction cost. Since it would probably be necessary to provide uninterrupted freight service, a major element of cost would entail construction of a new, parallel freight line within the existing right-of-way. Additional cost would also be required to minimize signals from the effects of electrification, new bridges, and the extension of drainage structures. Since the HSR would be fully grade separated, it may also be necessary to grade separate the freight line tracks, which would add considerable cost since the overhead clearance for the freight line would be 23'6" versus 16'6" for the HSR line.

d. Right-of-Way Costs

The principal advantage assumed in the use of existing railroad rights-of-way is that a continuous piece of land is available and could either be acquired or that joint use operating agreements could be negotiated with the railroad owners at a reasonable cost and within reasonable time frames. Another perceived advantage would be that locating an HSR facility in an existing railroad right-of-way would be more amenable from an environmental standpoint and would have less social impact than one constructed entirely on new alignment. Right-of-way costs would include the cost of new right-of-way necessary in areas where the horizontal curvature would need straightening or areas where bypasses would be constructed around high density communities. Additional cost would also be incurred for purchasing or leasing right-of-way from the existing operating railroad company.

2. Representational Route - Independent Alignment

This alternative was developed after it was determined that any alignment along an existing rail line would still require a substantial amount of new right-of-way in addition to that required from existing operating railroads. The principal objective in developing an alignment, fully independent of existing rail lines, would be a more direct route designed for the exclusive use of HSR technology. The new alignment plan would provide for double-tracks on a 100-foot right-of-way. All highways and intersecting roads/streets would be grade separated. Provisions would be made in the alignment to minimize severance of properties.

Several opportunities exist where the HSR could share rights-of-way with electric power transmission lines. A more detailed analysis should be made, during the conceptual engineering phase, of the feasibility of utilizing existing power transmission lines or major cross-county pipeline rights-of-way. This analysis should also consider the optimum size of the Triangle to increase the lengths of "common" corridor track. The plan must address the positive effect of lower initial construction while balancing the negative effect of increasing travel time within the respective corridors.

In addition to the cost advantage and the utilization of common infrastructure, provisions can be made for the ultimate accommodation of UHS (Mag-lev) equipment at such time as UHS technology becomes operationally and economically feasible.

The independent routes shown in **Figure VI-1** are described as follows:

- **Fort Worth - Dallas** - Existing RAILTRAN alignment with suburban stop midway south of the Dallas/Fort Worth International Airport.

- **Dallas - Houston** - From Union Station in Dallas along the SP alignment to the MKT Railroad, then south along the MKT line to IH 20, then south passing east of Lancaster, west of Bardwell Lake and Navarro Mills Lake to a junction with the Dallas - Austin route in the vicinity of Penelope. From the junction, south - southwest passing west of Kosse and east of Hearne, Bryan-College Station and Navasota to a junction with SP alignment in the vicinity of Hockley. From Hockley following the SP alignment along the same route described as the existing alignment.

- **San Antonio - Houston** - From the downtown station, north along the SP alignment to its intersection with the MKT alignment near IH 35; then north along the MKT alignment, west of IH 35, to the vicinity of FM 3009 where it would cross IH 35. The alignment would pass east of New Braunfels and San Marcos to the junction with the Austin-Houston route east of San Marcos. From the San Marcos junction it would turn east, passing north of Lockhart, south of Smithville, and bypass LaGrange and Fayetteville. East of Fayetteville, it would turn northeast and pass north of Bellville before turning east and joining the Dallas - Houston route at Hockley. From Hockley to downtown Houston, the route would be common with the Dallas - Houston route.

- **Austin - Houston** - From the downtown Austin station, the alignment would follow the MP alignment south, to north of Buda, before crossing east of IH 35 and joining the San Antonio - Houston route at the San Marcos junction. From San Marcos to downtown Houston, the route would be common with the Houston - San Antonio route.

- **Dallas - Austin** - From Dallas to the Penelope junction, the route would be common with the Dallas - Houston route. From this junction it would turn southwest, bypass Waco and Temple, and pass west of Holland, Barlett, and Taylor before joining the SP alignment west of Walter E. Long Lake, and then following the SP alignment to the downtown Austin station.

The independent alignments would follow existing railroad alignments within the urban areas with entry points into the metropolitan areas having significant influence on the selection of routes. For example, in the Houston area, the available entry routes are the MKT on the west along IH 10, the SP in the northwest along US 290, and the BN and MP on the north side. Since the cost in the urban areas would be significantly higher, the use of common routes was examined. Based on this principle, the SP alignment was chosen as the most logical entry into Houston. This location provides for a good entry for the Dallas - Houston route without compromising the San Antonio - Houston route.

3. Route Comparisons

In a comparison of the two types of system configuration (existing versus independent) considered for the Texas high speed rail system, the advantages of independent alignment become evident:

ALIGNMENT	Texas Triangle Total Track Mileage	1988 Estimated Cost Construction & R.O.W.
Existing	686 miles	$5,104,695,000
Independent	618 miles	$4,392,600,000

The considerable difference in estimated costs for the use of existing alignment as compared to the independent alignment indicates that the majority of the high speed rail system should be constructed on exclusive new alignment dedicated to HSR service. The one exception would be between Dallas and Fort Worth where the existing RAILTRAN trackage (formerly the Chicago, Rock Island, and Pacific Railroad) would be used. Within the urban areas, where operating speeds would be restricted to 45 to 60 mph, maximum utilization would be made of existing rail corridors.

D. RAIL STATIONS

A fundamental assumption was HSR service would be provided directly to the Central Business Districts (CBD's) of all study cities. Since the travel surveys indicated high origin and destination demands midway between Fort Worth and Dallas and in west Houston, suburban stations were included in those areas. The stations selected are described as follows:

1. Austin

The present Amtrak station, on the western edge of the CBD (see **Figure VI-3**), was selected as the potential station site for the Austin urbanized area. It is located west of Lamar Boulevard, north of First Street (north of the Colorado River). This location is accessible from all directions and is approximately midway between IH 35, on the east of the CBD, and Loop 1 (Mopac), to the west of the City.

2. Dallas

The station site selected for the Dallas central business district (see **Figure VI-4**) would be the Union Terminal on the south side of the CBD. The terminal presently serves Amtrak, which could provide interface between Amtrak and the HSR system.

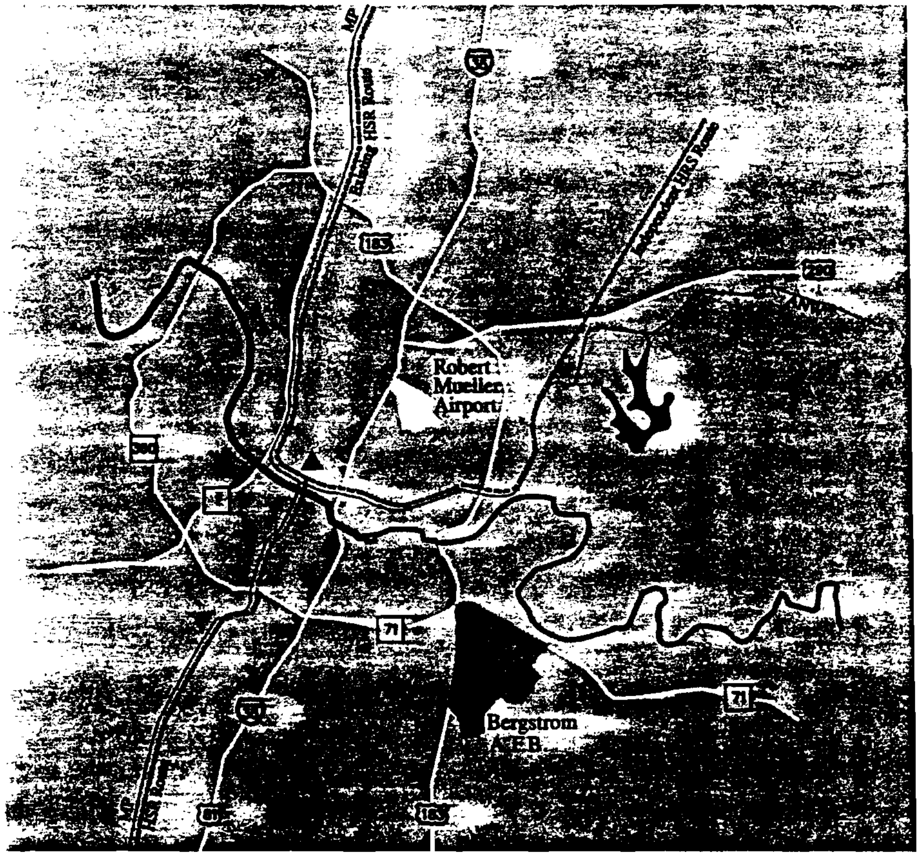
3. Fort Worth

The potential site selected for the Fort Worth station (see **Figure VI-4**) is the existing Union Station now in use by Amtrak. It is located on the southeastern edge of the CBD.

4. Dallas/Fort Worth - Mid-Cities Suburban Station

A suburban station in the highly developed area between Dallas and Fort Worth could be provided. This station would be located near State Highway 360 and would provide access to and from the cities of Arlington, Irving, and the Dallas/Fort Worth International Airport. There is adequate land available within the area to provide for parking with potential opportunities for joint commercial/retail development (see **Figure VI-4**).

Figure VI-3



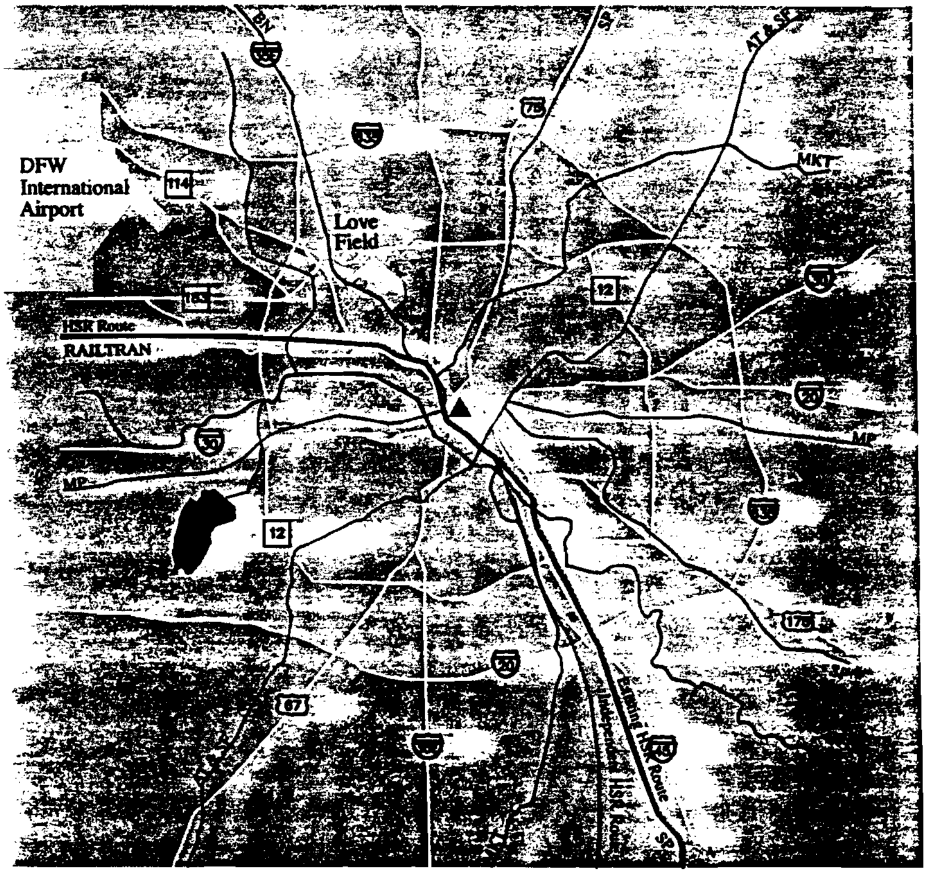
Austin

═ Road System
▬ Railroads
▬ River/Lakes
▬ HSR Route
▬ Military
▲ HSR Station

San Antonio

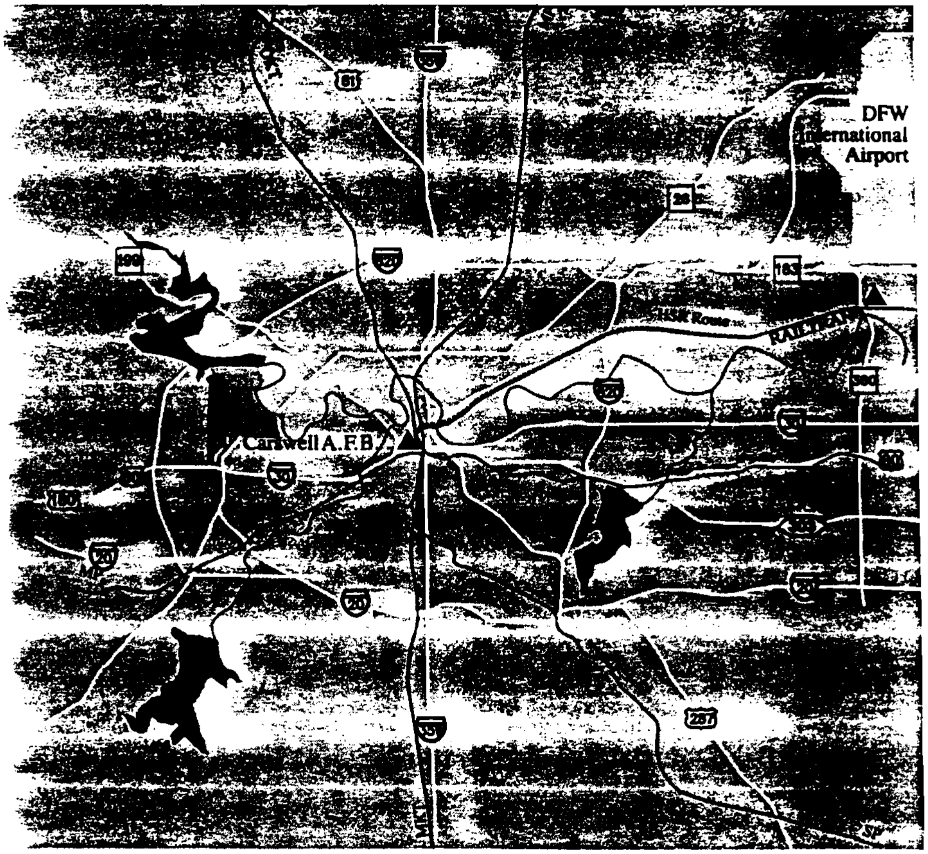
═ Road System
▬ Railroads
▬ River/Lakes
▬ HSR Route
▬ Military
▲ HSR Station

Figure VI-4



Dallas

═ Road System
▬ Railroads
▬ River/Lakes
▬ HSR Route
▲ HSR Station



Fort Worth

═ Road System
▬ Railroads
▬ River/Lakes
▬ HSR Route
▬ Military
▲ HSR Station

5. Houston

Four potential sites for the Houston Central Business District passenger terminal were identified, (see **Figure VI-5**). Other sites might be considered depending upon the final inter-city route established during the conceptual engineering stage. Connections to the CBD terminal sites could be by utilization of either the Southern Pacific or MKT rights-of-way. It is expected that the recent merger of the Union Pacific with the MKT may make the MKT right-of-way available, including the Eureka yard. Indications are the State Department of Highways and Public Transportation (SDHPT) may acquire the MKT right-of-way within the IH 610 Loop for a future roadway or for public transit purposes. Each of the potential terminal sites would have provisions for parking, car rentals, and concessions. The extent of parking and space available for commercial development would vary for each of the proposed locations.

Direct access to a terminal via the proposed "Metro System Connector" would be an asset that may help alleviate parking requirements and vehicular congestion within the terminal areas.

The four Houston sites considered were:

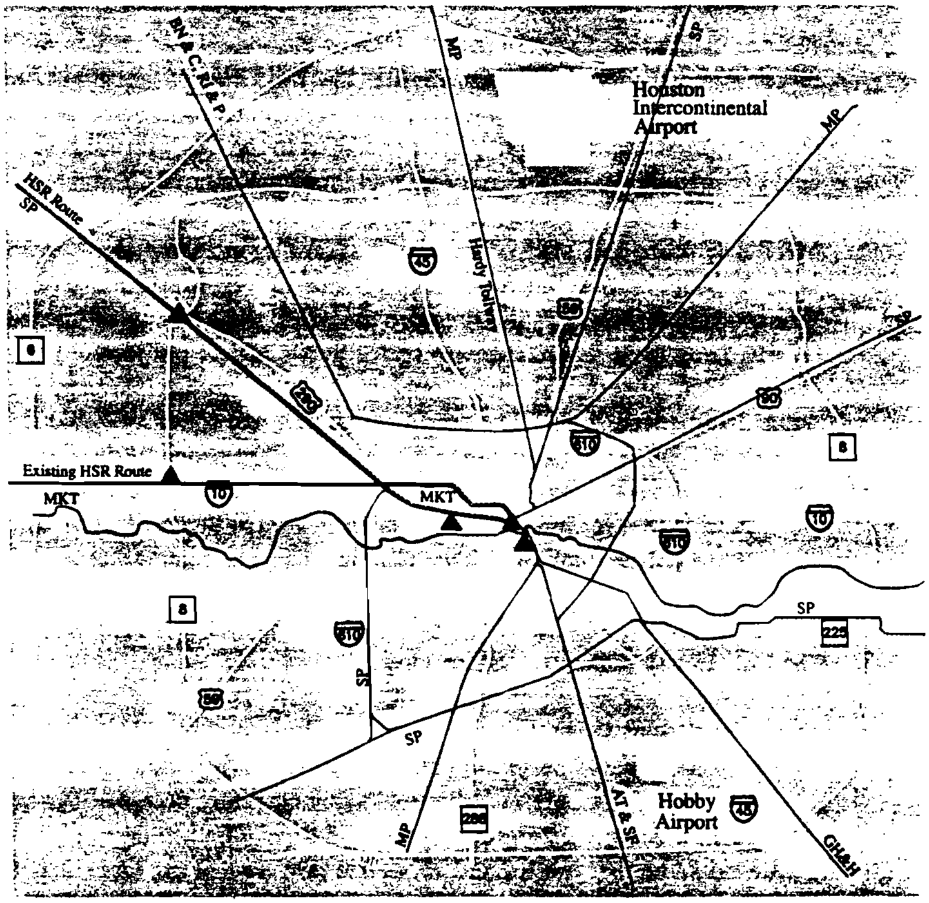
a. Memorial Drive

This station would be located near Memorial Drive and Studemont. The site covers an area of about 40 acres currently occupied by the American Rice, Inc., elevators. The principal disadvantages of this site would be that it is located about one mile west of the CBD, is not convenient to public transportation, and has difficult rail access via the high traffic density Southern Pacific rail lines. The principal advantages of this site is the large available area would provide adequate parking and some excellent opportunities for a joint development project. Rail access to the site would be by way of Southern Pacific right-of-way. This station site was also identified in the German High Speed Consortium's studies.

b. Union Station

The seven acre former Union Station site is located at the relatively lightly developed eastern edge of the CBD. It would be convenient to the George R. Brown Convention Center and would have relatively good access to the freeway system. The principal disadvantages to this location is the difficult and time consuming rail access and inaccessibility to public transportation.

Figure VI-5



Houston

┄ Road System

▬ Railroads

▬ River/Lakes

▬ HSR Route

▲ HSR Station

c. North Main Street

This station site is located on North Main Street, near the University of Houston downtown campus, immediately north of White Oak Bayou and IH 10. This site would be the most convenient location to the CBD. The "Metro System Connector" plans provide for a terminal at this location which could provide direct access between public transportation and the HSR. Rail access to the site would be by way of the MKT right-of-way. This site could ultimately become a consolidated rail terminal for HSR, Metro, and Amtrak rail service.

d. Amtrak Station

The existing Amtrak station, located on the Southern Pacific between IH 45 and Houston Avenue, would be relatively convenient to the CBD. This site would permit direct transfer between Amtrak trains and the HSR. The principal disadvantages of this location would be its lack of convenience to public transportation and roadway access.

6. Houston Suburban Station

Since the traffic studies indicate a heavy demand for service in west Houston, a suburban station was located near the junction of the Southern Pacific tracks and the Sam Houston Toll Road in northwest Houston (see **Figure VI-5**). This location provides exceptionally good access between all areas of West Houston and the HSR. The suburban stations could provide for a relatively large parking area and could offer excellent opportunities for joint commercial/retail/office development.

7. San Antonio

The potential station site in San Antonio would be located east of the CBD, near the intersection of IH 37 and Commerce Street, **Figure VI-3**. This site is the existing Amtrak station which formerly served Southern Pacific passenger trains.

Additional station location analyses will be required to establish the best locations of stations, design features, construction costs, and the degree of public/private participation that could be attainable.

E. CONCLUSIONS

The system configuration should be substantially based on new, independent right-of-way, designed for the exclusive use of high speed passenger rail service. The double-track system should be grade separated and fenced. Within urban areas and between Fort Worth and Dallas, maximum utilization would be made of existing rail corridors. Existing Amtrak train stations in four of the five cities could also service HSR. In Houston, four possible sites were identified as candidate locations. In addition to the CBD stations, two suburban stations were proposed: one mid-way between Fort Worth and Dallas; and the other in northwest Houston.

SECTION VII
SYSTEM OPERATIONS

The principal factors in a successful high speed rail operation are travel time between origin and destination, passenger comfort, and frequency of service. The convenience of the passenger terminals located in high density areas will shorten the travel time for HSR passengers. Train sets (number of cars) would be adjusted to provide comfortable seating for all passengers in modern, spacious, and well-designed coaches. Restaurant/lounge cars with telephone and television amenities would be provided on all train sets. Train service would be provided for 16 hours per day from 6:00 a.m. to 10:00 p.m., with increased frequency at peak hours to meet passenger demands. Track maintenance and inspection would be provided on a daily basis from midnight to 6:00 a.m. to assure continuous, uninterrupted service during the normal operating hours.

A. RAIL OPERATIONS

For purposes of train scheduling and fleet sizing, the travel demand volumes shown in **Tables IV-14** and **IV-15** were reduced to average daily traffic and then divided evenly by direction for each route. Each leg of the Triangle was evaluated on a "stand-alone" basis, i.e., examined as if each leg of the Triangle was an independent system. In the fleet calculations, the rolling stock requirements for the southern leg included the ridership of Houston to Austin and Houston to San Antonio. In the "stand-alone" scenario, fleet calculations were made for all three technologies (HS, VHS, and UHS). Only the VHS is presented herein. HS and UHS fleet calculations are shown in **Appendix D.**

The fleet for the Triangle was also determined as a system considering a staged implementation approach using VHS technology. The staging assumed the eastern leg of the Triangle would be constructed first, followed in consecutive order by the southern leg and the western leg.

1. Travel Times

Trip simulation diagrams were developed which included speed restrictions in urban areas. The segment between Fort Worth and Dallas, and for a distance 12 miles south of Dallas, was assumed to have a 60 mph speed limit. In the Houston area, a 60 mph limit was assumed for 14 miles northwest of Houston, to the suburban station, and 19 miles west of Houston, to the northwest suburban station. In the San Antonio area, a 60 mph speed limit was assumed from the CBD station, northeast, a distance of 18 miles. At the San Marcos junction, 60 mph speed limits were assumed for one mile south of San Marcos to six miles north of San Marcos, along the western Triangle leg. On the southern Triangle leg, a 60 mph speed limit was assumed from the San Marcos junction to three miles east. In Austin, a 60 mph speed limit was assumed from the CBD to nine miles south and from the CBD to 20 miles north.

Travel times were developed between origin and destination pair cities using a computer model which considered the maximum speed of the technology, acceleration, and deceleration limits (based on the technology or passenger comfort as applicable). The travel times for VHS Technology are shown in **Table VII-1**.

TABLE VII-1

One Way Trip Time, VHS Technology (Hrs:Min)

	Independent Alignment	**Existing Rail Alignment**
Fort Worth - Dallas	0:38	0:38
Dallas - Houston	1:48	1:53
Dallas - Austin	1:31	1:43
Austin - San Antonio	0:57	0:55
Austin - Houston	1:38	1:41
San Antonio - Houston	1:49	1:48
Fort Worth - Houston	2:29	2:34
Forth Worth - San Antonio	3:12	3:22
Dallas - San Antonio	2:31	2:41

Source: Morrison-Knudsen Engineers, Inc. &
Lichliter/Jameson & Associates, Inc.

Table VII-2 shows dwell times that were assumed at intermediate station stops. The trip times for various routes and route segments shown in **Table VII-1** include theoretical run time, plus recovery time between stations, plus the dwell times at any intermediate station stops.

TABLE VII-2

Dwell Times

Dallas	3 Minutes
Austin	3 Minutes
Mid City (DFW)	1 Minute
Houston Beltway	1 Minute

Source: Morrison-Knudsen Engineers, Inc.

2. Operating Criteria

The estimated ridership demand considered convenience of access, travel times, departure times, and frequency of service in comparison to other competing modes of transportation, most notably air travel. For such service to be comparable to air travel, the following operating criteria was established:

- Operating day: 16 hours (6:00 a.m. to 10:00 p.m.)
- Peak hours: 6:00 a.m. to 9:00 a.m.
  4:00 p.m. to 7:00 p.m.
- Train frequencies:

Time of Day	Route 1*	Routes 2 and 3*
Peak	30 minute	1 hour
Off-peak	1 hour	2 hours

- Turnaround time: 45 minute desirable
- Load factor (percent of train capacity): 60 percent

* Route 1 is Fort Worth - Dallas - Houston
* Route 2 is Houston - San Antonio - Austin
* Route 3 is San Antonio - Austin - Dallas - Fort Worth

The load factor represents the average demand-to-capacity upon which train schedules and fleet size (numbers and sizes of trains) were established. This figure was set below capacity to provide a margin for seasonal and other peak period travel. The figure of 60 percent was used since it is comparable to overall airline industry experience and that of the TGV Sud Est line in France (about 10 years' experience).

With anticipated growth in ridership, the initial fleet and schedules should be based on a lower load factor so that passengers would not be turned away (with consequent loss of revenue) due to lack of capacity in future years. To allow lead time in acquiring new passenger coaches, the scheduling analysis was based on the 60 percent load factor being achieved at five years from initiation of service. A second purchase of rolling stock was anticipated (to be acquired in 2008) to augment the fleet sufficiently to achieve the desired 60 percent load factor by the year 2015.

a. Train Schedules and Fleet Sizes

Scheduling charts (known as "string-line" graphs) were developed for the **VHS** technology between cities on all legs of the Triangle. These charts enabled the designer to "track" each train as it departed either terminal at frequencies established in the operating criteria. (The last train in each direction would arrive about one-half hour after the end of the assumed 16-hour day.) In the study analysis, all trains were assumed to depart their origins on the hour or half hour. String-line graphs were used to determine rolling stock requirements and movements and were developed for each target year, 1998 and 2015, and each technology.

Train sizes (i.e., required numbers of passenger coaches) were calculated on the basis of coach capacity, load factor, and peak hour demand. An average number of 60 passengers per coach was used for **HS** and **VHS** speed categories and 90 passengers per coach for **UHS**. It was necessary to establish a train size for each route based on the maximum demand. Some rationalization of the numbers was used to optimize the fleet sizes and to standardize on the number of train sizes. The legs of the Triangle were designated as Routes 1, 2, and 3. These route designations, shown in **Table VII-3**, show the train sizes for the **VHS** technology selected for each of the fleets in 1998 and 2015. Fleet determinations for **HS** and **UHS** technologies are shown in **Appendix D.**

HS and **VHS** trains were assumed to have two locomotives per consist for trains of five or more cars. Trains of four cars or less would have one locomotive. Every train is assumed to have a restaurant/lounge car in the consist. Maximum train consist for **HS** and **VHS** was assumed to be two locomotives and 10 trailing cars, including a restaurant car. For **UHS**, a maximum consist of six cars was assumed with at least one combination coach/restaurant car in each train.

On Route 1 (Fort Worth - Dallas - Houston), it was determined that 21 trains in each direction would be required (six in the morning peak, six in the evening peak, seven during mid-day service, and two at night, with the 9:00 a.m. and 7:00 p.m. departures considered off-peak trains). Seven train sets would be required at each terminal overnight to provide the service (the 6:00 a.m. train from one of the terminals would arrive less than one-half hour before the departure of the 9:00 a.m. train from the other terminal, so there would not be enough time to use the same train on the return run). During non-peak periods, up to five train sets would be stored at the terminals.

Route 2 would actually consist of two separate operating routes over a common track (Houston - San Antonio and Houston - Austin). Train sizes and fleet requirements were calculated for each operating route independent of the other.

Table VII-4 summarizes the numbers of active train sets and the total rolling stock requirements for the VHS technology (see **Appendix D** for **HS** and **UHS**). Spare units were included to account for rolling stock which would be out of service for routine service, maintenance, and unscheduled major repairs.

Table VII-3

Rolling Stock Fleet Determinations - Stand-Alone Scenarios - VHS Technology

1998

Route	City Pairs	No. of Peak One-Way Trains	Car* per Train
1	Fort Worth - Dallas - Houston	21	8
2	Houston - San Antonio - Austin	36	6
3	Fort Worth - Dallas - San Antonio	11	9

2015

Route	City Pairs	No. of Peak One-Way Trains	Car* per Train
1	Fort Worth - Dallas - Houston	34	10
2	Houston - San Antonio - Austin	45	9
3	Fort Worth - Dallas - San Antonio	22	10

* Includes restaurant car.

Source: Morris-Knudsen Engineers, Inc.

TABLE VII-4

Rolling Stock Fleet Requirements, Stand-Alone Scenarios, VHS Technology

1998

Route	Sets	Locomotives	Coaches	Restaurants
1	17	34	119	17
2	19	38	95	19
3	10	20	80	10

2015

Route	Sets	Locomotives	Coaches	Restaurants
1	23	46	207	23
2	19	38	152	19
3	17	34	153	17

Requirements include spares for ready reserve and scheduled repairs.

Source: Morrison-Knudsen Engineers, Inc.

The following sets forth the basis for estimation of spare train units:

- Routine Service and Maintenance: 10 percent of active train sets, rounded up to the next integer.

- Unscheduled Repair: One complete train set for each route.

Table VII-5 shows the rolling stock determinations and requirements for the VHS technology staging scenario. In this case, there was no duplication in system facilities or ridership. The totals represent the rolling stock for the Triangle as an integrated system.

TABLE VII-5

Rolling Stock Fleet Determinations, Staging Scenarios, VHS Technology

1998

Route	City Pairs	No. of Peak One-Way Trains	Car* per Train
1	Fort Worth - Dallas - Houston	21	8
2	Houston - San Antonio - Austin	36	6
3	San Antonio - Austin - Dallas - Fort Worth	11	7

2015

Route	City Pairs	No. of Peak One-Way Trains	Car* per Train
1	Fort Worth - Dallas - Houston	34	10
2	Houston - San Antonio - Austin	45	9
3	San Antonio - Austin - Dallas - Fort Worth	15	9

1998

Route	Sets	Locomotives	Coaches	Restaurants
1	17	34	119	17
2	19	38	95	19
3	10	20	60	10
Total	46	92	274	46

2015

Route	Sets	Locomotives	Coaches	Restaurants
1	23	46	207	23
2	19	38	152	19
3	12	24	96	12
Total	54	108	455	54

* Includes Restaurant Car

Source: Morris-Knudsen Engineers, Inc.

B. VEHICLE MAINTENANCE AND ADMINISTRATIVE FACILITIES

1. Maintenance Shops

The number and location of vehicle maintenance facilities would be similar for all three speed categories. The high speed network would require:

- A main repair shop where major maintenance work is performed on a scheduled basis. Service at the main repair shop would take from 24 hours to several weeks. The facility would be able to perform complete overhauls of the train sets.

- One or more running repair facilities, where vehicles are inspected, cleaned, and stored daily. Preventive maintenance and time interval inspections may also be performed at these facilities. Service at a running repair will last from one to eight hours; train sets would be available for service during the next peak period.

The main repair shop would be located near one of the major terminals.

System running repair facilities could be built in stages in Houston, Dallas, and/or San Antonio. Train crew accommodations would be incorporated into each running repair facility.

2. Ancillary Maintenance Facilities

Maintenance facilities would be required for maintaining the right-of-way, including bridges, viaducts, fencing, embankments, excavations, and landscaping. These facilities would also maintain the track, traction power facilities, including substations and catenary, and signaling, train control, and communications systems; be responsible for the security of the installations; and would serve as a base for the handling of emergency situations. The maintenance-of-way facilities would be located along the HSR right-of-way at approximately 50-mile intervals.

3. Administration Facilities

Administration of the high speed rail network would be located in the headquarters building. A logical location for this building would be near the main repair shop. The train control center could also be incorporated in this facility.

SECTION VIII SYSTEM REVENUES AND COSTS

Two of the most critical feasibility factors concern the revenues generated by a Texas High Speed Rail System and the costs involved in the construction and operation of the system. These two areas form the basis for the economic impact and financial analyses.

A. REVENUES

Revenues from the high speed rail system would be generated from two sources: ticket sales and revenues from supplemental sources. The revenue estimates were developed as follows:

1. Revenues From Fares

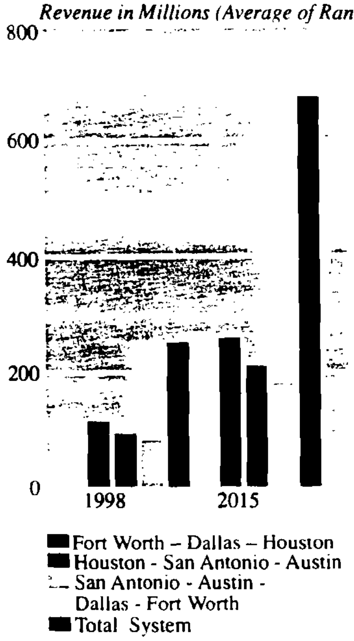
These revenues are directly related to the number of passengers riding the high speed rail system. Ridership estimates were developed and discussed in **Section IV**.

Gross revenues from ticket sales were determined by multiplying the estimated number of passengers in each corridor by a fare for that corridor. Fares comparable to existing air fares were established as a "base" fare for high speed rail. Average air fares were $57.00 for work trips and $49.00 for non-work trips for each corridor except Austin-San Antonio. Using the number of work trips and non-work trips in each corridor, a weighted average air fare of $52.00 was established. The $52.00 fare applied to all city pairs, except San Antonio-Austin, where a comparable fare of $27.00 fare was assumed. The $52.00 and $27.00 fares were referenced as base fares (100 percent of air fares).

Sensitivity analyses indicated that the optimum HSR fare to maximize system revenues should be approximately two-thirds of air fare, therefore, final ridership estimates were based on an HSR fare at 67 percent of air fare. These fares, $18.00 for the San Antonio - Austin city pair and $35.00 for all other city pairs, were used to calculated gross revenues.

Estimated fare revenues are summarized by HSR segment in **Table VIII-1** and **Figure VIII-1**.

Figure VIII-1
Projected Annual HSR Revenues



Source: Wilbur Smith Associates, Inc.

TABLE VIII-1

Estimated Fare Revenue
(Estimates in 1988 dollars)

Segment	1998 Fare Revenue	2015 Fare Revenue
Stage 1		
Fort Worth-Dallas-Houston	$107,226,000	$264,939,500
Stage 2		
Houston-San Antonio-Austin	73,164,000	201,257,000
Stage 3		
San Antonio-Austin-Dallas-Fort Worth	64,224,600	164,848,300
Total	**$262,510,300**	**$631,044,800**

Source: Wilbur Smith Associates

2. Supplemental Revenues

Supplemental revenue is income other than that generated by fares. These additional revenues are obtained from services provided to the passenger and the general public. The potential services that could be offered by high speed rail have been separated into five categories: package express, concessions/rentals (station), concessions/rental (train), rental car, and parking. Each category of supplemental revenue addressed a potential source of income that could augment fare revenues. A summary of total supplemental revenues by implementation stage is shown in **Table VIII-2.**

TABLE VIII-2

Estimated Supplemental Revenue
(Estimates in 1988 dollars)

Segment	1998 Supplemental Revenues	2015 Supplemental Revenues
Stage 1		
Fort Worth-Dallas-Houston	$ 8,382,200	$19,408,000
Stage 2		
Houston-San Antonio-Austin	4,442,900	10,938,000
Stage 3		
San Antonio-Austin-Dallas-Fort Worth	5,070,600	11,966,800

Assumptions used are VHS base demographics, HSR fare 67% of air fare and induced travel and suburban stations.

Source: Wilbur Smith Associates

a. Package Express

Package express is considered to be overnight delivery of letters and small packages. That type of service is currently being provided by Federal Express, Purolator Courier, Airborne Express, United Parcel Service, and a host of other local, regional, and national delivery companies. As that industry is not regulated, statistics on the volume of packages moved and the origin and destination of those packages is not readily available. Since no single definitive source of information on overnight express volumes was discovered, an estimate of the potential revenues of package express delivery service was deduced from data that was available from a variety of sources.

The Air Transport Association (ATA) receives voluntary reports of the volume of packages and letters delivered by 21 of the largest express carriers in the nation. However, these volumes are not broken down by origin and destination. A method was, therefore, developed that allowed this information to be broken down into origin and destinations. A demographic technique, called the step down ratio method, was used. Package express delivery volumes were assumed to be correlated to the population. The percentage of the national population in each city was assumed to be the percentage of the national package express delivery volume in each city.

This methodology resulted in an estimate of the amount of package express deliveries, in pounds, entering and leaving each city. Half of that total was assumed to leave the city. The volume of deliveries destined for other cities in the Triangle was assumed to correlate with the percentage of work trips taking place between each city pair. Based on these assumptions, an estimated volume of package express deliveries between city pairs was obtained.

The volumes derived were for 1988. Based on historical data from ATA and forecasts from the Transportation Research Board (TRB), a seven percent per year growth rate was assumed to 1998. A three percent per year growth rate was assumed from 1998 to 2015.

The average cost per pound from the ATA data was $20.00. The high speed rail market share of package express volume was assumed to be 10 percent. Using $15.00 as the gross revenue per pound and a 10 percent market share, an estimate of gross revenues for high speed rail was calculated for 1998 and 2015.

The resulting estimates were compared to volume data obtained later from the U.S. Postal Service for their Express Mail service. The volume of express mail deliveries by the Postal Service to other Triangle cities was in proportion to the estimates derived from the step-down ratio method. Thus, the volumes estimated appear reasonable.

The existing package express delivery companies have an extensive hub and spoke network that allows quick and dependable delivery across the nation through a well-developed pickup and delivery system. Therefore, a high speed rail packaged express service would have to expend considerable capital to enter a market already serviced by several companies. The estimated revenues would also be relatively small compared to farebox revenues. Offering a package express service to compete with established services could be difficult and could also detract from the major revenue source--passenger revenues. Market penetration could possibly be achieved by high speed rail contracting for mail service and package delivery with the post office and existing delivery companies seeking efficient, inexpensive transport for their priority mail. In this manner, high speed rail could provide a short-haul delivery service, just as it provides a convenient, short-haul passenger service.

b. Concessions/Rental (Station)

A second category of supplemental revenue would be income from concessions and rentals at the stations. A typical station was assumed in estimating the gross revenues from this source.

A typical station was assumed to have 5,000 square feet of leasable space. The small number of square feet was assumed since fewer people would be using the station as compared to an airport terminal. Also, waiting time was assumed to be much less and services would be available on the train, thus making the use of station services much lower.

Lease rates per square foot vary considerably among the cities and depend on station location and local market conditions. In order to arrive at a cost per square foot, lease rates from airport terminals in each of the cities was used. Lease rates from airport terminals were assumed to best represent rail station lease rates. Based on this assumption, a $28.35 per square foot per year revenue was assumed.

The square footage of the typical station was multiplied by the typical revenue, $28.35 per square foot of rental area to obtain an annual revenue of $141,750 per station per year for 1998. The revenue was then multiplied by the number of stations in each city pair to arrive at revenues per corridor. A 50 percent increase in revenues per square foot was assumed for 2015. The annual revenue per station in 2015 was estimated at $212,625. These revenue estimates are in 1988 dollars.

c. Concessions/Rental (Trains)

Food, beverage, and other services were assumed to be available on the train. Travel by train would allow passengers more freedom of movement and opportunities to make use of a wider array of on-board services than other travel modes. Since there was very little information on which to base an estimate of revenue from this source, a per passenger expenditure of $3.00 was assumed. It was also assumed that the net revenue for high speed rail would be 10 percent of the gross receipts for food and beverage.

d. Rental Car

Rental car operations were assumed to be available at each destination. The service would be provided by professional rental companies. Supplemental high speed rail revenues were estimated as a percentage of gross receipts, similar to contractual practice at airports.

Surveys of rental car use indicated that approximately five percent of the passengers could be expected to rent a car and use it for an average of two days at a rental cost of $50.00 per day. The survey also indicated an average vehicle occupancy of 1.2 occupants. Using this information provided by the surveys, gross car rental receipts were calculated. Eight percent of that total was then assumed as supplemental revenue for high speed rail. The eight percent fee was estimated based on existing charges assessed rental car companies at airports in each city.

e. Parking

Parking revenues represent a substantial part of supplemental revenues. Surveys of parking at airports in each of the cities formed the basis for the assumptions used. It was assumed that the parking would be operated by the high speed rail system, and all parking revenues would go directly to the system. Capital, operation, and maintenance costs for stations include parking facilities. Surveys indicated that approximately 25 percent of the passengers in the Dallas/Fort Worth-Houston Corridor would use station parking, whereas, only 15 percent of the passengers in the other corridors would use this same service. It was assumed that the vehicle remained parked for an average of two days at a cost of $5.00 per day.

3. Summary of Revenues

TABLE VIII-3

Summary of Total Revenue
(Estimates are in 1988 dollars)

Segment	1998 Total Revenue[1]	2015 Total Revenue[1]
Stage 1		
Fort Worth-Dallas-Houston	$115,608,200	$284,347,500
Stage 2		
Houston-San Antonio-Austin	77,606,900	212,195,000
Stage 3		
San Antonio-Austin-Dallas-Fort Worth	69,295,200	176,815,100
TOTAL	**$262,510,300**	**$673,357,600**

[1] Total of farebox and supplemental revenues.

Source: Wilbur Smith Associates

B. COSTS

1. Basis of Costs

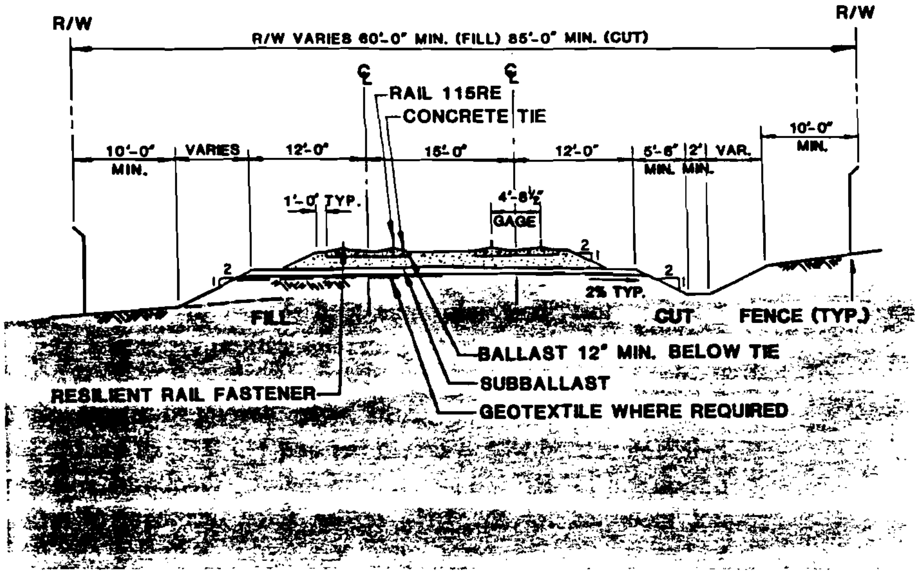
The capital costs were developed in 1988 constant dollars for three technology classes on two alternate routes. Costs were estimated on the basis of the typical sections shown in **Figure VIII-2.** The alignments were developed utilizing the most current United States Geological Survey (USGS) maps. A total of 14 major items of work were identified for estimating purposes as follows:

- Earthwork
- Railroad Reconstruction
- Trackwork
- Structures
- Right-of-Way
- Electrification
- Stations
- Maintenance Facilities
- Train Control
- Rolling Stock
- Engineering
- Construction Management
- Right-of-Way Acquisition
- Contingencies

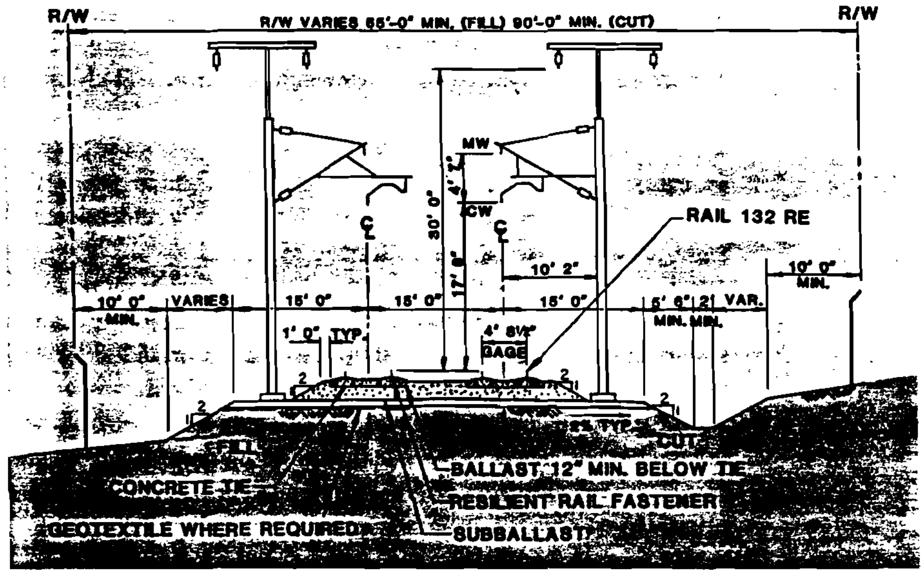
To allocate the cost to each leg of the Triangle, the total route was divided into nine segments for the existing alignments and eight segments for the independent alignment. A complete cost estimate for each segment was developed and the cost summarized for each Triangle leg. Unit prices were developed using State Department of Highways and Public Transportation (SDHPT) data for earthwork and structure items and other recent contract award prices. The following summarizes the basis of estimate for each item.

Figure VIII-2
Typical Sections

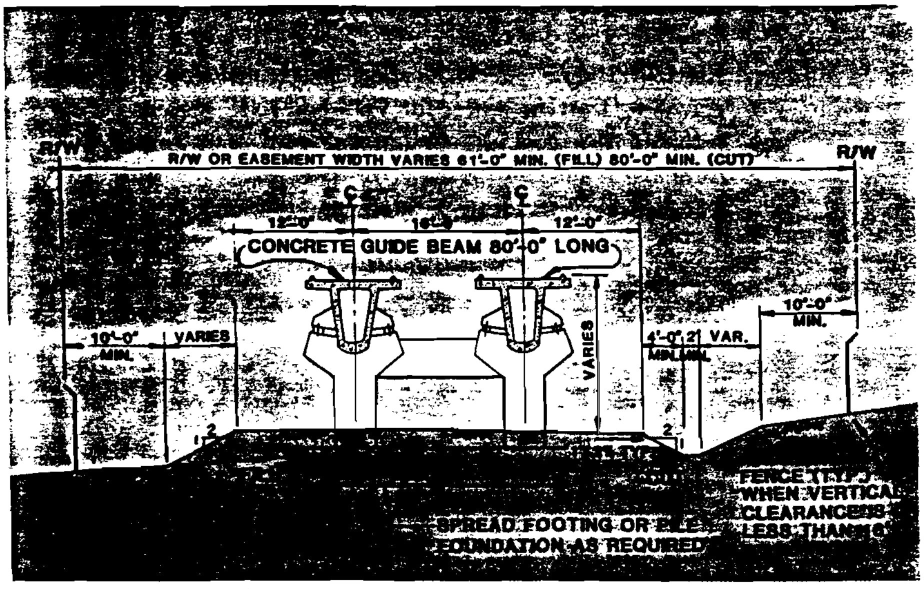
High Speed (HS)



Very High Speed (VHS)



Ultra High Speed (UHS)



Source: Morris-Knudsen Engineers, Inc.

- **Earthwork:** Earthwork unit prices used were the Texas statewide average unit prices as reported by SDHPT. Earthwork quantities were calculated by using existing 1" = 2000' USGS maps and by averaging cuts and fills.

- **Railroad Reconstruction:** Railroad reconstruction costs included the cost of temporary and permanent relocation of existing railroad freight lines where the high speed rail would share right-of-way with the existing railroads. For the VHS and UHS options, this cost also included the cost for electrical immunization of the existing communications systems.

- **Trackwork:** Trackwork costs were developed based on a ballasted section with concrete ties and 115 RE rail for the HS option and 132 RE rail for the VHS option. Trackwork cost was not identified for the UHS option since this item of work, excluding the concrete guideway, was included in the "electrification" item. The guideway structure for the UHS system was included in the item "structures."

- **Structures:** Two types of structures were identified: (1) Medium to long structures including grade separations with streets, highways and other railroads, and 2) Stream crossings with spans in excess of 20 feet. The total cost of the grade separation included the structure, approach, roadways, utility relocation and right-of-way in excess of that for the HSR line.

- **Right-of-way:** Right-of-way costs were based on unit prices per square foot for land. These unit prices were provided by real estate professionals in each city, using published data and recent sales data. The cost of acquiring right-of-way from railroads was assumed to be equal to the acquisition of adjacent land. Right-of-way cost varied from $2,000 per acre in rural areas to $40 per square foot in urban areas. It was assumed that the HSR line would require one-half of the right-of-way of the Rock Island Railroad between Fort Worth and Dallas.

- **Electrification:** Electrification costs included the cost of providing traction power for VHS and UHS options. This cost included the cost of substations, auto transformer stations, catenaries and an average of five miles of new 138 kV transmission line for each traction substation.

- **Stations:** Passenger station costs included station building, platforms, parking (surface or garages), access improvements, and right-of-way. At certain locations, such as Dallas Union Station, the cost included some renovation of the existing station, additional trackwork and platforms.

- **Maintenance Facilities:** Three classes of maintenance facilities were identified and priced. The major repair shop would perform the major rolling stock overhauls. The running repair facilities to be located at Houston, San Antonio, and Dallas would handle preventive maintenance and cleaning. The maintenance-of-way facilities to be located along the route would handle on-line right-of-way bridge and track maintenance.

- **Train Control:** Train control costs included the complete signal and centralized traffic control system.

- **Rolling Stock:** Rolling stock costs included the cost of the power units, coaches, and restaurant cars. The rolling stock acquisition was separated into two purchases, one in 1997 and one in the 2007.

- **Engineering:** Engineering costs were estimated at nine percent of all above items, excluding rolling stock.

- **Construction Management:** Construction Management was estimated at three percent of all items, except rolling stock.

- **Right-of-Way Acquisition:** Legal costs and other work related to the acquisition of the necessary right-of-way was estimated at 25 percent of the right-of-way cost.

- **Contingencies:** An amount of five percent of all cost items was provided to allow for omissions and contingencies.

Construction would be performed using American Railway Engineering Association specifications and standards with appropriate special provisions. It was assumed that all construction contracts would be awarded on the basis of competitive bidding.

Unit prices used for the principal items of work are shown in **Table VIII-4**.

TABLE VIII-4

High Speed Rail, Unit Price Summary (1988 Prices)

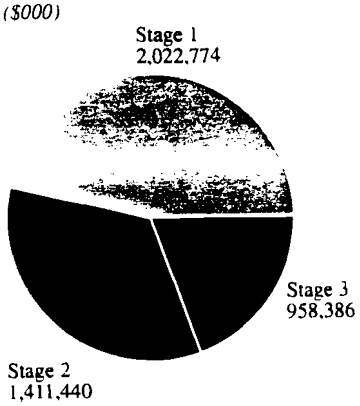
Description	Unit	Unit
Preparing R.O.W.	STA	$1,400.00
Remove Old Pavement	SY	3.50
Excavation	CY	2.70
Embank (Dens Cont)	CY	3.20
6" Lime Treated Subgrade	SY	1.30
Lime (TY A or B)	TON	74.00
Crushed Aggregate	CY	25.50
6" Cement Stabilized Base	SY	6.00
8" Cement Stabilized Base	SY	8.00
Asphalt Stabilized Base	TON	35.00
Asphalt Concrete Pavement	TON	35.00
6" Concrete Pavement	SY	19.00
8" Concrete Pavement	SY	19.00
10" Concrete Pavement	SY	18.60
Retaining Walls	SF	21.00
Concrete Bridges	SF	40.00
Steel Bridges	SF	50.00
24" RCP	LF	22.00
Inlets	EA	1,400.00
Manholes	EA	1,600.00
Fencing	LF	11.00
Existing Track Relocation (HS)	LF	82.50
Existing Track Relocation (VHS & UHS)	LF	105.25
Trackwork on Grade (Double Track)	LF	207.00
Trackwork on Structure (Double Track)	LF	256.00

Source: Lichliter/Jameson & Associates, Inc.
Morrison-Knudsen Engineers, Inc.

C. CAPITAL COSTS

Figure VIII-3
System Capital Costs–1988 Dollars

($000)



Source: Lichliter/Jameson & Associates, Inc.

The VHS capital costs for each segment are summarized in **Tables VIII-5** and **VIII-6**. To evaluate the priority of each segment of the system, estimates of cost were prepared on a "Stand-Alone" basis. The "Stand-Alone" alternative assumed each leg of the Triangle would be constructed independently. This analysis, therefore, includes significant duplicated costs since each leg of the Triangle includes infrastructure which would be common with another leg. This analysis, therefore, was developed only for the purpose of establishing the priority of construction for each leg of the Triangle.

Estimates of cost for the VHS option in each leg of the Triangle are presented in **Tables VIII-7** and **VIII-8**. These costs are based on the following staging scenario:

Stage 1: Fort Worth - Dallas - Houston
Stage 2: Houston - San Antonio - Austin
Stage 3: San Antonio - Austin - Dallas - Fort Worth

The complete cost estimates per segment and by stage for all three technologies are provided in **Tables E-1** through **E-12** in **Appendix E**.

The estimated capital costs for each of the three stages of development and the total system are shown in **Table VIII-9** and depicted in **Figure VIII-3**.

TABLE VIII-5

Texas High Speed Rail

Independent Alignment: VHS Option
Cost Summary by Segment ($000)

Segment	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Total**
Length (Miles)	32.77	65.97	48.53	32.21	126.46	28.64	53.86	130.05	618.49
Earthwork	5,004	19,819	51,885	5,736	41,956	8,152	17,349	45,707	195,608
Railroad Reconstruction	18,208	6,420	0	15,124	3,526	7,431	8,262	0	58,972
Trackwork	37,511	72,921	162,840	35,774	139,483	31,720	59,836	142,196	682,282
Structures	100,008	81,990	117,110	56,865	143,316	39,747	78,943	100,170	718,149
Right-of-Way	17,500	13,723	3,601	29,764	12,800	16,724	11,044	3,153	108,307
Electrification	23,136	46,575	104,862	22,740	89,281	20,220	38,025	91,815	436,654
Stations	10,000	5,000	0	20,000	10,000	0	10,000	0	55,000
Maintenance Facilities	1,000	17,000	5,000	57,500	4,000	1,000	17,000	4,000	106,500
Train Control	18,120	39,660	98,822	5,000	69,054	18,790	29,440	70,986	349,872
Rolling Stock (1997)	0	0	277,700	0	191,000	0	0	305,900	774,600
Engineering	20,744	27,280	48,971	22,365	46,207	12,940	24,291	41,222	244,021
Construction Management	6,915	9,093	16,324	7,455	15,402	4,313	8,097	13,741	81,340
Right-of-Way Acquisition	4,375	3,431	900	7,441	3,200	4,181	2,761	788	27,077
Contingencies	13,126	17,146	44,401	14,288	38,461	8,261	15,252	40,984	191,919
Total	**275,647**	**360,058**	**932,415**	**300,053**	**807,686**	**173,478**	**320,300**	**860,663**	**4,030,300**
Rolling Stock (2007)	0	0	154,600	0	150,700	0	0	57,000	362,300

Segment Description

1 Fort Worth - Dallas Union Station
2 Dallas Union Station - Corsicana Junction
3 Corsicana Junction - Houston 610 Junction
4 Houston 610 Junction - Houston Downtown
5 Austin SW Junction - Austin Downtown
6 Austin SW Junction - San Marcos
7 San Marcos - San Antonio
8 San Marcos - Houston 610 Junction

Source: Lichliter/Jameson & Associates, Inc.
Morrison-Knudsen Engineers, Inc.

TABLE VIII-6

Texas High Speed Rail

Existing Alignment: VHS Option
Cost Summary by Segment ($000)

Segment	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Total**
Length (Miles)	32.77	54.60	203.92	5.00	156.75	0.72	27.27	52.73	152.31	686.07
Earthwork	5,004	16,333	64,077	611	48,438	0	7,940	16,951	49,588	208,943
Railroad Reconstruction	18,208	18,577	68,939	0	50,331	800	12,367	14,630	38,090	221,941
Trackwork	37,511	61,172	223,739	5,930	172,814	973	30,043	58,821	166.695	757,698
Structures	100,008	90,014	206,939	16,072	201,852	5,168	36,118	80,785	160,709	897,665
Right-of-Way	17,500	15,745	23,028	10,000	41,314	3,040	13,530	10,592	15,207	149,956
Electrification	28,000	37,750	142,500	0	107,250	0	24,500	36,750	107,250	484,000
Stations	10,000	5,000	10,000	10,000	10,000	0	0	10,000	10,000	65,000
Maintenance Facilities	1,000	17,000	5,000	57,500	4,000	0	1,000	17,000	4,000	106.500
Train Control	18,120	33.050	114,110	5,000	85,730	0	18.370	28,970	85,730	389,080
Rolling Stock (1997)	0	0	307.700	0	191,000	0	0	0	305,900	804.600
Engineering	21,182	26,518	77,250	9,460	64,956	898	12,948	24.705	57,354	295,270
Construction Management	7,061	8.839	25,750	3,153	21,652	299	4,316	8.235	19,118	98,423
Right-of-Way Acquisition	4,375	3,936	5,757	2,500	10,329	760	3,383	2,648	3,802	37,489
Contingencies	13,398	16,697	63,739	6,011	50,483	597	8,226	15,504	51,172	225,828
TOTAL	**281,367**	**350,631**	**1,338,528**	**126,238**	**1,060,147**	**12,535**	**172,741**	**325,590**	**1,074,615**	**4,742,395**
Rolling Stock (2007)	0	0	154,600	0	150,700	0	0	0	57,000	362,300

Segment Description

1	Fort Worth - Dallas Union Station
2	Dallas Union Station - Corsicana Junction
3	Corsicana Junction - Houston 610 Junction
4	Houston 610 Junction - Houston Downtown
5	Corsicana Junction - Austin SW Junction
6	Austin SW Junction - Austin Downtown
7	Austin SW Junction - San Marcos
8	San Marcos - San Antonio
9	San Marcos - Houston 610 Junction

Source: Lichliter/Jameson & Associates, Inc.
Morrison-Knudsen Engineers, Inc.

TABLE VIII-7

Texas High Speed Rail

Staging
Independent Alignment: VHS Option
Cost Summary ($000)

Item	Stage 1 Houston-Dallas-Ft. Worth	Stage 2 Houston-Austin-San Antonio	Stage 3 San Antonio-Austin-Dallas-Ft. Worth
Length	279.48	212.55	126.46
Earthwork	82,444	71,208	41,956
Railroad Reconstruction	39,753	15,693	3,526
Trackwork	309,047	233,752	139,483
Structures	355,973	218,860	143,316
Right-of-Way	64,588	30,920	12,800
Electrification	197,313	150,060	89,281
Stations	35,000	10,000	10,000
Maintenance Facilities	80,500	22,000	4,000
Train Control	161,602	119,216	69,054
Rolling Stock (1997)	277,700	305,900	191,000
Engineering	119,360	78,454	46,207
Construction Management	39,787	26,151	15,402
Right-of-Way Acquisition	16,147	7,730	3,200
Contingencies	88,961	64,497	38,461
Total Cost ($000)	1,868,174	1,354,440	807,686
Cost per Mile ($000)	6,684	6,372	6,387
Rolling Stock (2007)	154,600	57,000	150,700

Source: Lichliter/Jameson & Associates, Inc.
Morrison-Knudsen Engineers, Inc.

TABLE VIII-8

Texas High Speed Rail

Staging
Existing Alignment: VHS Option
Cost Summary ($000)

Item	STAGE 1 Houston-Dallas-Ft. Worth	STAGE 2 Houston-Austin-San Antonio	STAGE 3 San Antonio-Austin-Dallas-Ft. Worth
Length	296.29	233.03	156.75
Earthwork	86,026	74,479	48,438
Railroad Reconstruction	105,724	65,887	50,331
Trackwork	328,353	256,532	172,814
Structures	413,033	282,780	201,852
Right-of-Way	66,273	42,369	41,314
Electrification	208,250	168,500	107,250
Stations	35,000	20,000	10,000
Maintenance Facilities	80,500	22,000	4,000
Train Control	170,280	133,070	85,730
Rolling Stock (1997)	307,700	305,900	191,000
Engineering	134,409	95,905	64,956
Construction Management	44,803	31,968	21,652
Right-of-Way Acquisition	16,568	10,592	10,329
Contingencies	99,846	75,499	50,483
Total Cost ($000)	2,096,765	1,585,482	1,060,147
Cost Per Mile ($000)	7,077	6,804	6,763
Rolling Stock (2007)	154,600	57,000	150,700

Source: Lichliter/Jameson & Associates, Inc.
Morrison-Knudsen Engineers, Inc.

D. OPERATIONS AND MAINTENANCE (O&M) COSTS

O&M costs consist of two components: fixed and variable. The fixed portion includes those costs related to the system which do not appreciably change with the number of riders or number of trains running, such as central administration, traffic control center, and the staffing of passenger stations (see **Table VIII-10** for independent alignment and **Table VIII-11** for existing alignment).

The variable portion of the costs are those affected by ridership and are a function of train-miles such as: electrical energy, rolling stock maintenance and train crews (see **Table VIII-12** for independent alignment and **Table-VIII 13** for existing alignment). Annual train-miles are computed as the product of the total number of trains by the distance traveled and the number of days - assuming 80 percent of the weekday travel for weekends.

O&M costs not included in these tables but incorporated in the financial analysis are:

- Advertising (expenditures to promote ridership of the system and revenues from advertising of others permitted within the trains and facilities).
- Ticket sales costs - agents' fees or other costs of ticket sales (except for passenger station staff).

O&M costs are expected to increase with time due to the increase in ridership projected to the year 2015. Although an increase in train-miles was calculated for year 2008 when the fleet second purchase was assumed, this value was not used. Instead, an all-encompassing increase of 2.0 percent per annum was applied during the financial analysis to the 1998 O&M costs over the period from 1998 to 2015.

The O&M costs of the "Stand-Alone Scenario" for all three technologies are presented in **Tables E-13** through **E-20** in **Appendix E**.

should be
top
page

Table VIII-9
Estimated Capital Costs, VHS Option, Independent Alignment
(1988 Dollars)

Estimated Costs	Stage 1	Stage 2	Stage 3	Total
Construction*	1,509,739,000	1,009,890,000	600,686,000	3,120,315,000
Right-of-Way	80,735,000	38,650,000	16,000,000	135,385,000
Rolling Stock	432,300,000	362,900,000	341,700,000	1,136,900,000
Total	**$2,022,774,000**	**$1,411,440,000**	**$958,386,000**	**$4,392,600,000**
Annual Operation & Maintenance	$62,740,000	$39,800,000	$25,030,000	$127,520,000

* Includes Engineering and Contingencies

TABLE VIII-10

Texas High Speed Rail Study
Cost Estimate, Independent Alignment, VHS Technology
Operations and Maintenance Costs – Fixed Costs

Costs Per Year - Staging Scenario

Item	Basis of Quantity		Implementation Stage			
	Refer.	Rate	Stage 1: Fort Worth-Dallas-Houston	Stage 2: Houston-Austin-San Antonio	Stage 3: San Antonio-Austin-Dallas-Fort Worth	Total
			Amount	Amount	Amount	Amount
Fixed Operating Costs						
Administration	LS	1	$1,000,000	$0	$0	$1,000,000
Insurance	LS	1	$5,000,000	$0	$0	$5,000,000
Traffic Control	LS	1	$1,000,000	$0	$0	$1,000,000
Electrical Demand Charge	RTE-MI	1	$6,417,000	$4,899,000	$2,898,000	$14,214,000
Staff for Pass. Stations			$5,000,000	$3,000,000	$0	$8,000,000
Subtotal			**$18,417,000**	**$7,899,000**	**$2,898,000**	**$29,214,000**
Maintenance of Fixed Facilities						
Right-of-Way and Track	TRK-MI	1	$4,464,000	$3,408,000	$2,016,000	$9,888,000
Signalling	RTE-MI	1	$5,580,000	$4,260,000	$2,520,000	$12,360,000
Administration Building	CAP.COST	1.0%	$40,000	$0	$0	$40,000
Passenger Stations	CAP.COST	1.0%	$500,000	$300,000	$0	$800,000
Maintenance Facilities	CAP.COST	0.5%	$200,000	$0	$0	$200,000
Electrification	CAP.COST	2.0%	$4,155,000	$3,285,000	$2,070,000	$9,510,000
Subtotal			**$14,939,000**	**$11,253,000**	**$6,606,000**	**$32,798,000**
TOTAL			**$33,356,000**	**$19,152,000**	**$9,504,000**	**$62,012,000**

Source: Morrison-Knudsen Engineers, Inc.
Lichliter/Jameson & Associates, Inc.

TABLE VIII-11

Texas High Speed Rail Study
Cost Estimate, Existing Alignment - VHS Technology
Operations and Maintenance Costs -- Fixed Costs

Costs Per Year - Staging Scenario

Item	Basis of Quantity Refer.	Rate	Implementation Stage Stage 1: Fort Worth-Dallas-Houston	Stage 2: Houston-Austin-San Antonio	Stage 3: San Antonio-Austin-Dallas-Fort Worth	Total
			Amount	**Amount**	**Amount**	**Amount**
Fixed Operating Costs						
Administration	LS	1	$1,000,000	$0	$0	$1,000,000
Insurance	LS	1	$5,000,000	$0	$0	$5,000,000
Traffic Control	LS	1	$1,000,000	$0	$0	$1,000,000
Electrical Demand Charge	RTE-MI	1	$6,831,000	$5,474,000	$3,611,000	$15,916,000
Staff for Pass. Stations			$5,000,000	$3,000,000	$0	$8,000,000
Subtotal			**$18,831,000**	**$8,474,000**	**$3,611,000**	**$30,916,000**
Maintenance of Fixed Facilities						
Right-of-Way and Track	TRK-MI	1	$4,752,000	$3,808,000	$2,512,000	$11,072,000
Signaling	RTE-MI	1	$5,940,000	$4,760,000	$3,140,000	$13,840,000
Administration Building	CAP.COST	1.0%	$40,000	$0	$0	$40,000
Passenger Stations	CAP.COST	1.0%	$500,000	$300,000	$0	$800,000
Maintenance Facilities	CAP.COST	0.5%	$200,000	$0	$0	$200,000
Electrification	CAP.COST	2.0%	$4,155,000	$3,285,000	$2,070,000	$9,510,000
Subtotal			**$15,587,000**	**$12,153,000**	**$7,722,000**	**$35,462,000**
TOTAL			**$34,418,000**	**$20,627,000**	**$11,333,000**	**$66,378,000**

Source: Morrison-Knudsen Engineers, Inc.
Lichliter/Jameson & Associates, Inc.

TABLE VIII-12

Texas High Speed Rail Study
Cost Estimate, Independent Alignment, VHS Technology
Operations and Maintenance Costs -- Variable Costs

Costs Per Year - Staging Scenario

	Implementation Stage			
Item	**Stage 1:** Fort Worth-Dallas-Houston	**Stage 2:** Houston-Austin-San Antonio	**Stage 3:** San Antonio-Austin-Dallas-Fort Worth	**Total**
	Amount	**Amount**	**Amount**	**Amount**
Routine Servicing	$4,048,000	$3,871,000	$2,337,000	$10,256,000
Cleaning	$2,024,000	$1,935,500	$1,168,500	$5,128,000
Major Repair	$2,024,000	$1,935,500	$1,168,500	$5,128,000
Energy	$4,371,840	$4,180,680	$2,523,960	$11,076,480
Train Crew	$4,048,000	$3,871,000	$2,337,000	$10,256,000
TOTAL (1998)	$16,515,840	$15,793,680	$9,534,960	$41,844,480
TOTAL (2008)	$26,736,200	$19,743,100	$14,932,800	$61,412,200

Source: Morrison-Knudsen Engineers, Inc.
Lichliter/Jameson & Associates, Inc.

TABLE VIII-13

Texas High Speed Rail Study
Cost Estimate, Existing Alignment, VHS Technology
Operations and Maintenance Costs -- Variable Costs

Costs Per Year - Staging Scenario

	Implementation Stage			
Item	**Stage 1:** Fort Worth-Dallas-Houston	**Stage 2:** Houston-Austin-San Antonio	**Stage 3:** San Antonio-Austin-Dallas-Fort Worth	**Total**
	Amount	**Amount**	**Amount**	**Amount**
Routine Servicing	$4,291,000	$3,765,000	$2,467,000	$10,523,000
Cleaning	$2,145,500	$1,882,500	$1,233,500	$5,261,500
Major Repair	$2,145,500	$1,882,500	$1,233,500	$5,261,500
Energy	$4,634,280	$4,066,200	$2,664,360	$11,364,840
Train Crew	$4,291,000	$3,765,000	$2,467,000	$10,523,000
Total (1998)	$17,507,280	$15,361,200	$10,065,360	$42,933,840
Total (2008)	$28,343,800	$19,200,500	$13,725,100	$61,269,400

Source: Morrison-Knudsen Engineers, Inc.
Lichliter/Jameson & Associates, Inc.

E. CONCLUSIONS

Revenue Forecasts and System Costs - Based on the assumptions developed regarding the HSR and existing transportation modes, the high speed rail system would be expected to generate over $260 million per year by 1998 if the entire system were in place. The first stage (Fort Worth - Dallas - Houston) was estimated to generate nearly $116 million in 1998, increasing to over $284 million by year 2015. The full system was estimated to generate over $673 million in 2015 (all estimates in 1988 dollars). The estimated capital cost of the completed HSR system, in 1988 dollars, would be $4,392,600,000. Operating and Maintenance (O&M) costs for the entire HSR system were estimated to be approximately $186 million per year. For only the first stage of development, O&M costs were estimated to be approximately $79 million.

SECTION IX
FINANCE

Implementation of the Texas high speed rail system would be economically sound based on a specific set of current conditions and assumptions. A phased approach is recommended for financing the system which would employ a combination of both public and private sector involvement. The system should generate sufficient passenger and supplemental revenues to support projected annual operating and maintenance costs along with debt service requirements associated with the capital costs of the system.

A phased approach is recommended for financing the system.

The plan of finance would be a multifaceted funding program. The magnitude of the construction and operating and maintenance costs, as they correspond to the timely generation of passenger and supplemental revenues, dictates participation from several sectors. It is anticipated that financing of the system would be a combination of public and private sector financing, with initial financial advances from governmental entities. Financing of the program is obviously sensitive to changes in interest rates in the market place. A blended interest rate of 8.0 percent (notes and bonds) was assumed for the project financing.

A. PUBLIC SECTOR FINANCING

The Technical and Miscellaneous Revenue Act of 1988 provides the key to financing a majority of the HSR project.

1. HR 4333

Recent passage of the Technical and Miscellaneous Revenue Act of 1988 (HR 4333) provides the key to financing a majority of the HSR project. This act provides for tax-exempt revenue bond financing for construction of HSR systems (not including rolling stock). Some key features to the Act are:

Tax-exempt financing is available for systems with average speeds in excess of 150 miles per hour.

a. To be a qualifying facility for tax-exempt financing, trains must operate at average speeds in excess of 150 miles per hour between stations;

b. HSR rail facilities are accorded the same treatment as airport bonds with the following exceptions:

   (1) The facilities financed with the proceeds of such bonds need not be governmentally owned; however, any private owner must make an irrevocable election not to claim depreciation or take any tax credit with respect to the bond financed property;

   (2) Twenty-five percent of each issue must receive an allocation from the state private activity bond volume limitation; and,

   (3) Any proceeds of an issue not spent within three years of the date of issuance must be used to redeem outstanding bonds. Redemption must occur no later than six months after the date that is three years from the date of issuance.

c. Tax-exempt facility bond funds cannot be used for the purchase of rolling stock.

It is anticipated that an agency of the State, empowered by the Legislature to plan, develop, operate and maintain the system, as well as issue tax-exempt debt, would be the issuing entity. While tax-exempt financing would be somewhat dependent upon the availability of state allocated monies for private activity type projects, the overall interest cost associated with financing such a system is greatly reduced through the use of tax-exempt debt.

The public sector would also be called upon to provide supplemental funding in ways other than providing financing programs. It is expected that federal and/or state agencies who have historically been involved in the funding of transportation type projects would also be potential sources of financial advances, as well as various local public authorities.

2. Tax-Exempt Debt Structure

Tax-exempt debt would be structured and issued on a timetable to provide the most attractive financing package to the market place at the time of funding. Debt would be expected to be offered as both short-term notes and long-term bonds. Notes and bonds would be issued with either a variable interest rate structure or on a fixed rate basis. The issuance of variable rate debt would initially permit the system to achieve low interest rates historically associated with the short-term end of the tax-exempt yield curve. Variable rate debt would, however, run the risk of increased interest rates in the future should tax-exempt interest rates, in general, increase. On the other hand, fixed rate debt issues would enable the system to lock-in a specific interest rate at the time of issuance, thus eliminating the risk of rising interest rates through maturity.

a. Note Issuance

Because the Technical and Miscellaneous Revenue Act of 1988 stipulates that all proceeds from the issuance of tax-exempt debt for high speed rail facilities must be used within three years of issuance, separate note issues would be issued throughout the construction period.

As funding will be provided for a system with no previous operating history, it is planned to further secure the notes with letters of credit issued by banks or lending institutions with credit rating levels of "AAA" or "AA" or by the use of another type of similarly rated credit enhancement. Unless market conditions dramatically change by the time debt is issued, one or both of the credit enhancement alternatives will be necessary to successfully market the notes and achieve the lowest interest costs.

b. Bond Issuance

Long term bonds would be structured to provide funds to defease the notes as they mature and to amortize the capital costs of the system over its operating life. An investment grade rating of at least "A" would be required, otherwise, a bond insurance policy would be obtained on the bonds. Long term bonds would be structured to provide at least a 1.25 times annual debt service coverage, to provide adequate debt coverage to satisfy the rating agencies, insurance companies, and investors. Sufficient excess revenues would also be provided to ensure that the franchisee (responsible for financing the rolling stock) is provided a reasonable rate of return on their investment.

The structure of the bonds would be a combination of serial coupon bonds and discount bonds, such as capital appreciation bonds. The combination of these bonds would allow interest costs to be reduced in the early years of system operation to offset initial low passenger and supplemental revenues.

B. PRIVATE SECTOR FINANCING

Private sector funding assistance would be solicited from contractors, franchisees, and vendors involved in developing and equipping the project. Within this "value added" category are developers to whom development rights to construct stations would be awarded, or to entities whose programs or businesses along the service routes would be greatly enhanced by existence of the system. Stations developed in the major cities and suburbs could potentially be completely funded by the local public sector or private developers. It is anticipated that the rolling stock could be funded by the franchisee and its lenders since, by law, tax-exempt financing under HR 4333 is not currently available for rolling stock. The franchisee would be expected to receive an internal rate of return on its investment payable from excess revenues generated, once the system is in place and fare service is begun.

Stations developed in the major cities and suburbs could potentially be completely funded by the local public sector or private developers.

C. FINANCIAL FEASIBILITY

The following procedures were utilized in analyzing the financial feasibility of the HSR system:

- Cash flows in 1988 dollars were projected based upon estimated capital and operating costs and passenger and supplemental revenues for **High Speed (HS)**, **Very High Speed (VHS)** and **Ultra High Speed (UHS)** technologies for each of the following routes, operating as stand-alone corridors, using identical assumptions:

    - Fort Worth - Dallas - Houston
    - Houston - San Antonio - Austin
    - San Antonio - Austin - Dallas - Fort Worth

- Each cash flow was evaluated in terms of annual debt service coverage produced throughout the maturity of the debt issued. **Table IX-1** summarizes the comparative financial results:

TABLE IX-1

Comparative Analyses of Each Corridor and Each Technology (1988 Dollars)

Technology	Corridor*	Costs (000's)	Dollar Amount Note Issues (000's)	Annual Debt Service Coverage (2005)	Annual Debt Service Coverage (2015)
HS	Stage 1	$1,272,082	$1,580,310	0.45x	0.50x
HS	Stage 2	1,070,982	1,332,405	0.49x	0.55x
HS	Stage 3	1,414,839	1,757,550	0.38x	0.45x
VHS	Stage 1	1,555,474	1,927,620	0.83x	0.98x
VHS	Stage 2	1,318,594	1,635,830	0.71x	0.87x
VHS	Stage 3	1,771,172	2,120,850	0.39x	0.42x
UHS	Stage 1	3,788,294	4,677,010	0.45x	0.49x
UHS	Stage 2	3,098,886	3,828,490	0.45x	0.51x
UHS	Stage 3	4,073,897	5,025,645	0.27x	0.32x

$ 372,000,000 in financing costs?

* Stage 1 - Fort Worth - Dallas - Houston
Stage 2 - Houston - San Antonio - Austin
Stage 3 - San Antonio - Austin - Dallas - Fort Worth

Source: Underwood, Neuhaus & Co.,Inc.

The above economic analysis indicated the following:

- VHS Technology has the most favorable ratio of revenues to capital cost relative to the other technologies.
- The HSR system, utilizing VHS technology, should be implemented in the staged construction plan as indicated above.

D. STAGED FINANCING

1. General

In the staging of each leg of the total HSR system, economies of scale would be created by common right-of-way, trackwork, structures, and other infrastructure being utilized by more than one leg. This arrangement would increase the operating efficiency of the system since overall construction and operating costs would be reduced while passenger revenues would remain unchanged. Supplemental revenues would only moderately change. Staging of the HSR system development would be accomplished as follows:

- Stage 1 - Fort Worth - Dallas - Houston
- Stage 2 - Houston - San Antonio - Austin
- Stage 3 - San Antonio - Austin - Dallas - Fort Worth

2. Assumptions for Tax-Exempt Debt Issues

The following assumptions were made concerning the tax-exempt debt issues:

- System Staging - It was assumed that the HSR system would be implemented in stages as defined above and in four year increments, as follows:

Corridor	Construction Period
Fort Worth - Dallas - Houston	July 1991 - December 1997
Houston - San Antonio - Austin	July 1995 - December 2001
San Antonio - Austin - Dallas - Forth Worth	July 1999 - December 2005

- Inflation - Capital/construction costs, operating and maintenance costs and passenger and supplemental revenues were inflated by two percent per year from 1988 dollar levels. Revenues and operating and maintenance costs for each staged corridor were inflated during the first eighteen years of operation and remained constant thereafter.

- Interest Rates - Interest rates were assumed to be at current market (1988) levels of approximately 8.0 percent on all serial coupon maturities and 8.15 percent on all capital appreciation bonds.

- Governmental and Other Financial Advances - It was assumed that $114,678,000 of advances for the entire system ($99,721,000 for Stage 1 and $14,957,000 for Stage 2) would be received from governmental entities or other sources for pre-construction engineering and right-of-way determination. The specific sources of such funding were not identified; however, they were assumed to be available at the commencement of construction for Stages 1 and 2. Dollars generated in excess of 1.25 times debt service coverage were designated for repayment of financial advances.

Advances for preliminary engineering and right-of-way would be repaid when the full system is complete.

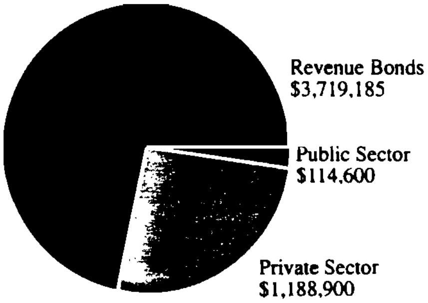
- Construction Fund Drawdowns and Investment Rates - The note proceeds required for construction in a particular year were assumed to be drawn down in equal installments. Construction funds were assumed to be invested at the note yield in United States Treasury securities until funds would be utilized. In order to abide by current federal tax laws, the investment rates would not exceed the note yield. All investment earnings on construction funds would flow back to the construction fund for additional construction needs.

- Capitalized Interest - Interest was capitalized on the notes through the construction period and would be sufficient to cover all letters of credit fees and debt service on the notes. Capitalized interest funds were assumed to be invested in United States Treasury securities at the note yield until funds would be utilized. All investment earnings on capitalized interest funds would flow back to the capitalized interest fund for interest costs during construction.

System Financing Sources

Total System – Includes Inflation

($000)

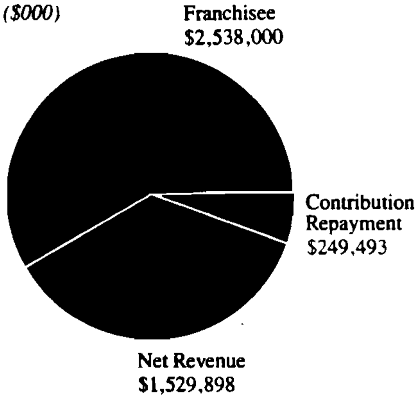


Source: Underwood, Neuhaus & Co.,Inc.

System Revenues Available 1998-2031

After Debt Service

($000)



Source: Underwood, Neuhaus & Co.,Inc.

- Principal Amortization - Principal would be amortized on the long-term bond issues for a 30 year period. The issues were structured to provide proportional debt service in relation to projected revenues.

- Debt Service Reserve Fund - A debt service reserve fund would be established for the long-term bonds in an amount equal to average annual debt service requirements. The reserve fund was assumed to be completely funded from bond proceeds and would be invested at the bond yield. Annual earnings would be used to pay debt service with the reserve fund itself applied to pay debt service on the final maturity of the bonds.

- Cost of Issuance and Underwriter's Discount - For each note issue and each long-term bond issue, costs of issuance and underwriter's discount were assumed to total 1.25 percent of the proceeds'amount of each issue.

3. Summary of Findings

The financial results of the staged scenario is summarized below. The detail of the financial analysis for the total HSR system and each staged corridor is included within the financing analysis contained in **Appendix G.**

The cash flows included herein project the financial performance of the HSR system based on the above assumptions.

Total HSR System

- Cash flow generated ranges from a low of $18.6 million in 1998 to a high of $166.2 million in the years 2023-2030.

- Average gross annual debt service coverage is approximately 1.26 during the debt service period.

- A $114.6 million advance is required in order to achieve the projected 1.25 debt service coverage.

- The cash flow projects a cumulative $2.5 billion to repay franchisee investment, $249 million to repay system advances, and a $1.53 billion cumulative net cash flow in the year 2031, the year of the final maturity debt issued to finance Stage 1.

Stage 1 - Fort Worth - Dallas - Houston

- This first stage would require an advance of $99.7 million to finance a portion of the right-of-way and preliminary engineering design in years 1991-1993 in order to realize sufficient debt service coverage.

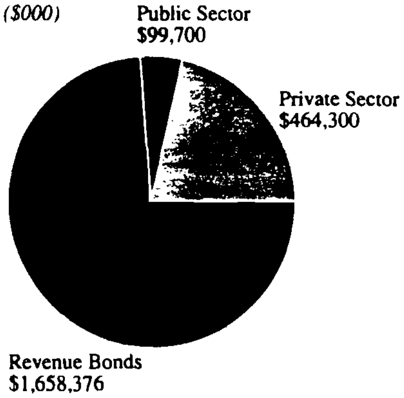
- Annual gross cash flows generated range from $18.6 million in 1998 to $67.4 million in the years 2015-2030.

- Approximately $1.4 billion is generated from 1998 through 2031 to repay capital investment and provide a return to franchisees and private investment in station construction.

System Financing Sources

Stage 1 – Includes Inflation

($000)

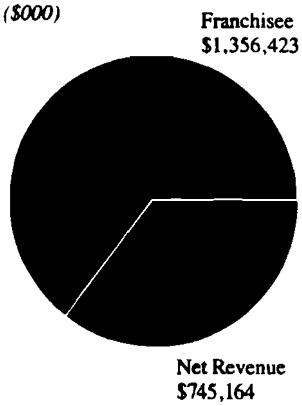


Source: Underwood, Neuhaus & Co.,Inc.

System Revenues Available

After Debt Service

($000)



Source: Underwood, Neuhaus & Co.,Inc.

Stage 2 - Houston - San Antonio - Austin

- This stage would generate annual gross cash flow ranging between $11.0 million in 2003 to a high of $57.1 million in 2019 through 2031.

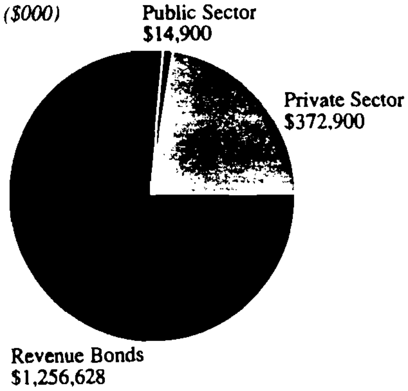
- An initial advance of $14.9 million would be required to pay a portion of the preliminary engineering design and right-of-way determination in order to maintain debt service coverage equal to 1.25.

- Revenue generated to repay capital investment and provide a return on the investment to franchisees and private investment are $787.3 million from 2002 through 2031.

System Financing Sources

Stage 2 – Includes Inflation

($000)

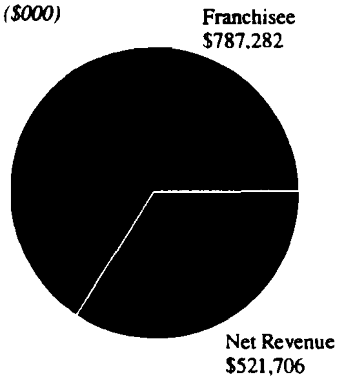


Source: Underwood, Neuhaus & Co.,Inc.

System Revenues Available 2002-2031

After Debt Service

($000)



Source: Underwood, Neuhaus & Co.,Inc.

Note: Revenues reflect amounts generated through 2031. Additional revenues are available subsequent to this date. (See Appendix G.)

Stage 3 - San Antonio - Austin - Dallas - Fort Worth

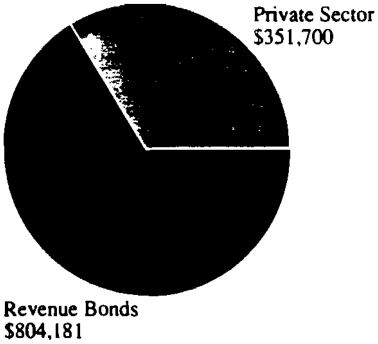
- The construction and implementation of this final stage would produce gross annual debt service coverage exceeding 1.33 with zero initial advances.

- This stage would generate $249 million of excess cash flow through the year 2031 to repay the initial advances of Stages 1 and 2 with $395 million generated from net cash flows to repay capital investment to franchisees and other private investment.

System Financing Sources

Stage 3 – Includes Inflation

($000)

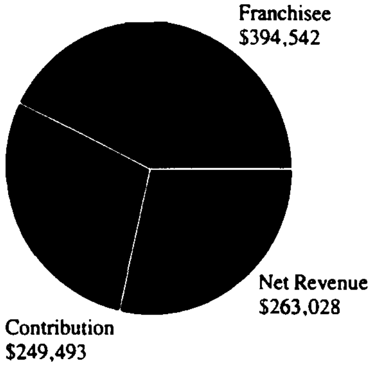


Source: Underwood, Neuhaus & Co.,Inc.

System Revenues Available 1998-2031

After Debt Service

($000)



Source: Underwood, Neuhaus & Co.,Inc.

Note: Revenues reflect amounts generated through 2031. Additional revenues are available subsequent to this date. (See Appendix G.)

E. CONCLUSIONS

The financial analysis and findings herein outlined indicate that the Texas high speed rail system, when constructed in stages, is an economically sound project. An integral part of the financing includes the advancement of funds for preliminary work on the system design prior to incurring substantial interest costs for permanent long-term financing. The analysis indicates substantial cash flow can be generated to entice the investment of capital from rolling stock suppliers and other private interests; however, this investment and the securing of private resources is critical to the success of the implementation of high speed rail in Texas.

SECTION X
ECONOMIC IMPACTS

A. TEXAS' PRESENT ECONOMIC POSITION

Texas has been recovering from the effects of oil price devaluation for some time. Leading the recovery is growth in the services industry which has added thousands of jobs in Texas during the latter part of 1987 and 1988. Manufacturing, especially durable manufacturing, is also strong. Industries that produce capital goods, such as transportation equipment and fabricated metal products, continue to create new positions. The government sector is somewhat a dichotomy - job growth continues to occur at state and local levels while federal employment declines. However, the role of the federal government in Texas is quite important, due to the variety of endeavors dependent upon federal funds.

Texas' recovery continues at a slow but steady pace.

The remainder of Texas' economy is stagnant, as the shortage of investment capital and the reduction in disposable income over the last several years are still holding down spending. There is ample evidence, however, that Texans are actively working to stimulate economic development. In the meantime, the recovery continues a slow but steady pace and it is expected that current trends will remain stable for 1989.

Although they may depend upon each other for business, retail, and commercial inter-action; the five cities which comprise the terminals for the Texas Triangle each have their own individual economic indicators:

1. Dallas

As the financial center of Texas, the economic base of Dallas has been hit hard over the 18 months of 1987 and mid-1988. Most of the problem loans of the financial institutions are tied to real estate and development. As the rate of non-performing loans has risen, economic growth has dropped to zero. Despite these problems, there are some positive signs for the Dallas economy. Manufacturing, of which "high tech" has a significant share, has experienced a rise in exports as a result of the lower dollar. In addition to being a financial center, Dallas is also a center of commerce, especially retail trade. Indications are that trade is outperforming the economy as a whole. The Dallas/Fort Worth International Airport complex is a major asset and a job generator for the Dallas market.

2. Fort Worth

The transportation complex surrounding Dallas/Fort Worth International Airport continues to stimulate economic growth in the Fort Worth area, creating jobs in the transportation, manufacturing and wholesale trade industries. Over 25 percent of the economic output of Fort Worth is derived from the manufacturing industries which have taken advantage of the improved international trade climate. Defense related manufacturing, in particular, is a large element of the Fort Worth economy. Trade, finance, insurance, real estate, and construction are all suffering varying degrees of hardship; however, industries that sell their products outside the area are balancing the economy.

3. Houston

The Houston economy has strongly improved during 1987 and 1988, although the depths of the recession helped exaggerate the percentage rate of recovery. With the exception of the development-related sectors of the economy (including the financial sector), all industries are showing employment gains during the past year. There are several factors which account for this expansion:

- The low starting base - most industries have not approached the pre-recession peak level of employment.
- Consolidation of many field operations at the headquarters in Houston, with mining the prime example.
- The national export boom in manufactured goods, many of which are produced in, and shipped from, Houston.
- The relatively low cost of doing business in Houston, especially as compared to non-Texas urban areas.

4. Austin

The traditional base of the Austin economy has been government. As the State Capitol and home to the principal campus of the University of Texas, almost 30 percent of the wage and salary jobs in the metropolitan area come from the public sector. The perception of Austin as having a high quality of life has combined with the research capabilities at UT to make the city an attractive site for "high tech" manufacturing firms, a trend well evidenced by the location of two major research consortiums in the last five years.

Austin experienced a tremendous real estate boom in 1983-1985, with substantial overbuilding, particularly commercial office buildings. Austin has had the highest vacancy rate of office buildings in the nation for some time. Although absorption may be picking up, it will be some time before excess capacity is absorbed. The ripple effect of overbuilding has damaged not only the real estate community, but the financial sector as well.

5. San Antonio

The relative stability of the San Antonio economy can be traced to two principal factors - government and tourism. With five Air Force bases in the area, a large Army base, and a huge retired military population, the federal government is the source of income for many San Antonio residents. Since this income is not affected by state or local economic conditions, San Antonio has been well positioned to weather much of the economic woes that have afflicted Texas since 1984. Tourist dollars represent another source of sales and income that are not affected substantially by Texas trends. Recent openings of new tourist attractions and hotels will expand the assets of this industry. Another industry being developed is "bio-technology", with several research centers and a number of firms beginning to create and market products for a variety of applications. San Antonio also serves as a financial center for much activity on the border.

B. TEXAS' ECONOMIC OUTLOOK

The current problems of the Texas economy should be largely overcome within the next several years as the majority of the restructuring of the financial industry will likely have occurred. The resurgence of the manufacturing industries and such diverse factors as international trade with Mexico and the attractive business climate of the State should help Texas run slightly counter-cyclical to the expected national recession in 1989 or 1990. The Texas economy is expected to diversify and expand in the next 25 years.

The Texas economy is expected to diversify and expand in the next 25 years.

The recovery of the Texas economy will result in associated growth in economic health of the five Triangle cities. Dallas' long-term economic outlook is good. The problems with the area's financial sector are not expected to persist beyond the next five years, which leads to the projection that economic expansion in Dallas should exceed that of Texas within the next several years. More than many other Texas cities, Fort Worth's economy more closely parallels that of the nation as a whole. Fort Worth is forecasted to expand more rapidly than Texas as whole, both in the short and long term. Houston is expected to be the growth leader in Texas over the next three years, with a rate of real overall expansion that should be almost double that

Problems with Dallas' financial sector are not expected to persist beyond the next five years.

Fort Worth's economy should expand more rapidly than Texas as a whole.

Houston should be the growth leader in Texas over the next three years.

Austin and San Antonio should enjoy solid growth over the next several decades.

of the state as a whole. Long term growth rates in Houston should level somewhat, but are expected to remain solid. Austin will continue to absorb excess office space and clear non-performing loans that are stunting its real estate market. Following these improvements in its economic posture, Austin should enjoy solid growth through the next several decades. San Antonio should experience a solid expansion in its economic posture over the next three years and beyond, primarily due to its solid foundation in military and tourism spending.

C. EFFECT OF HIGH SPEED RAIL ON THE TRIANGLE ECONOMY

Indirect benefits are often the deciding factor when an expenditure of public funds is being considered.

Whenever an investment of the magnitude of the Texas high speed rail project (Texas HSR) is under consideration, careful evaluation must be made of both the costs and benefits of implementation. At the same time, the question of a project's costs and benefits must be posed in terms appropriate to the situation at hand. Cost-benefit analysis is a bedrock of many business decisions. If the anticipated direct revenues to be derived from a given course of action outweigh the corresponding direct outlays, then the decision typically is to proceed. When the proposed project involves the expenditure of a substantial amount of public funds, however, the criteria used to evaluate financial feasibility shift to broader social considerations. In addition to the direct costs and benefits associated with the initiative, certain indirect "spillovers" must be factored into the equation. For example, indirect costs such as a negative impact on the environment may prevent the construction and operation of a facility which would otherwise have been built. On the other hand, indirect benefits are often the deciding factor when an expenditure of public funds is being considered. In many instances, direct benefits alone cannot justify spending for socially desirable public goods.

The focus of this analysis was on the direct, indirect, and "spillover" benefits which would accrue to the State and its major urban areas if the HSR is built. The benefit stream would not be limited, however, to fees collected for the use of the train. Whenever an infusion of funds occurs, there are multiplier, or "ripple", effects on spending, income, and job creation throughout an area. This economic analysis examined the multiplier impact for both the initial capital investment for construction and the funding of ongoing operations, as well as the effect of the expected increase in tourist activity in Texas' major urban areas.

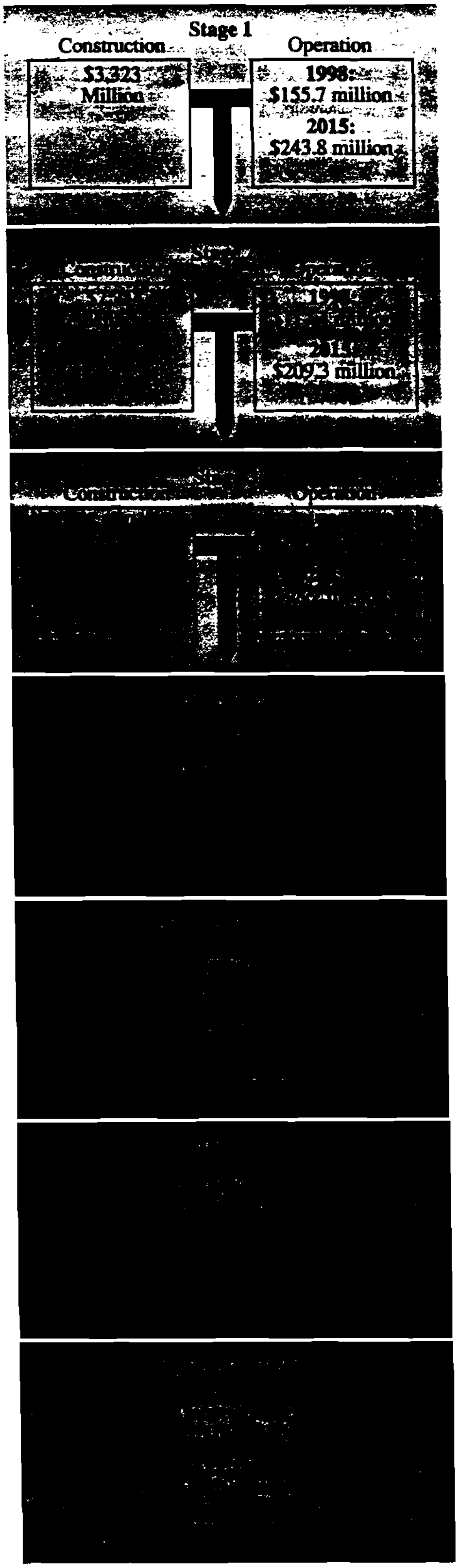
In addition to these obvious direct and indirect outlays, the potential economic development implications of adding a resource such as the HSR to the asset base of the state was explored. This element of the analysis is based on assumptions regarding the "value-capture" of goods and services that are presently purchased outside Texas and the creation of new expenditures for industrial targeting. More specifically, two scenarios were developed. Although both are extremely cautious, they revealed the possibilities inherent in a project of this nature. A synopsis of target industry potential generated by high speed rail was also included. In summary, the study provided a complete analysis and review of the expected and potential economic benefits that may be derived from the HSR. All expenditure and earning amounts are expressed in constant 1988 dollars throughout this section.

1. Construction and Operation

Based on total estimated "in state" construction spending of approximately $2.88 billion, an additional $4.1 billion would be spent in Texas, bringing the total new expenditures related to the construction phase of HSR to $6.98 billion (see **Figure X-1**). For every dollar spent directly to build the facility, a total of $2.43 in spending would ripple through the economy. Approximately half of the spending would occur in the course of building Stage 1, with Stage 2 generating 30 percent and Stage 3 accounting for the remaining 20 percent. The industry receiving the largest share of the total outlays would be construction; but, it is interesting that over 25 percent of the new spending would be for manufactured products, while "services" would capture about 17 percent. Other industries would receive smaller slices of the spending pie. Although the least relative impact would be felt in commodities, i.e., agriculture and mining, these industries can nonetheless expect an increase in aggregate activity in excess of $168 million.

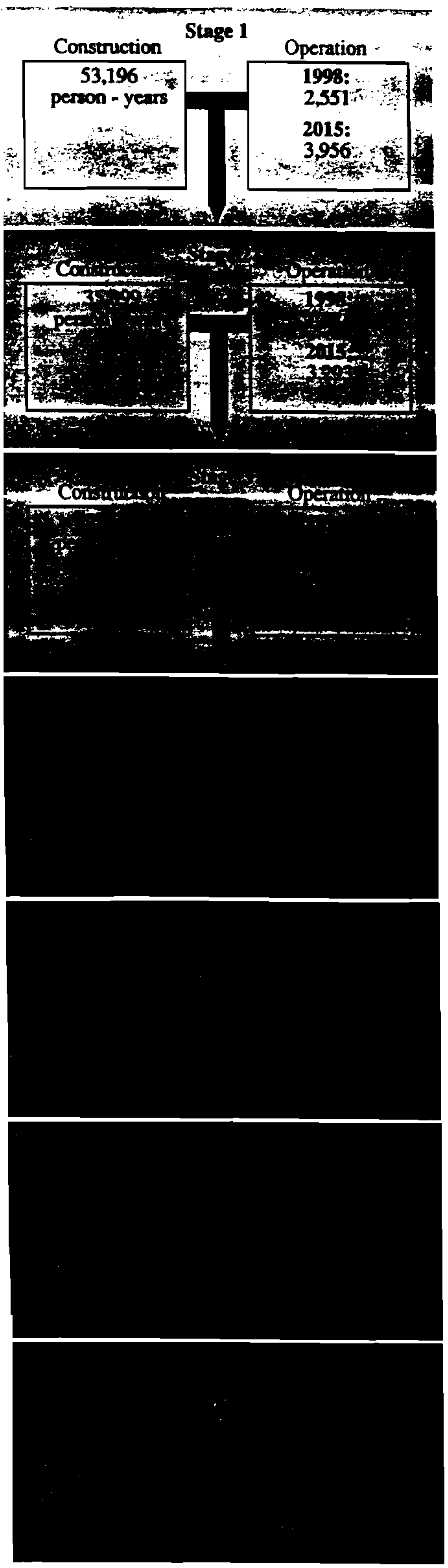
In addition to the benefits of increased spending via construction, the infusion of funds derived from the costs of the ongoing operations of the facility were considered. Initially, the model was created to estimate the ripple effect of operations-related spending in 1998, i.e., the initial year of operation. The anticipated effects were then calculated in 2015, when the system would be expected to reach its sustainable level of ridership and real revenue. Based on an engineering assessment of fixed and variable costs of the system's actual operation and the supplemental revenues generated from factors such as parking and concessions, the level of new direct and indirect expenditures derived from ongoing operations was projected to be approximately $351 million in 1998; by 2015, this amount would increase to $569 million. Most of this spending would be distributed relatively evenly among services, finance, insurance, and real estate, trade, the regulated industries, and manufacturing. To put the total impact of the construction and operation of the Texas HSR in perspective, it should be noted that every major industry group except those predicated on commodities (mining and agriculture) could see spending for their products and services increase by over $500 million dollars once the full impact of the project was felt in 2015.

Figure X-1
New Expenditures as a Result of the Texas HSR



Source: M. Ray Perryman Consultants, Inc.

Figure X-2
Job Creation as a Result of the Texas HSR



Source: M. Ray Perryman Consultants, Inc.

Similar overall patterns tended to be observed when the economic impact of construction and operation was measured in terms of new jobs created (see **Figure X-2**). A total of 111,118 person-years of employment was predicated upon spending generated over the life of the construction phase of the project, with operations ultimately leading to 9,042 permanent positions in Texas. The structure of new earnings (see **Figure X-3**) was also similar to that of expenditures and employment, although income would tend to be proportionately higher in industries which are relatively labor-intensive, such as services.

2. Tourism

A variety of factors surrounding the HSR are expected to expand tourist activity in the five urban areas to be joined by the system. The principal cause would be simply an increase in the ease of travel. In addition, the novelty of the train may lead tourists to choose HSR who might otherwise not have traveled at all. Based on estimates of induced ridership, the ripple effect of increased tourist activity was projected to provide over $115 million in new expenditures, $39 million in new income, and over 2,500 permanent new jobs in all major sectors of the Texas economy at the onset of operations. By 2015, these totals would increase to $298 million in spending, $102 million in earnings, and 6,500 jobs.

3. Economic Development

In a very real sense, the HSR represents a true economic development initiative for the state. It would enhance the asset base available to both current Texas business concerns and potential industrial relocation prospects. A highly technical process was undertaken to evaluate the potential economic development implications of the project under two different scenarios, both of which assumed that the project would capture a portion of the existing local market for goods and services which would benefit from high speed rail and which are presently being imported from other areas. In the first scenario, value-capture rates of 2.0 to 10.0 percent were assumed, depending on the industry in question and its potential for utilization of the HSR. In the second scenario, a flat value-capture rate of 20 percent was assumed for all industries which would find high speed rail to be a substantial potential benefit and which are presently exported by at least one of the five urban areas. In both cases, no growth or expansion of the market was assumed and no sales outside of Texas were examined. Consequently, both scenarios were extremely guarded in their estimates of the potential economic development impact of the project. **Table X-1** summarizes the jobs estimated to be created under the two scenarios.

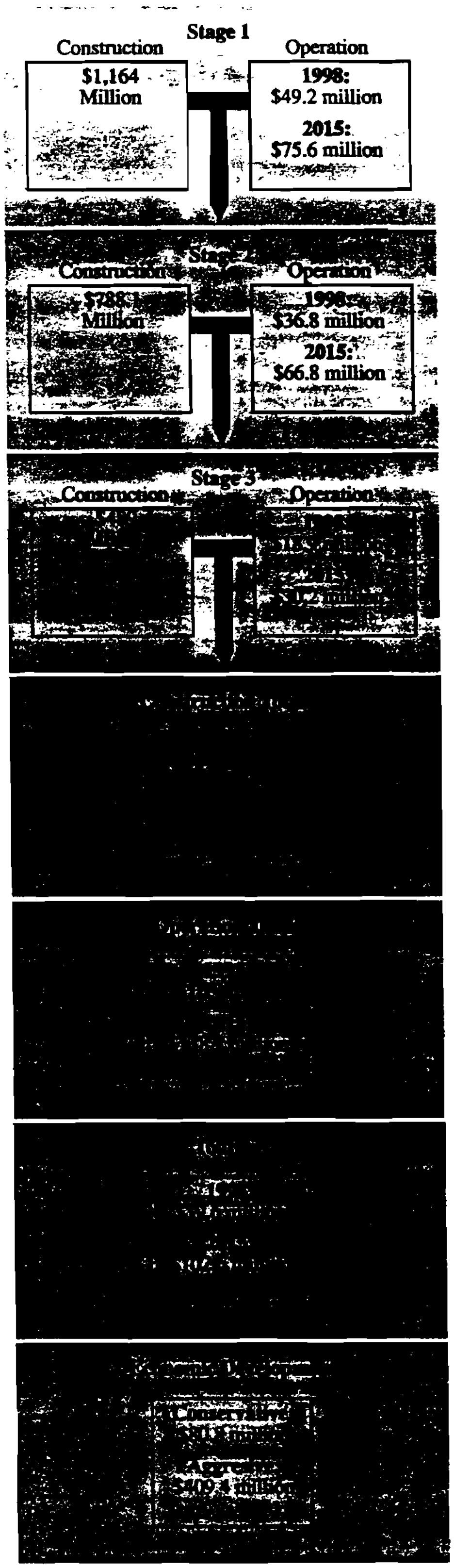
TABLE X-1

Two Scenarios for Job Creation in Texas as a Result of the Potential Economic Development Associated With the Texas HSR

	By Industrial Sector	
	Conservative	Aggressive
Agricultural Products	60	324
Forestry & Fishery Products	1	7
Coal Mining	2	8
Crude Petroleum & Natural Gas	9	48
Miscellaneous Mining	3	15
New Construction	17	84
Maintenance & Repair	60	317
Food Products & Tobacco	41	221
Textile Mill Products	1	8
Apparel	35	206
Paper & Allied Products	22	166
Printing & Publishing	82	435
Chemicals & Petroleum Refining	71	455
Rubber & Leather Products	25	125
Lumber Products & Furniture	31	190
Stone, Clay, & Glass	11	59
Primary Metals	18	100
Fabricated Metal Products	69	439
Nonelectrical Machinery	245	1,079
Electric & Electronic Equipment	352	1,601
Motor Vehicles	2	11
Other Transportation Equipment	23	80
Instruments & Related Products	14	73
Miscellaneous Manufacturing	30	149
Transportation	206	802
Communication	59	300
Utilities	16	83
Wholesale Trade	307	1,553
Retail Trade	332	1,693
Finance	53	260
Insurance	54	269
Real Estate	58	305
Hotels & Amusements	82	446
Personal Services	71	361
Business Services	493	2,310
Eating & Drinking Places	200	991
Health Services	173	1,202
Miscellaneous Services	224	1,350
Households	55	277
TOTAL	**3,604**	**18,398**

Source: M. Ray Perryman Consultants, Inc.

Figure X-3
New Earnings as a Result of the Texas HSR

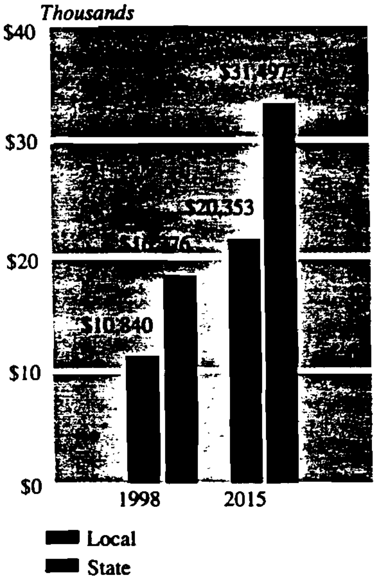


Source: M. Ray Perryman Consultants, Inc.

Under the first (or more conservative scenario, the level of new expenditures was projected to be approximately $261 million, while new earnings approached $81 million. A total of 3,604 permanent positions would be created in all major industry groups in Texas, with over one-third being "primary" or "export-oriented" jobs. Under the second set of assumptions, expenditures would increase to $1.33 billion, total earnings would climb to $596 million, and the number of new Texas jobs would reach 18,398, with approximately 6,500 of these positions being export-oriented. Even beyond the estimated impact of economic development surrounding the Texas HSR, the presence of a new resource would help create a more favorable environment for certain categories of business. Included in this analysis was a list of 56 industries which could be targeted for relocation or expansion by virtue of the presence of high speed rail in Texas. All of these sectors are presently net importers in each of the five metropolitan areas. Moreover, they would benefit from this particular type of transportation service and have no structural impediments to a location in Texas.

It is evident that both the direct and multiplier economic impact of building and operating the Texas HSR could be enormous. The construction phase alone would generate almost $7 billion in new spending and 111,118 person-years of employment, while ongoing operations would lead to 9,042 permanent positions. When the positions derived from ongoing operations are combined with the jobs created as a result of increased tourist activity, Texas payrolls would expand permanently by over 15,000 workers. The phrase "good jobs at good wages" is applicable; many of these jobs would be in industries that sell their products and services outside of local markets and, thus, bring further income to the State.

Figure X-4
Anticipated Annual Tax Revenues Related to HSR



Source: M. Ray Perryman Consultants, Inc.

4. Increased Tax Revenue

One obvious byproduct of the operations, supplemental activity, and induced tourism associated with the Texas high speed rail project is the generation of new tax dollars for state and local governments. Using the relevant fiscal impact multipliers from the U.S. Travel Data Center, localized to the structure of the individual counties in the system, it was estimated that state revenues will total approximately $16.8 million in 1998 and $31.5 million in 2015. For local public entities, the corresponding revenues are anticipated to be $10.8 million in 1998 and $20.4 million in 2015. (See Figure X-4.)

D. CONCLUSIONS

The economic development implications of the Texas HSR are an important rationale for its implementation. The potential impact of the results of the economic development process was modelled under two cautious scenarios; the results barely scratch the surface of the facility's potential. Nevertheless, at a minimum, an additional 3,600 jobs could be created. If the more aggressive of the two scenarios occurs, then the Texas employment base could increase by over 18,000 permanent additional workers. The principal limitation of this analysis was its assumption that the existing market would remain static and that the Texas HSR would only value-capture services that currently are purchased out of state. One of the truths of the economic development process is that new opportunities present themselves in a time and fashion that cannot always be anticipated. The key to continuing success is to foster the development of resources that can both provide new opportunities and maximize those that occur as a result of other activity. The Texas HSR would be a quintessential example of exactly such a resource.

SECTION XI ENVIRONMENTAL CONSIDERATIONS

Development of a Texas high speed rail system will require careful consideration of the social and environmental consequences of its construction and operation. A comprehensive assessment of a number of impacts regarding social, biologic, and biotic values must be made, along with an analysis of possible trade-offs or mitigation procedures. Whether or not federal funds are used for the project may determine the extent to which these factors must be considered. However, regardless of the source of funding, there are a number of laws and regulations that will apply and that will affect implementation plans, schedules, design criteria, and other activities involved with the project. **Tables F-1 and F-2**, included in **Appendix F**, outline the known state and federal laws and regulations which may apply to the HSR program.

The environmental analysis performed for this study concentrated on identifying the laws and regulations referred to above and recognizing the readily apparent impact considerations that must be further examined in detail during project development. The impact considerations discussed below would apply to any alignment ultimately selected for the HSR.

A. IMPACT CONSIDERATIONS

1. Air Quality

System-wide, high speed rail would be viewed as beneficial in terms of air quality. By offering an alternative mode of travel, rail provides an opportunity to reduce the negative air quality impact of vehicular and airline traffic. The emissions associated with rail operation are generally considered minor compared to emissions associated with motor vehicles and aircraft take-offs and landings. The **Very High Speed (VHS)** rail system would be electrified, which would allow more efficient energy conversion at a central power facility. Other, alternative fuel sources could be employed such as coal, nuclear, oil, or gas.

High speed rail would be viewed as beneficial to air quality as compared to air and automobile modes.

Vehicular traffic generated at stations and associated parking facilities could result in higher emission concentrations in the localized areas. The air quality impact for such areas should be evaluated when location, design, and traffic and circulation data is available for the various stations.

Construction activities could impact air quality on a temporary basis due to equipment emissions, traffic diversion, dust producing construction activities, clearing, and burning. Throughout the project area, examination of and compliance with local regulations controlling these construction activities would be necessary. Various construction practices are available which would reduce temporary negative air quality impacts.

2. Biological Resources (Threatened or Endangered Species)

The HSR alignment will traverse areas supporting a wide variety of plant and animal species. Information provided by the Texas Parks and Wildlife Department's Natural Heritage Program indicates that numerous special species (including those species which are state and federally listed as threatened or endangered) and natural communities are known to occur in many of the counties traversed by high speed rail. Surveys of the project area by qualified biologists should be conducted so that sensitive habitat areas and natural communities can be avoided or mitigation can be developed during alignment definition and preliminary engineering.

Sensitive habitat areas and natural communities should be avoided or mitigation developed.

3. Cultural Resources

Section 106 of the National Historic Preservation Act of 1966; Section 4(f), of the Department of Transportation Act of 1966; the Antiquities Code of Texas; and Chapter 26 of the Texas Parks and Wildlife Code provide procedures to protect parks, historical and archeological resources. Section 106 directs Federal agencies to evaluate the effect of a proposed action on any district, site, building, structure, or object eligible for, or included on, the National Register of Historic Places. Section 4(f) specifies that projects requiring the use of land from a significant publicly owned park, recreation area, wildlife and waterfowl refuge, or any significant historic site may not be approved unless the following determinations are made:

- There is no feasible and prudent alternative to the use of land; and
- The action includes all possible planning to minimize harm to the property resulting from such use.

The Antiquities Code of Texas provides permitting procedures for survey, excavation, demolition, or restoration of State archeological landmarks or for the discovery of eligible landmarks on public land. State archeological landmarks and sites eligible for designation include the following:

- "Sites, objects, buildings, artifacts, implements, and locations of historical, archeological, scientific, or educational interest, including those pertaining to prehistoric and historical American Indians or aboriginal campsites dwellings and habitation sites, their artifacts and implements of culture, as well as archeological sites of every character that are located in, on, or under the surface of any land belonging to the State of Texas or to any county, city, or political subdivision of the state."

Chapter 26 of the Parks and Wildlife Code of Texas specifies that programs or projects requiring the use or taking of any public land designated or used as a park, recreation area, scientific area, wildlife refuge, or historic site meet the following requirements prior to approval by a department, agency, political subdivision, county, or municipality of the site:

- there is no feasible and prudent alternative to the use or taking of such land; and

- the program or project includes all reasonable planning to minimize harm to the land as a park, recreation area, scientific area, wildlife refuge, or historic site resulting from the use or taking.

In order to comply with the various regulations described above, inventories should be completed to identify public parks and listed historical and archeological sites within the project area. Surveys of the project area should also be completed to identify those sites, etc., which are not currently listed but are eligible for inclusion on the National Register of Historic Places or as State Archeological Landmarks.

Inventories of parks, historical, and archeological sites must be completed; and they should be avoided, where possible.

Where possible, the alignment should avoid parks and historical and archeological sites. In situations where these sites cannot be avoided, the procedures of the above described regulations must be followed.

4. Electromagnetic Interference

By using electrically powered equipment, the potential for electromagnetic impact exists. The extent of this impact would need to be evaluated once alignments have been identified and design characteristics determined. Appropriate mitigation measures, such as shielding, are available and could be proposed once impact has been established.

5. Farmland

All alternatives, particularly those utilizing new right-of-way, could involve the use of farmland. To comply with the terms of the Farmland Protection Policy Act, coordination with the U.S. Department of Agriculture Soil Conservation Service should be initiated early on in the engineering and environmental study phases of the project. Appropriate soil conservation procedures and forms including the Farmland Conversion Impact Rating Form (AD-1006), would need to be completed.

6. Hazardous Waste Sites

Hazardous waste sites, which are regulated by the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), should be identified during the early planning stages. The identification of permitted and non-regulated hazardous waste sites would be accomplished through coordination with the Environmental Protection Agency (Region VI) and the Texas Water Commission. Field surveys should also be completed to identify sites not listed by these regulatory agencies. All sites should be clearly marked and avoided if at all possible. Mitigation measures and/or appropriate "clean up" procedures should be developed and followed for those sites affected by the project.

7. Land Use

The greatest potential for land use impact would be in the station area locations. These areas could experience secondary changes in land use patterns due to the location of the stations. New commercial and possibly some residential uses in the station areas and the transportation corridors extending from the stations could be expected. Coordination with local officials should take place in the station area planning phase so that consistency with local plans and ordinances can be assured.

The project could impact land use in both urban and rural areas by restricting access. Once alignments are established, area land use and traffic patterns should be analyzed and mitigation developed, such as grade separations, for those areas which could be isolated by the high speed rail facility. Other considerations, particularly noise, vibration, and visual impacts of high speed rail, could influence land use patterns in the vicinity of the facility.

8. Noise and Vibration

Federal agencies, including the Department of Transportation, Environmental Protection Agency, and Department of Housing and Urban Development, are involved in regulating noise impact. In addition, many municipalities have noise ordinances which must be complied with during construction and operation.

The construction and operation of high speed rail has the potential of adversely impacting noise and vibration levels. Sources of noise and vibration during construction include the operation of heavy equipment, demolition activities and traffic detours. Sources and levels of operational noise and vibration will vary depending on the technology selected with its specific design features and operating characteristics.

Noise sensitive areas should be avoided or mitigation measures should be developed.

Certain types of land uses and structures are sensitive to noise and vibration impacts. Inventories of noise and vibration sensitive uses/structures, such as residential areas, churches, schools, hospitals, parks, recording studios, and historic structures, should be conducted within alignment corridors. These sensitive sites should be avoided as much as possible to minimize impact. However, these uses are more likely to be encountered in dense urban areas where avoidance alternatives are limited. In areas where adverse impacts are indicated, mitigation measures, such as noise barriers, should be developed. Facility design alternatives are also available which reduce noise impact. Extensive noise and vibration analysis, including monitoring and projections, would need to be conducted to evaluate the extent of potential impact.

9. Relocation and Acquisition

The extent of acquisition and relocation necessary for high speed rail cannot be determined at the feasibility study stage. Acquisition would be minimized on alignments using existing right-of-way. Alignments using new right-of-way should be located to limit acquisition of improvements and parcel bisection. However, for a project of this magnitude, substantial acquisition would be unavoidable. Acquisition and relocation would be more likely where urban areas would be bypassed or on new location in rural areas. Acquisition of existing railroad right-of-way would be preferable in the dense urban areas of San Antonio, Houston, Dallas, Fort Worth, and Austin.

Once alignments have been more accurately defined, acquisition and relocation impacts can be determined. Any acquisition and relocation program must be conducted in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended.

10. Visual

Visual impact is an aesthetic judgement which would be evaluated by examining the relationship of the proposed facility to the surrounding environment. The extent and nature of visual impact would vary with location, technology and design. With sensitive selection of alignment routes, visual impact in urban areas can be greatly minimized. Alignments which would use existing right-of-way offer the best opportunities for reducing visual impact in urban areas. In rural settings, the visual impact has the potential of seeming more obtrusive because of the scarcity of man-made structures. Local ordinances governing aesthetics, such as landscaping requirements, height restrictions, and building material restrictions should be closely examined and followed.

11. Water Resources

a. Floodplains

The high speed rail alignment would traverse floodplains associated with numerous rivers, streams, creeks, and drainage channels. When alignments are more accurately defined, flood insurance rate or flood hazard boundary maps should be consulted to identify floodplain boundaries. Design measures, such as bridges and culverts, would need to be taken to minimize impact to floodplains.

Local ordinances and regulations should be examined and complied with once alignments are more accurately defined. Federal regulations including Executive Order 11988, Floodplain Management; Department of Transportation Order 5650.2, Floodplain Management and Protection; and U.S. Army Corps of Engineers rules may be applicable and should be taken into consideration in alignment definition and facility design.

b. Navigable Waters

Several rivers would be crossed by the high speed rail alignments including the Blanco, Brazos, Colorado, Guadalupe, Navasota, San Gabriel, San Marcos, and Trinity Rivers. Many of the rivers would likely be considered navigable waters subject to Sections 9 and 10 of the Rivers and Harbors Act of 1899. The U.S. Coast Guard issues permits for the construction of bridges over navigable waterways under Section 9. Section 10 is administered by the Corps of Engineers and covers any work, including excavation, fill, alteration, or modification of the channel. Once alignments are better defined, jurisdictional determinations should be requested from the Corps of Engineers and Coast Guard.

c. Water Quality

The Texas Water Commission (TWC) is the primary agency in Texas responsible for restoring and protecting the water quality of the State's surface and ground waters. Both federal and state regulations are used by the TWC to accomplish its water quality objectives.

Texas is divided into 23 river basins, six of which are traversed by the high speed rail alignments including the Brazos, Colorado, Guadalupe, San Antonio, San Jacinto, and Trinity River Basins. Water quality standards and data are established and maintained by the TWC for surface water segments in each of the river basins.

The high speed rail alignments would cross major aquifers within the State including the Edwards, Carrizo - Wilcox, Gulf Coast, Alluvium, and the Trinity Group. Various State and Federal agencies including the TWC, Texas Water Development Board, Texas Department of Health, Texas Bureau of Economic Geology, various Underground Conservation Districts, and the U.S. Geological Survey are involved in ground water protection and monitoring. The TWC can make specific rulings to protect sensitive ground waters, such as the Edwards Aquifer in Central Texas.

The TWC develops and issues permits which specify wastewater quality for wastewater discharges. Coordination and permit application with the TWC would need to be initiated should the high speed rail project involve wastewater discharges. State effluent regulations found in Title 31 of the Texas Administrative Code must be met in the design and operation of high speed rail facilities.

d. Wetlands

Protection of wetlands is addressed in Executive Order 11990 and regulated in Section 404 of the Clean Water Act. Section 404 regulates activities that involve placing dredged or fill material in "waters of the United States" which include navigable waters, the channels and floodways of other tributaries and streams, lakes and adjacent wetlands. Wetlands are defined as lowlands covered by shallow and sometimes temporary or intermittent waters. The type of land areas usually considered wetlands include swamps, bogs, marshes, shallow lakes and ponds with emergent vegetation, and other lands that are periodically or permanently covered with water or that support vegetation which grows in wet areas.

Wetland areas can be expected to be encountered within the various high speed rail corridor segments. Wetland inventories should be conducted so that avoidance of wetlands can be attempted during alignment definition. Coordination with the Corps of Engineers would be necessary for jurisdictional determinations and to conclusively identify and classify wetlands. For situations where wetland impact cannot be avoided, mitigation measures would need to be developed in coordination with the Corps of Engineers.

e. Wild and Scenic Rivers

Within the State of Texas, only one segment of the Rio Grande River is currently included as part of the National Wild and Scenic River System. The 1985 Texas Outdoor Recreation Plan has recommended other Texas rivers for the National System, but these have not been approved. Although impact to National System designated rivers is unlikely, coordination with the Texas Department of Parks and Wildlife should be initiated to confirm that there are no designated rivers affected by the project.

f. Other Considerations

Additional social and environmental considerations, other than those identified above, could be involved, depending upon the final alignment of HSR within a corridor. Each community, either in close proximity to the rail line or through which the lines are routed, will have certain characteristic goals and aspirations. Such considerations must be recognized and carefully considered as decisions on project details are made.

B. CONCLUSIONS

A comprehensive environmental analysis will be required for the Texas high speed rail system, regardless of whether federal funds are utilized in its development. Any project of this size, which would affect such a broad area of Texas, will have social, economic and environmental impacts, both locally and region-wide. Considerable coordination with local, state, and federal agencies will be required, as well as private sector organizations, associations, interested parties, and the public. All proposed actions must be considered in consonance with those state and federal environmental laws and regulations which may apply to the project.

SECTION XII
IMPLEMENTATION

The Texas high speed rail feasibility study represents the first step in a long and complex process of bringing the project to fruition. Determining that high speed rail is relevant to Texas and that it is a feasible addition to the State's transportation system, while significant, does not, in itself, result in implementation of the system. Adoption of the recommendations of this study should lead to the initiation of continuing analyses including the refinement of potential ridership; revenues; economic benefits; costs of construction, operation and maintenance; environmental analysis; enabling legislation; preliminary and final engineering design; right-of-way and other land acquisition; awarding of construction contracts; equipment acquisition and testing; and, finally, staffing and training the operating entity and commencing service. These elements must be carefully identified and scheduled on an interactive basis and managed effectively from beginning to completion. The information developed for this study should serve as the guide to successful planning and correlation of future activities.

The development of a high speed rail system, from initial feasibility planning to completion, is a lengthy process involving the careful meshing of numerous tasks. As an indication, the following development times of other HSR systems provide insight into the length of the process:

The development of a high speed rail system is a lengthy process.

France	TGV-SE	1969-1981	12 years
France	TGV-Atlantique	1975-1989	14 years
Germany	ICE	1970-1991	21 years
Florida	HSR	1975-1995	20 years (proposed)

The information developed for this study will need to be augmented by additional studies, planning, and engineering on individual elements to provide the level of information and technical input implicit in a project of this magnitude. The various studies, planning projects, and other actions are discussed individually under their specific headings.

The next technical phase of implementation will include development of revenue projections and engineering to a level sufficient to support revenue bond financing.

A. RIDERSHIP REFINEMENTS

Travel demand in the corridors between study cities was measured and ridership forecasts were made based upon certain basic assumptions that may or may not be valid in the future. The assumptions regarding ridership were:

1. There would be a continuation of existing development trends in the study cities, e.g., densities, urbanization, etc., would continue as in the past.
2. The relative character, functions, and interrelationships of the study cities would continue.
3. The trip making characteristics of travelers would continue in the future.
4. No basic technology changes would occur from those presently existing as regards communications or existing transportation modes.

5. The same transportation capability available today will continue to exist as regards the airline and highway systems; however, congestion on these modes is expected to increase.

6. Present energy sources would continue to exist in future years at the same relative availability and cost.

The expectations that all of the above assumptions will continue in the future as they have in the past is open to conjecture. Further studies would confirm or provide a more assured basis for modifying these basic assumptions. Additional scenarios which reflect changes in the assumptions and their sensitivity need to be tested and evaluated.

Forecasting future ridership for a new mode of transportation, which is non-existent in Texas or in the United States, presents problems in establishing formulae for diversions and attractions from existing modes. Travel demand models developed for this study assumed certain traveler characteristics based on travel surveys and focus group perceptions of high speed rail. This information was used to determine the modal split and to also estimate induced travel forecasts. The demographics and geographics in the United States are different from those countries that presently have functioning high speed rail systems with reliable information on before/after comparisons of modal diversions. Refinements of the ridership forecast models contained in this study would, therefore, provide an increased confidence in ridership and revenue forecasts. These refinements would also provide greater credibility of system design (number of train sets, consists, etc.) and increased certainty in the financial forecasting and recommend means of funding.

B. ENGINEERING ANALYSIS

The conceptual design and "order-of-magnitude" cost estimates performed in this study need further analysis to determine the precise route and alignment of the facility. The refinement of engineering design will be necessary to prepare more reliable cost estimates, establish general right-of-way needs, and enable more detailed environmental analysis to be made.

The next phase of project development would focus on those items of work necessary to support revenue bond financing of Stage 1 (Fort Worth - Dallas - Houston) of the high speed rail system. It would also refine elements of Stages 2 and 3 to assure that implementation of Stage 1 will be consistent with the future needs of Stages 2 and 3.

The engineering work performed in the next phase would include advancement of the design of Stage 1 to a level which would permit preparation of reliable estimates of cost for construction, right-of-way, signalization, rolling stock, train operations, and maintenance. Major tasks to be performed include:

1. Utilizing aerial planimetric mapping, develop a schematic layout of the entire route between Houston, Dallas, and Fort Worth, including the following:

    a. Horizontal and vertical alignments for main line tracks, including all switching arrangements.

    b. Station layouts, including terminal, parking, and platform configuration.

    c. Maintenance facility layouts (both major facilities for rolling stock and maintenance-of-way) including shops, parking, yards, and storage facilities.

    d. Power supply stations and connecting power lines.

    e. Grade separations, structures, and stream crossings.

2. Geotechnical investigations for bridges, trackwork, and typical sections in cut and fill at-grade sections.

3. Preliminary drainage plan to determine structure requirements at stream crossings.

4. Schematic layouts of overhead and traction power systems.

5. Schematic layouts of signaling and train control systems.

6. Schematic layouts of communications and SCADA systems.

7. Establish rolling stock requirements and refine scheduling of improvements.

8. Preliminary right-of-way plans based on schematic layouts, planimetric data, and field surveys.

9. Suggested program of project segments for further allocation of design projects for the entire Stage 1 development.

10. Cost estimates for Stage 1 Development, with individual cost estimates for each project segment.

11. Coordinate project design with staff and elected officials of city, county, and state governments; local property owners; public utilities; river authorities; regional transit authorities; railroad companies; State Department of Highways and Public Transportation; Federal Railroad Administration; and other interested agencies, firms or individuals.

12. Assist the designated State agency (responsible for HSR) in the scheduling, conduct, and follow-up activities pertaining to public meetings and/or public hearings for the project.

The work described above should be managed by a general engineering consultant, with elements of the work subcontracted to other consulting engineering firms in the various disciplines, as required.

Upon completion of the conceptual engineering and environmental analysis phases, it will be necessary to move directly into the preliminary engineering and right-of-way determination for Stage 1 (Fort Worth - Dallas - Houston). This phase will utilize the information developed under the previous phases to clearly define the route, design features, rolling stock, right-of-way, and other features necessary for the later development of final construction plans.

After completing the preliminary design and construction cost estimates, decisions regarding segmentation and scheduling must be made in order to establish a program of development, tied to the funds programmed for expenditure. Once the individual segments have been determined, separate contracts for final design and right-of-way plans and acquisition will be awarded. By this time, the environmental investigations should have been completed in concert with the permit application and approval process.

C. ENVIRONMENTAL ANALYSIS

A preliminary analysis of required environmental actions was discussed in **Section XI**. The location, design, construction, and operation of a major new transportation mode will require a comprehensive analysis of environmental constraints and impacts. A separate study, dependent upon other phases of project development, would be necessary in order to adequately address social and environmental concerns and possible mitigations. During project development, it will be necessary to conduct a complete environmental analysis for the three legs of the Triangle, either on a system-wide basis or on individual segments. Because of the diverse terrain, habitats, wildlife, and plant life found within the regions comprising the Texas Triangle, the environmental analysis will, by necessity, be very comprehensive. In addition, considerable interaction with property owners, community leaders, elected officials, environmentally concerned agencies, and interested citizens will be essential.

The findings and recommendations developed as a result of this effort would enable the responsible HSR agency to proceed with detailed design and right-of-way acquisition based on the mitigation actions and system decisions identified by this analysis.

D. CONSTRUCTION

As plans for each segment are completed and right-of-way acquired, individual projects would be advertised for construction and contracts would be awarded to the successful bidders. It is expected that contracts would also be awarded for construction inspection, material testing, and project management. The following summarizes the type and relative order of contracts that would be required to move the project to completion:

1. Refine conceptual design
2. Environmental impact studies
3. Guide specifications for rolling stock, train control, signalization, and electrification
4. Preliminary engineering, design, and right-of-way determination
5. Final design and cost estimates
6. Right-of-way and land acquisition
7. Procurement of rolling stock
8. Permit applications and approvals
9. Advertisement and award of construction contracts to successful bidders
10. Construction inspection, testing, and management

A number of individual contracts will be required to move the project to completion.

Items 3 through 7 represent a number of contracts under each item because of the need to segment the project into reasonable lengths for concurrent construction. Project implementation requires further study with a multitude of factors influencing the schedule. For example: the times required for individual construction contracts would vary dependent upon whether the project is in a rural or urban area; whether the construction to be performed is relatively simple or complex; and whether the project is in the relatively dry north/central Texas area as compared to the east/Gulf Coast area which is subject to greater annual rainfall.

It is assumed the project would be implemented consistent with conventional public works competitive bidding procedures.

E. PROCUREMENT OF ROLLING STOCK

The procurement of rolling stock for the high speed rail system would take place concurrently with the construction process. If it is assumed that the trains would be operated by a public agency as a public utility, the following process would be required:

1. Determine the type of equipment from the generic class
2. Develop specifications and standards for competitive bidding
3. Advertise for procurement of equipment and award contract to successful bidder
4. Inspect equipment during manufacturing process or inspect upon delivery
5. Delivery and testing

If the trains are to be operated by a private franchisee under contract to the responsible State agency (as recommended in this study), a somewhat different process may be required:

1. Determine type of equipment desired (generic class)
2. Develop specifications, standards, performance levels, etc.
3. Develop scope and criteria of system operation and advertise for proposals from interested private operators
4. Award franchise to selected operator
5. Conduct test phase of facility operation prior to beginning scheduled service

Equipment procurement and system construction must be carefully coordinated.

The equipment procurement process should "dovetail" with the construction process so that whenever a useable segment of the system has been completed, control equipment would have been installed, power sources activated, stations completed, train sets ready, and staff trained to place on the tracks for final testing of the system prior to initiating scheduled service.

Further examination into various aspects of the procurement of major items would influence the approach to acquiring the equipment and the type to be acquired, such as:

- Types and levels of amenities to be furnished
- First class versus coach class accommodations
- Economics of priority freight service (shared with passenger service or off-peak service)
- Specification outline of features and issues to adapt foreign supply to U.S. supply

F. FINANCIAL AND JOINT DEVELOPMENT PLAN

Since the cash flow analysis is dependent upon cost and revenue data developed in this study for "representational" routes and "order of magnitude" costs for generic classes of technology, a more precise analysis of these factors will provide increased confidence in a refined cash flow analysis and revenue coverage. More accurate estimates of revenues and capital cost will be essential in marketing revenue bonds.

One of the premises of major transportation system development is that users should bear the burden of paying for construction, operation, and maintenance of the system, in whole or in part. However, for any completely new mode, such as high speed rail, it is hardly conceivable that users alone will be able to pay the total cost of system development and operation. If the State's highway system had depended upon highway users as the singular group of taxpayers to develop and maintain the system, Texas would not today enjoy the level of service or resultant economic benefits which it does. Instead, local governments and private property owners made available thousands of acres of right-of-way for the construction of highways.

Moreover, the Farm to Market Road system, which is so unique to Texas, was developed on the basis of General Fund money made available to the State Department of Highways and Public Transportation on an annual basis for construction of the system. Urban transportation systems have also been developed on the basis of largesse from local, state, and national grants. Airports and waterways have been subsidized by general fund monies or ad valorem taxation. Even the railroads in Texas, at least in the beginning, enjoyed the benefit of land grants from the State of Texas as a means of underwriting some of the capital costs associated with railroad construction across and within the State.

Development of a high speed rail system will involve creative financing and public/private participation.

Today, the trend of interagency or joint public/private participation continues to exist. Improvements to shallow draft and deep channel waterways require cost participation by local sponsors or navigation/port authorities. The development of new highway facilities often involves the participation of the private sector (generally landowners or developers) for such projects to prove viable from either a cost or priority standpoint. Airport development generally involves similar opportunities for creative financing. Therefore, it is reasonable to assume that development of a high speed rail system (or any link in that system) would logically involve creative financing and public/private participation.

Exploring the possibilities for joint development and creating a climate for public/private participation involves considerable negotiation and compromise of all parties. In addition, if fixed plans are to be made on the basis of joint participation, firm commitments by all parties is important. Therefore, before any financial plan can be developed and adopted as the basis for project development, it will be necessary, in conjunction with preliminary planning and right-of-way determination, to contact all interested parties who would be receptive to participating in the project. Firm commitments must be agreed upon by all parties.

Further studies will provide more precise information regarding revenue generation and capital cost options. In turn, this information will indicate what program of financing the capital, operating, and maintenance costs will be needed. Cash flow projections would be developed, assuming such variables as interest rates and bond market conditions. Meetings would be held with governmental finance officers and potential institutional investors to appraise factors which could influence the final financial plan. Meetings would also be held with potential equipment vendors and franchisees to determine potential financial support. Similar meetings would be held with local governmental agencies to evaluate potential cooperative financial assistance.

Continuous public involvement will be required as the project progresses.

The findings of this effort, including refined ridership and revenue projections, would result in a final investment grade financial plan for implementation of Stage 1.

G. PUBLIC INVOLVEMENT AND MARKETING

The development of an HSR system would require the continuous involvement of the public as planning, programming, design, and construction take place. The agency designated by the Legislature as responsible for its development must take every opportunity to involve interested parties in the development process.

A systematic project marketing plan would require the development and dissemination of factual data and information to the public and to decision makers. A project of this magnitude would impact a large proportion of the State's population. The marketing strategy program should be centralized and managed by the agency responsible for implementation and operation of the HSR system. An individual within the agency should be designated as the Public Affairs Officer, responsible for the preparation and distribution of project information.

1. Immediate Activities

Some of the immediate marketing activities that should be implemented are:

- Meetings with State Legislative Committees - Early meetings should be held with the various legislative committees in the Texas Senate and House of Representatives, including but not limited to, the committees on transportation, finance, and appropriations. Such meetings should include the presentation of testimony regarding implementation costs, revenues, operating characteristics, economic impacts, and needed legislation to proceed with development of HSR. Similar meetings should be held with the Governor, the Lieutenant Governor, and the Speaker of the House.

- Preparation of Public Information Brochure - A public information brochure should be prepared for mass distribution to major state, county, and city elected officials. The brochure should also be made available to the media, civic groups, and other interested parties statewide.

- Public Presentation - Study team members and others participating in the study can expect to be invited to present programs before a variety of audiences. The Texas Turnpike Authority and, ultimately, the agency designated by the Legislature as responsible for HSR in Texas, should prepare a speaker's list, an outline of information to be included in any presentations and, perhaps, a "standard" presentation to be used as a basic reference in preparing remarks for public meetings. Additional speaker aids such as transparencies, slides, illustrations, and handouts would be valuable material for such occasions. Additionally, "VCR" video tapes could be utilized for programs or public service television viewing.

2. Future Activities

Any new public service, to be successful, must have the continued support of citizens as well as policy makers. It must build a clientele who recognize its advantages to them personally, as well as its contribution to the economic health of the State. Accordingly, the following activities should be undertaken following the designation of the responsible agency by the Legislature and the appropriation of funds for continuation of the HSR project:

To be successful, any new public service must have the continued support of citizens and policy makers.

- The activities begun previously should be continued and expanded upon to seek an even broader understanding and support.

- The agency, through its designated public affairs officer, should contract with a firm to assist the agency in the preparation and wide dissemination of informational material to all interested groups and individuals who would help promote the development of high speed rail in Texas.

- The public affairs officer should establish working relationships with the media to provide an atmosphere of informational exchange. Periodic news releases of progress on the HSR will ensure that the public is kept abreast of the program, its status, and its progress.

- Legislators and public officials must be kept fully informed of developments on the HSR and be advised of its progress. Locally elected officials should be briefed at periodic intervals so that they can be kept aware of what is happening in their respective areas.

- Every opportunity should be taken to meet with and inform concerned citizen groups and organizations of HSR progress. In addition, interested industry associations, such as the Associated General Contractors, Texas Good Roads/Transportation Association, and others, should be kept similarly informed.

A strong, ongoing marketing program will be essential.

A strong, ongoing marketing program should be implemented as the first link of the system comes on line and begins to provide fare service. It is essential that a dedicated, continuing marketing program, structured to the needs of the state and local communities, be designed and implemented from the very beginning of the project. As operational segments are completed and testing performed, introductory rides for members of the Legislature, local elected officials, media representatives, and others should be arranged to acquaint them with HSR and to help promote public awareness of the forthcoming service.

H. SCHEDULE OF SYSTEM DEVELOPMENT

Planning, design, construction, and procurement activities must be carefully scheduled and controlled by the agency designated by the Legislature to be responsible for further development and operation of the high speed rail system. Public involvement and marketing would be important aspects throughout the entire process of system development. Times for public meetings and public hearings must be recognized and built into the schedules for each phase of the process.

The development of any new transportation system is time consuming, involved, and often a tedious process, from inception to completion. For "pay-as-you-go" systems, such as the Interstate Highway System, the time required for the development of the system can be quite lengthy, spanning a number of decades. The Interstate Highway System was begun in 1956 and was scheduled to be completed by 1975. However, in 1988, 32 years later, the system has not been completed, even though, in fairness to the program, it must be recognized that design standards, inflation, traffic growth, environmental concerns, and other factors have contributed to a stretching out of the program.

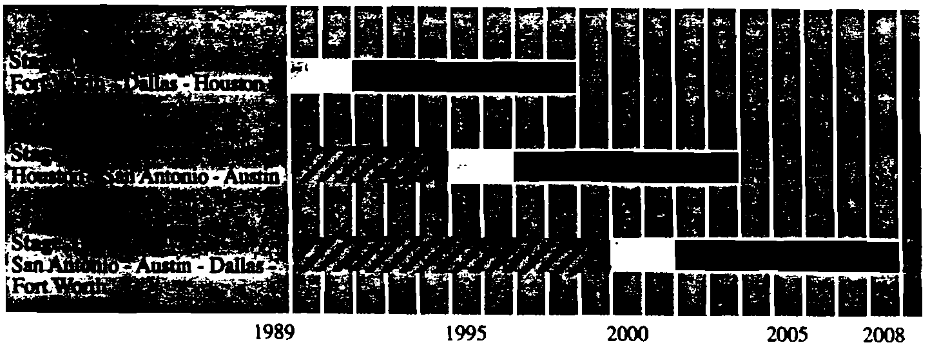
In contrast, transportation systems developed in time of national emergency, such as the "big inch" cross country pipeline and the Gulf Intracoastal Waterway, can be and were developed in amazingly short time periods. Toll roads have also been developed in much shorter time periods than most state freeways, simply because they are not generally subject to many of the constraints which tend to impede free highways. Also, toll facilities generally employ revenue bond financing and, therefore, are not dependent upon annual apportionments from public bodies for their planning and construction.

1. Implementation Schedule

The HSR could be implemented more rapidly than most new transportation systems since much of its financing would be through the issuance of bonds. Also, since most of the system would be on new alignment, handling traffic (both rail and automotive) during construction would be minimized. The schedule of development, set forth in **Figure XII-1**, presents an achievable plan, provided the activities shown are carefully coordinated and delays are avoided.

The high speed rail system could be implemented more rapidly than most new transportation systems.

Figure XII-1
Staged Implementation of HSR System



Activities

☐ Final Planning, Engineering and Environmental

■ Pre-Construction (Preliminary and Final Engineering and R.O.W.)

■ Construction, Equipment Procurement and Testing

▨ May be Accelerated

Source: Lichliter/Jameson & Associates, Inc.

The schedule was developed on the expectation that the Fort Worth - Dallas - Houston Corridor would be the first segment completed and opened for service in 1998. The Houston - San Antonio - Austin segment would be completed and opened for service by 2003; and the San Antonio - Austin - Dallas - Fort Worth segment would be completed and placed in service by 2008. The implementation of the first high speed rail system over the "east" leg of the Triangle is based on the use of "proven" technology (VHS) that has operating, commercial systems in place.

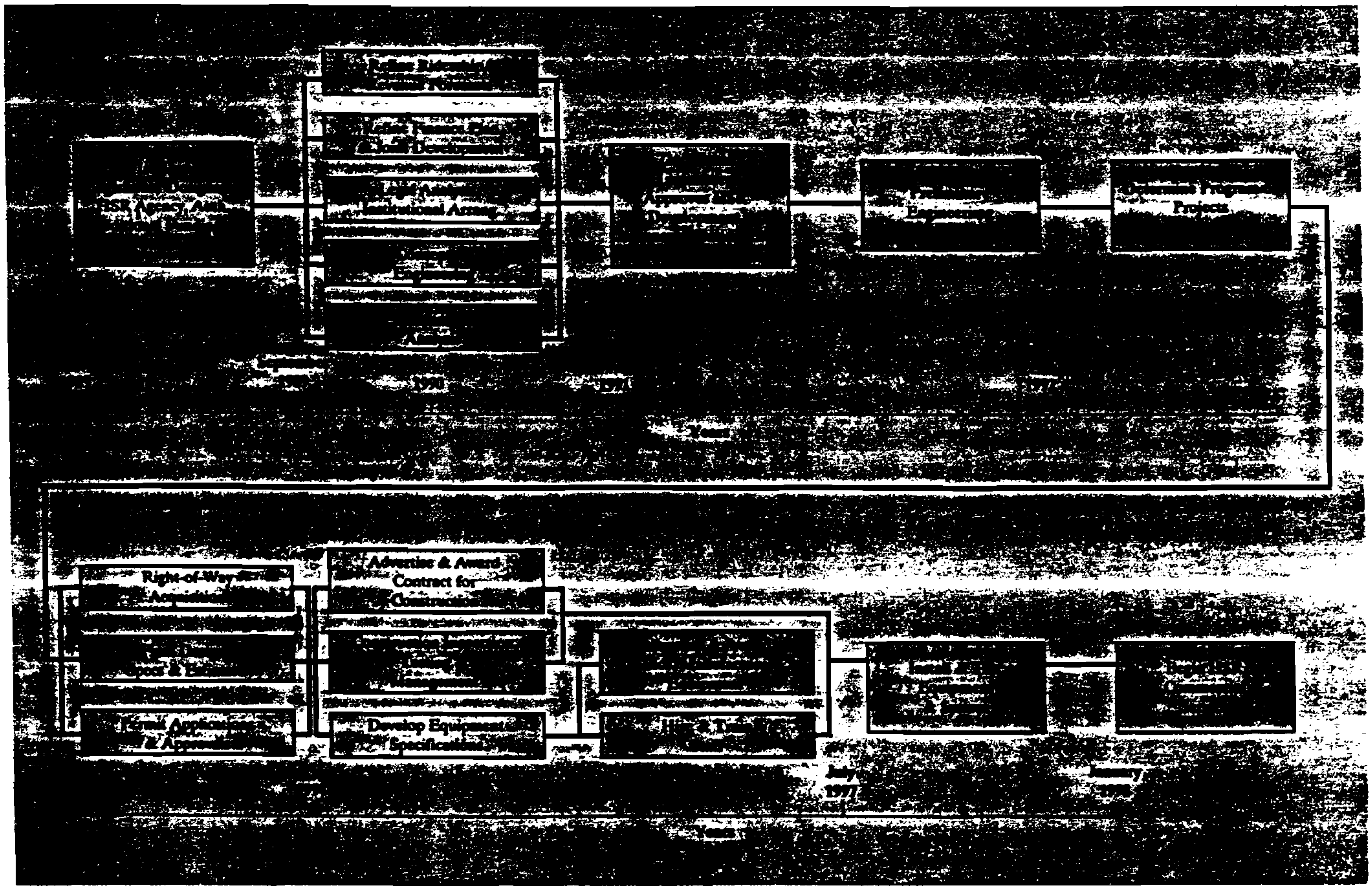
Figure XII-1 is based on seven major activities: 1) Legislature's Decision to Proceed; 2) Final Planning; 3) Engineering and Environmental; 4) Pre-Construction; 5) Construction; 6) Equipment Procurement; and 7) Begin HSR Service. The first major activity requires a positive finding by the 71st Texas Legislature that additional analyses (Final Planning) should proceed during the next State biennium. As shown in **Figure XII-2**, such a decision would also include the designation of an agency to proceed with HSR planning and the appropriation of sufficient State funds to perform such analyses. During the period from mid-1989 to the end of 1990, additional planning and engineering work would be performed prior to convening of the 72nd Texas Legislature in January, 1991.

With the additional information developed during the Final Planning and the Engineering/Environmental phases, the 72nd Texas Legislature would be in a position to designate the State agency responsible for HSR development and operation (if not done by the 71st Regular Session). The Legislature would also approve the development of the HSR system, authorize the issuance of bonds, appropriate funds to support the administrative activities of the responsible State agency, and perform such other actions as would be necessary to proceed with the project.

The first construction contracts would be awarded in 1994.

The Pre-Construction phase of project development would involve activities necessary to advance the Fort Worth - Dallas - Houston segment to construction. Preliminary engineering; right-of-way determination and acquisition; final design and specifications; securing of approval of applications and permits; and other necessary activities would be performed during the three years (1991 through 1993) set aside for these activities.

The first construction contracts would be awarded in early 1994, most likely for the more complex urban entry sections in Fort Worth - Dallas - Houston. Other contracts would be let as plans and rights-of-way become available. It is expected that the entire length from Fort Worth - Dallas - Houston would be under construction simultaneously, leading to completion of the projects no later than mid-1997.



Source: Lichliter/Jameson & Associates, Inc.

Figure XII-2
Texas High Speed Rail Development Flow Chart

Fort Worth–Dallas–Houston

The Equipment Procurement phase of the schedule would begin in early 1994 and would be a concurrent activity with construction. Equipment procurement is estimated to require at least two and one-half years from the award of bids. This assumes one and one-half years for the manufacturer to produce the first prototype train set. Thereafter, by producing two train sets every two months, the procurement should be completed within another year. Full testing of the system should require an additional six months after final acceptance of subsystems, and construction projects. This schedule of train set procurement assumes the use of foreign equipment with minimum modification. If U.S. equipment is specified, an additional two to four years development time could be necessary.

Revenue service on the Fort Worth - Dallas - Houston Corridor could begin in January, 1998.

Through strict adherence to the schedule, service on the Fort Worth - Dallas - Houston leg of the Triangle could begin in January, 1998. It must be stressed, however, that perseverance, dedication, and timely decisions will be required of all concerned.

The "south" leg of the Triangle (Houston - San Antonio - Austin) would follow substantially the same schedule as the "east" leg, i.e., a seven-year development process from pre-construction to initiation of service. To meet a start-up date of 2003, the pre-construction would begin in 1996. The "west" leg of the Triangle (San Antonio - Austin -Dallas - Fort Worth) would begin pre-construction activities in 2001 for a start-up of fare service in 2008.

I. LEGISLATIVE ACTIONS

Specific actions by the 71st Legislature will be necessary.

Specific actions by the 71st Legislature and subsequent Legislatures will be necessary to proceed with the development of the Texas high speed rail system. Since the legislative sessions are held every two years, appropriate legislative actions would be required on a timely basis to assure adherence to the implementation schedule.The preliminary implementation schedule is based on completing Stage 1 (Fort Worth - Dallas - Houston) by 1998. The key to maintaining the schedule would will be appropriate actions by the 71st State Legislature in taking the following principal actions to advance planning, financing, engineering, and construction.

- Endorsement of the concept of a high speed rail system with appropriate support for advance planning, financial analysis, and preliminary engineering.

- Creation of a new State agency for implementing and operating HSR or designation of an existing State agency, in an interim capacity, as responsible for carrying out advance planning and preliminary engineering.

- Appropriation of adequate funding to the designated agency for necessary planning and engineering activities.

1. Designation of a Responsible State Agency

Since no existing State agency is presently staffed or authorized to carry out development of a high speed rail system, it would be essential that the Legislature either create a new agency with this responsibility or empower an existing State agency, on an interim or permanent basis, to perform this function.

A State agency, responsible for high speed rail, must be designated on an interim or permanent basis.

a. Creation of a New State Agency

In Europe and Japan, HSR systems are operated by the railroad companies which themselves are owned and controlled by the national government. These services are operated as a part of the national railroad passenger service. In the United States, railroads are privately owned and operate exclusively to provide freight service. Only Amtrak provides inter-city passenger service, under the overall control of the federal government.

Recognizing that high speed rail service would be a State asset, the states of Florida, Ohio, and Pennsylvania have established separate agencies responsible for implementing and operating High Speed Rail Systems within their respective states. These agencies are empowered with the singular responsibility for financing, constructing, and operating their respective system. **Appendix H** sets forth a summary of the authorities and responsibilities of each of these State agencies.

To provide the Texas high speed rail system the same stature and recognition as other transportation modes, an agency similar to those established in other states should be created by the Texas Legislature.

2. Interim Responsible Agency

Time is of the essence in developing a project of this magnitude. Because of the time required to establish and organize a separate high speed rail authority, an existing State agency should be designated to temporarily serve as the responsible agency for the final planning stage. During this interim period, additional planning in all areas is expected to establish the final feasibility of a high speed rail system.

There are several existing agencies which could be empowered by the Legislature to serve as the "interim" implementing agency. These include:

- Texas State Department of Highways and Public Transportation (SDHPT) - The SDHPT is responsible for planning, designing, construction, and maintenance of all highways in Texas. This agency, with a staff of approximately 15,000, also manages the State's waterway ferries, participates in local public transportation projects, and has State responsibility for the non-federal sponsorship of the Gulf Intracoastal Waterway.

- Texas Railroad Commission (TRC) - The TRC is primarily a regulatory agency for the oil and gas industry, as well as railroads. Its primary focus is ~~in the areas of~~ setting freight ~~rates~~, ~~approving railroad abandonments~~, ~~granting applications to construct~~ and operate ~~common carrier railroads~~, and establishing and enforcing safety standards.

- Texas Turnpike Authority (TTA) - The TTA was established for the purpose of planning, designing, and constructing toll roads funded by direct road user fees. This agency's principal focus has been directed to implementing highway and bridge projects through tax-exempt revenue bond financing. The source of project funding by TTA has, without exception, dictated that projects managed by this agency be implemented and opened to traffic within short time schedules. TTA is experienced in working with major financial institutions in implementing large revenue bond issues for major transportation projects. This agency was designated by the 71st Legislature to manage and supervise the feasibility study of the Texas high speed rail system.

Since the Texas Turnpike Authority currently has the framework of expertise in projects similar to that of the HSR project, it is logical that this agency continue, on at least an interim basis, to serve as the executing agency for the next phase of the HSR project.

In preparing legislation which proposes either the creation of a new authority or restructuring of an existing agency, consideration should be given to incorporating language similar to that found in existing laws in other states (Florida, Ohio, Pennsylvania). Such laws could be referenced as "model" legislation. Items which should specifically be considered in evaluating such legislation are:

- Jurisdictional Support - The question of who would have jurisdiction in regard to construction, financing, operations, maintenance, etc. Areas of overlapping responsibilities with other agencies must be addressed.

- Board of Directors - All existing HSR authorities and commissions are managed by a board of directors appointed by the Governor to serve terms varying from four to six years. The number of directors varies from seven to twelve. Most agencies advise that the board of directors should be kept to a minimum. The SDHPT is effectively managed by a commission of three members. A board of directors consisting of three to five members would permit representation from all areas to be served by the Texas HSR system.

A board of directors consisting of three to five members would permit representation from all areas to be served by the Texas HSR system.

- Intergovernmental Overlap Options - Options for ownership of tracks, right-of-way, stations, and equipment must be addressed. As an example, the State could own the tracks and infra-structure; stations could be owned by local governments or the private sector; and train sets could be owned by a franchisee.
- Operator Options - Legislation should identify who could operate the system, i.e., whether the State or a franchisee will be responsible (and the degree of responsibility). The same should hold true for stations, maintenance, etc.
- Trackage Rights - In the case of urban entries, HSR may share rights-of-way with existing railroads or highways. Delineation of HSR rights and obligations in such cases should be clearly defined.

Since HSR is an emerging technology in the United States, legislation concerning its operations and financing can be viewed as being in a state of evolution. The recent enactment of the Miscellaneous and Technical Revenue Act of 1988 (HR 4333), permitting tax-exempt revenue bond issues for HSR projects, is one example. It is expected that as HSR becomes more broadly recognized as a transportation option in the United States, more changes in national legislation will occur. It is, therefore, important that legislative and legal issues be monitored.

Performance of implementation functions is dependent upon State appropriations.

3. Legislative Appropriations

Sufficient funds must be appropriated by the 71st Texas Legislature to perform the implementation functions previously discussed. Either the newly created responsible State agency, the designated existing State agency, or the "interim" agency (whichever action the Legislature elects to take) must be provided with sufficient funds during the biennium beginning September 1, 1989, to assure that scheduled activities are completed.

Regardless of the decision made by the Legislature regarding the responsible State agency, consideration should be given to reimbursing the Texas Turnpike Authority for expenditures already incurred in the management and performance of this study. Unlike other State agencies, TTA does not have appropriated funds to perform administrative, planning, and managerial functions. The Authority is financed through toll revenues received from users of the facilities developed and operated under their jurisdiction. The tolls must also be used for debt service, maintenance, and operations of the toll facilities, in addition to administrative costs and funding of feasibility studies. On those occasions when the Authority performs a feasibility study, their account is reimbursed from the proceeds of bond sales once a project is implemented. Accordingly, financial accommodation should be made by the Legislature to replace the funds expended on this study to avoid depletion of TTA's planning capabilities.

The estimated cost of performing the work described in this section, during the next State biennium, is shown in **Table XII-1.**

TABLE XII-1

Estimated Needed Legislative Appropriations

	Necessary Appropriations	
Activity	**Recommended**	**Minimum**
Refine Ridership/Revenue Forecasts	$ 900,000	$ 600,000
Refine Financial Plan	800,000	500,000
Legal Analysis	350,000	250,000
Conceptual Engineering	6,500,000	3,250,000
Environmental Analysis	7,500,000	3,750,000
Preliminary Engineering/R.O.W. Determination	14,150,000	10,600,000
Program Administration/Management	1,200,000	800,000
Total	**$ 31,400,000**	**$ 19,750,000**

In addition to the above, the Texas Turnpike Authority has expended $325,000 for this study and $250,000 for its administration, not including funds made available through a grant from the Federal Railroad Administration.

The funding requirements are presented as either "recommended" or "minimum." The recommended amount would fund the carrying forward of certain planning activities for the entire Texas Triangle, while performing other activities which would pertain only to Stage 1 (Fort Worth - Dallas - Houston). The minimum would be the amount of funding necessary to perform activities only for Stage 1 implementation, with other analyses deferred until future years.

In summary, if the Legislature elects to fund the "recommended" level, a total appropriation of $31,975,000 would be necessary. To fund only the "minimum" level of effort, $20,325,000 would be required. Both levels include funds to reimburse TTA for the expenditures already incurred.

J. CONCLUSIONS

To proceed with the timely development of a Texas HSR system, additional planning will be required for ridership forecasting, revenue estimation, financial analysis, engineering, and environmental assessment. By careful coordination of these activities, the system development can be implemented on a scheduled basis which would permit passenger service to begin on the Fort Worth - Dallas - Houston Route by 1998.

The Texas Legislature should take certain actions during the 71st Regular Session if HSR development is to proceed.

- Designate an existing, new, or "interim" State agency as responsible for HSR in Texas;

- Enact legislation outlining the duties, responsibilities, organization, and authorities of the designated agency; and

- Appropriate sufficient funds to perform certain implementation functions during the biennium commencing September 1, 1989.

SECTION XIII
SUMMARY OF FINDINGS AND RECOMMENDATIONS

The results of this study indicate that high speed rail within the Texas Triangle is relevant, financially sound and a viable travel mode to supplement highway and air travel in Texas. The economic benefits that are expected to accrue to the regions served, and Texas as a whole, could exceed the economic expectations associated with the Homeport installations on the Gulf Coast and the superconducting supercollider installation near Waxahachie.

A. FINDINGS

The performance of this study has resulted in a number of findings and conclusions, which are summarized as follows:

1. Previous High Speed Rail Studies

High speed rail has been the subject of numerous studies in other states and Texas during the past decade. Each of the studies has concluded that HSR is a relevant alternate to established transportation systems, with Florida, California, Ohio, and Pennsylvania being the states who have shown the greatest interest in adding HSR to their transportation system.

2. Available Technology

High speed rail service has been in commercial operation in Japan and Europe for some time. Most high speed rail systems in operation today, including Amtrak operation in the Northeast Corridor of the United States, operate within a range of speeds from 80 mph to 125 mph, which was designated as the High Speed (HS) technology category in this study. HSR systems which operate at speeds ranging from 125 mph to 200 mph, which were designated as Very High Speed (VHS) in this study, are in commercial service in France, Italy, and Japan. Other European nations, including Sweden, West Germany and the United Kingdom, are planning to begin operation of VHS systems in the near future. Most new VHS systems will operate in the upper range of speeds established for this category of HSR. Only two nations, Japan and West Germany, are working toward the development of HSR technology which would operate at speeds in excess of 200 mph. The highest category of HSR was designated Ultra High Speed (UHS) in this study. It was concluded by the study team that VHS would be the appropriate technology for the Texas Triangle since it is a proven technology, provides competitive trip times, provides the most favorable benefit/cost ratios and is fundable under provisions of the Technical and Miscellaneous Revenue Act of 1988.

3. Alternatives to High Speed Rail

Texas' existing inter-city transportation system, comprised of highway and air travel, is presently experiencing considerable crowding of air corridors and congestion of highways, streets, and airport terminals. The anticipated growth in travel by the end of the century and into the next century will place considerable demands on the existing transportation modes. These demands will be even greater if high speed rail is not included in the State's infrastructure. Without HSR, transportation service (particularly air) will worsen unless considerable expansion of present airport facilities and additional airline service is undertaken at taxpayer's and private sector expense.

4. Ridership Forecasts

A high speed rail system is estimated to attract approximately 25 percent of inter-city travelers by year 1998, increasing to one-third of inter-city travel by the year 2015. Fare structure would be competitive with airline service. Staged development of the HSR system calls for the first stage to be the segment from Fort Worth to Dallas to Houston. Stage 2 would be the link from Houston to San Antonio and Austin. The final stage, Stage 3, would complete the Triangle by developing the link from San Antonio to Austin to Dallas to Fort Worth. Estimated annual ridership for Stage 1 is three million in 1998, increasing to 7.5 million in 2015.

5. Routes

Basic design requirements were established for use in route selection:

- A double-track, grade-separated, fenced, and dedicated right-of-way would be provided.

- Existing rail corridors would be followed between Fort Worth and Dallas and in all urban areas.

- The entire 620-mile system would be constructed in stages with the Fort Worth - Dallas - Houston line as the first stage.

- Principal passenger terminals in all Triangle cities would be located in or near central business districts. Suburban stations would be provided between Fort Worth and Dallas and in Northwest Houston.

- A number of possible route alternatives were analyzed. These included use of existing rail corridors, separate (independent) alignments and use of highway medians. The independent alignment was determined to be the most cost effective option.

6. The Texas HSR System

The HSR would provide travelers a choice between high speed passenger rail, automobile or airline for inter-city travel. The trip times would be competitive with air travel and faster than travel by automobile. HSR would provide passengers with equal or better amenities than would either air or automobile. Central city passenger stations (or suburban stations in Houston and between Dallas and Fort Worth) would be easily accessible by local street and highway systems.

7. Revenue Forecasts and System Costs

Based on the assumptions developed regarding the HSR and existing transportation modes, the high speed rail system could be expected to generate over $600 million by the year 2008 when the entire system is operational. The first stage (Fort Worth - Dallas - Houston) was estimated to generate nearly $138 million in 1998, increasing to over $475 million by year 2015. The estimated capital cost of the completed HSR system, in 1988 dollars, would be $4,392,600,000. Operating and Maintenance (O&M) costs for the entire HSR system were estimated to be approximately $186 million per year. For the first stage of development, O&M costs were estimated to be about $79 million.

8. Economic Impacts

The effect of HSR on the Texas economy could be significant. The construction phase alone was estimated to generate new spending in excess of $7 billion, with a permanent increase of over $500 million annually once the HSR operation was on-going. The market for Texas goods and services could also be expected to expand by $351 million annually. Construction of the full system could create 111,000 person years of employment, with on-going operations leading to 9,000 new, permanent positions. Texas payrolls could expand permanently by over 15,000 workers when the positions created by on-going operations were combined with jobs created as a result of increased tourism. Under the most conservative of several scenarios analyzed, an additional 3,600 new permanent positions could be created in all major industry groups in Texas, with over one-third being "primary" or "export-oriented" jobs. Construction of Stage 1, alone, could create nearly 56,000 person years of new employment by 1998 and $3.5 billion in new expenditures. In addition to job creation and increased economic expenditures, the state and local governments could realize increased annual tax revenues in year 1998 of nearly $17 million and $11 million, respectively. By year 2015, increased annual state tax revenues were estimated to be $31.5 million, with local government tax revenue increases of $20.4 million annually.

9. Project Finance

Financing the HSR is expected to include a combination of both public and private sector financing, with initial financial advances from governmental or other sources. Tax-exempt revenue bond financing under the Technical and Miscellaneous Revenue Act of 1988 (HR 4333) could provide the bulk of the capital funds necessary to construct the system. Tax-exempt financing, however, would be dependent upon the availability of state allocated monies for private activity type projects. Overall interest costs associated with financing would be significantly reduced by the use of tax-exempt debt. It was assumed that short-term notes would finance construction, secured by letters of credit issued by banks or lending institutions with rating levels of "AAA" or "AA". A financial advance of approximately $100 million by governmental sources or others would be required for the Fort Worth - Dallas - Houston segment (Stage 1) to cover pre-construction costs from 1991 to 1993. The Houston - San Antonio - Austin corridor (Stage 2) would require an advance of approximately $15 million to cover pre-construction costs. The San Antonio - Austin - Dallas - Fort Worth segment (Stage 3) would not require any financial advance. All financial advances would be repaid after completion and placing into service of Stage 3 from revenues generated in excess of funds required for debt service, operations and maintenance, and franchisee payments. Financing of the system would be economically sound, based on a specific set of current conditions and assumptions. A blended interest rate of 8.0 percent was assumed for financing notes and bonds. Revenues and costs were inflated at 2.0 percent per year. A 1.25 times coverage of annual debt service by revenues was assumed to provide adequate coverage to satisfy the rating agencies, insurers, and investors.

10. Environmental Considerations

A comprehensive environmental analysis would be required for the high speed rail system, regardless of whether federal funds are utilized in its development. The project would affect a broad area of the State and may have social, economic, and environmental impacts which must be considered. Coordination with local, state, and federal agencies would be required, as well as private sector organizations, associations, interested parties, and the public. Proposed actions must be considered in consonance with state and federal environmental laws and regulations which may apply to the project.

11. Project Implementation

Additional planning and engineering analyses would be required to proceed with timely development of the HSR program. Such planning and engineering would involve refinements in ridership estimates, revenue forecasts, and financial analysis. Additional conceptual engineering, preliminary engineering, and a comprehensive environmental assessment would have to be performed. Final design, right-of-way procurement, system construction, equipment procurement, and system testing must be accomplished in a coordinated and timely manner to permit revenue service to begin by 1998. The Fort Worth - Dallas - Houston segment would be the first stage to be completed, with successive stages to follow at approximate five-year intervals. The two final stages could be accelerated, if desired. Certain specific actions will be required of the 71st Legislature in order to conform with the recommended implementation plan. The legislature must: (l) designate an existing, new, or "interim" agency as responsible for HSR implementation in Texas; (2) enact legislation outlining the duties, responsibilities, organization, and authorities of the designated agency; and (3) appropriate sufficient funds to perform certain implementation functions during the biennium commencing September l, 1989.

B. RECOMMENDATIONS

Based on the findings of this study, it is recommended that the following specific actions be taken regarding the development of high speed passenger rail in Texas:

1. **That the 71st Texas Legislature, acting in regular session, issue such directives and enact necessary legislation to recognize the importance of high speed rail to the State as an alternate transportation mode.**

2. **That the 71st Texas Legislature, acting in regular session, designate the Texas Turnpike Authority as the "interim" executing agency for the HSR project until such time as a Texas high speed rail authority is created which would be responsible for financing, constructing, managing, and operating the system.**

3. **That the 71st Texas Legislature, acting in regular session, appropriate funding for the biennium beginning September 1, 1989, to carry forward the planning, administration, and management of the HSR program as set forth herein, including reimbursement to the Texas Turnpike Authority of the funds expended to date in the performance and management of this study.**

4. **That the staged development of a high speed rail system in Texas be undertaken, utilizing Very High Speed (VHS) rail technology, on a dedicated independent alignment.**

APPENDIX A

GLOSSARY OF TERMS

GLOSSARY OF TERMS

Air Passenger Surveys - A methodology utilized by transportation planners to gather data through personal contact with travelers or by distributing pre-printed questionnaire forms for mail-back by air travelers. The data obtained is that which is not readily attainable by only counting passengers or referring to statistical data compiled by airlines and/or governmental agencies.

Aspects - The display of signal lights on block signals alongside the track which advise train operators of action they should take as regards clearance of the track in front of the train, within the blocks.

Automatic Block Signals - Signals which display lights alongside the track which advise the train operator the status of the length of track (block) to his front and which permit safe stopping in the event the track is occupied.

Blocks - Segments of track which vary in length according to the characteristics of the route geometry and the amount of train traffic, with the minimum length generally being the safe stopping distance of a train.

Central Business District - A term which refers to the generally accepted (but sometimes loosely delineated) downtown area of a city where commercial establishments, financial institutions, other service establishments and governmental offices are most concentrated.

Conceptual Engineering - Engineering analysis of design involving the most basic preliminary engineering, sufficient only to explore a "concept" of design but which is not sufficient to establish precise design features for construction or detailed cost estimation.

Consist - The term used to describe the make-up of a train set, i.e., the consist will specifically describe the type of cars making up the train set, such as one locomotive, six passenger coaches and one restaurant/lounge car.

Demographics - Statistical information which is generally in the form of specific elements such as population, numbers of households, labor force numbers, employment numbers, hotel/motel units, college enrollment, and other data. The information is used to establish a profile of a community or target group for further analysis or projections.

Diesel-Electric Trains - Trains with power units (locomotives) that contain diesel powered turbines that produce electricity which, in turn, powers electric wheel traction motors for moving the locomotive.

Fleet - The term used to describe the total number of trains operating along one given corridor.

Focus Group Surveys - The establishment of a sample representative group of individuals and, through either personal interviews or by use of pre-printed questionnaires, determining certain preferences which can then be used statistically to develop characteristics of the sample group and then be expanded to the target group as a whole.

Geometrics - The vertical and horizontal alignments of a facility, along with other related design features which define the physical configuration of the facility.

German High Speed Consortium - A group of German industries which joined together in 1985 to explore the opportunity for development of high speed rail service between Fort Worth, Dallas and Houston. The Consortium was composed of the following industries: Siemens AG, Consortium Leader; AEG Aktiengesellshaft; Brown, Boveri & Cie AG; Krauss-Maffei AG; Krupp Industrietechnik GmbH; Linke-Hofmann-Busch GmbH; Lord Mass Electric Company; Messerchmitt-Bolkow-Blohm GmbH; and, Thyssen Industrie AG. The studies which were performed for the Consortium in 1985 and 1987 were supported by the Federal Ministry of Research & Technology, Federal Republic of Germany.

Grade Separated - The physical separation of one level of a facility from the other at points of crossing or other conflict, i.e., designing a rail line to overpass, on another level, either above or below a street or highway.

Guideway - The generic term used for rail tracks in the case of conventional railroads or the concrete beam structure on which a Mag-lev train operates.

High Speed Rail - A general term referring to passenger train service operating at average speeds in excess of 80 mph.

Infrastructure - The physical facilities which, in aggregate, make up the assembly of features which are needed to operate a system or provide a public service.

Magnetic Levitation (Mag-lev) - A method of propulsion which is achieved by utilizing magnetic attraction or repulsion as a means of either moving or stopping a train of advanced design. The concept utilizes linear induction motors (LIM) to overcome adhesion present in steel wheels on rails by establishing fields of equal or opposite polarity which permit the conveyance to hover (or float) above a guideway.

Maintenance-Of-Way Facilities - Facilities located along the route of a train, as differentiated from central maintenance facilities or shops at terminals, for the purpose of providing routine maintenance for tracks and other infrastructure.

Models - As used in the report, models refers to computerized systems for analysis and forecasting of population, traffic, economics or financial estimates. The models are developed utilizing demographic data, past trends, certain defined variables/assumptions, and then, by use of mathematical formulae contained in a computer program, creating estimates of the factors to which the model is addressed.

"Order-Of-Magnitude" Costs - The development of preliminary estimated costs based on general engineering design, sufficient for establishing approximate cost estimates for further detailed analysis and confirmation at the preliminary design stage.

Representational Rail Route-Existing Alignment - A route selected for purposes of this study which generally follows an existing railroad freight route, with certain deviations for by-passes of cities and/or straightening of alignment.

Representational Rail Route-New Alignment - A route selected for purposes of this study which is a new, independent alignment (not following any presently established corridor of either another railroad or highway). Where the route is cross-country, it is sometimes referred to as "on new location".

Roadside Surveys - A methodology utilized by transportation planners to gather data through personal interviews or by distributing pre-printed questionnaire forms for mail-back by drivers. Information obtained through roadside surveys is that which is not readily attainable by only counting and/or classifying vehicles.

Rolling Stock - A general term to describe all equipment which rolls on the steel rails (or travels on a Mag-lev fixed guideway), i.e., locomotives, coaches, etc.

Sensitivity - The recognition that certain assumptions or variables used in model development and forecasting have either a greater or lesser effect upon the results produced. Sensitivity is determined by either increasing or decreasing the assumptions/variables by a pre-determined amount (such as a percentage increase or decrease) to explore the effect that such changes have on the resultant projection.

Staging - The development of a project by certain defined increments at a pre-determined schedule, in contrast to developing the entire project as a single effort within one specific time period.

Suburban - A general term used to delineate the area on the periphery of a city that is mostly comprised of residential units and shopping areas which tend to be more widely spaced than in the more populous areas of the city. Generally, suburbs tend to be located just outside city limits but within the urbanized limits established by the U.S. Bureau of Census.

Traction Power Facilities - Those facilities which provide electric power directly to a train, which includes the power substations and catenary for HS and VHS categories and the long stator for Mag-lev(UHS).

Traffic Zones - A defined geographic area which is used, along with other defined geographic areas, to determine traffic demand and traffic flow, either within the defined area or between areas. Traffic zones can be styled at the discretion of the traffic planner; however, they will generally follow the boundaries of counties, urbanized areas, urban areas, census tracts established by the U.S. Bureau of Census, or may be an area enclosed by major transportation facilities (usually city arterial streets or major highways).

Train Sets - The individual trains made up of locomotives, passenger coaches, restaurant cars or other specific types of cars.

Travel Demand - The existing or future volume of travel, either by air, highway or other mode, of individuals between origin and destination.

Turbine-Powered Trains - Trains with power units (locomotives) that contain gasoline powered turbines that produce electricity which, in turn, powers electric wheel traction motors for moving the locomotive.

Wayside - Beside or in close proximity to the railroad track.

APPENDIX B

SELECTED REFERENCES

SELECTED REFERENCES

1. AACOG/CAPCO. Airport Master Plan Index.

2. AACOG/CAPCO. Regional Aviation System Plan. February 17, 1988.

3. Allen, G. Freeman. "Window On Europe Highball for Austrian and Swiss high speed". Passenger Train Journal.

4. Allen, Geoffrey Freeman. "Jane's World Railways 1987-88". Twenty-Ninth Edition.

5. Alsthom Francorail-MTE. TGV Paris Sud Est.

6. Alsthom. TGV Expansion Prospects Strengthened By Continued Success In France.

7. ANF Industrie. The Turbotrain.

8. Austin American-Statesman. Northwest/north-central corridor. July 21, 1988.

9. Barton-Aschman Associates, Inc. Florida's High Speed Rail Study. Final Report. September, 1984.

10. Bernard-Andre Genest, Ph.D. Canatrans, Inc. Study Design for the Comparative Assessment of the Transrapid System and an Advanced Railway System in High Speed Service Between Montreal, Mirabel and Ottawa. May 1982.

11. Blumstein, J.C. and N.M. Brand. "European Experience and North American Choice". International Conference on Maglev and Linear Drives. May 14-16, 1986. Vancouver B.C., Canada.

12. Blumstein, J.C. and N.M. Brand. TGB or MAGLEV European Experience And North American Choice. March 1986.

13. Boccara, Albert. "High Drama, High Speed: The Saga Of The Train". France Magazine. No. 10, Spring 1988, Page 14.

14. Bombardier Corporation. The Bombardin "LRC" Train Technology. June 1988.

15. Bombardier Corporation. High Speed Intercity Train - LRC.

16. Bombardier Corporation. Letters May 31, 1988 and July 11, 1988, with technical data on LRC.

17. Boveri, Asea Brown. Three-Phase A.C. Drive Technology for Railway Traction.

18. Brand, Nicholas M., et. al. Operating and Maintenance Costs of the Paris - Lyons TGV High Speed Rail System and Applicability to Corridors in North America. May 1985.

19. Breda Costruzioni Ferroviarie. Letter June 8, 1988, with Technical Data on ETR-500.

20. Breda Costruzioni Ferroviarie SpA. Elettrotreno serie ETR 500.

21. Bringinshaw, David. "European Schemas Gain Momentum". International Railway Journal. Pages 40, 42 and 44. September 1987.

22. British Rail Engineering Limited. The High Speed Train.

23. British Rail Engineering Limited. The International Coach.

24. British Rail Engineering Limited. The Journey Shrinker HST - the world's fastest diesel train.

25. British Rail Engineering Limited. Locomotives New Construction Group.

26. British Rail Engineering Limited. Tomorrow's trains today.

27. The Budd Company. Las Vegas to Los Angeles High Speed/Super Speed Ground Transportation System Feasibility Study. Volume 1, Phase 1, Final Report. January, 1983.

28. Buffington, Jesse L. Railroad Property Acquisition, Use, Taxation and Abandonment. Texas Rail System Evaluation. Technical Report. Texas Transportation Institute, Texas A&M University. January 1977.

29. California Department of Transportation and the Federal Highway Administration. Report Of Scoping Regarding Proposed California High Speed Train. March 1984.

30. Campbell, T.I., et al. Canadian Institute of Guided Ground Transport. Costing of the Revised Canadian Maglev Guideway Design. CIGGT Report No. 86-20. TC Report No. TP 7921E. July 1986.

31. Canadian Institute of Guided Ground Transport. High-Speed Trains In France: Paris-SUD EST. October 1981.

32. Capital Metropolitan Transportation Authority. Transitway Corridor Analysis Project - TCAP - Project Information Booklet. March, 1988.

33. Centre Audiovisuel SNCF. Railway Films 1987/1988.

34. Christiansen, Dennis L. The History Of Rail Passenger Service In Texas, 1820 - 1976. Passenger Service Evaluation. Technical Report 1. Texas Transportation Institute, Texas A&M University System. January 1976.

35. Christiansen, Dennis L. Robert B. Stout and Douglas S. Grady. An Evaluation Of The Need For Intercity Rail Passenger Service In Texas. Passenger Service Evaluation. Technical Report 5. Texas Transportation Institute, Texas A&M University System. January 1977.

36. Christiansen, Dennis L. and Robert B. Stout. An Evaluation Of Intercity Travel In Major Texas Corridors. Passenger Service Evaluation. Technical Report 4. Texas Transportation Institute, Texas A&M University System. November 1976.

37. Christiansen, Dennis L. Rail Passenger Service In Texas Summary Report. Texas Transportation Institute, Texas A&M University System. March 1977.

38. City of Austin Department of Aviation. Austin's Airport Is On The Move. July 6, 1988.

39. City of Las Vegas and Robert E. Parson, Inc. Super-Speed Ground Transportation System Las Vegas/Southern California Corridor Phase II. Final Report. June, 1987.

40. Claire de Narbonne-Fontanieu. "Journey Through a Cultural Landscape". France Magazine. No. 10, Spring 1988, Page 20.

41. Collin, Patrick B. and William C. Rogers. General Overview Of Railroad Safety In Texas. Texas Rail System Evaluation. Texas Transportation Institute, Texas A&M University. August 1977.

42. Commonwealth Research Corporation. Improved Passenger Equipment Evaluation Program. Texas Triangle Feasibility Study. Working Paper. October 1977.

43. Cooper, Hal B.H. Jr. Executive Summary of the Program Of Implementation for the Texas Triangle High Speed Rail Passenger Project. June 25, 1986.

44. Cooper, Hal B.H. Jr. Project Summary for the High Speed Rail Passenger System in the Texas Triangle. June 25, 1986.

45. Cooper, Hal B.H. Jr. Rail Freight Service Operation in the Houston-Dallas Intercity Corridor. June 25, 1986.

46. Cress & Associates, Inc., Harris Miller Miller & Hanson, Inc. and Ozuna & Associates, Inc. San Antonio International Airport Master Plan. August 29, 1984.

47. Dalton - Dalton - Newport. Ohio High Speed Intercity Rail Passenger Program Phase II Technical Appendix Inventory of Existing Rail Facilities Considered for Passenger Service. December 19, 1979.

48. Dalton - Dalton - Newport. Ohio High Speed Intercity Rail Passenger Program Phase II Technical Appendix Selection of Test Service Packages for Further Development. May 6, 1980.

49. Dalton - Dalton - Newport. Ohio High Speed Intercity Rail Passenger Program Phase II Working Paper 1 Evaluation Methodology. June 15, 1979.

50. Dalton - Dalton - Newport. Ohio High Speed Intercity Rail Passenger Program Phase II Working Paper 10 Evaluation Methodology For Program Development. July 1980.

51. Dalton - Dalton - Newport. Ohio High Speed Intercity Rail Passenger Program Phase II Working Paper 9 Schedule and Priority Assumptions for Program Development. July 1980.

52. Dalton - Dalton - Newport. Ohio High Speed Rail Test Track Facility Preliminary Design. September 1982.

53. The Department of International Cooperation, French National Railways. The French TGV Family: A Success Story. November 10, 1988.

54. Deutche Bundesbahn. Bahn-Akzente. Annex 30, June 1988.

55. Duchemin, Jack. The Magnetic Dream. 1987.

56. Embassy of the Federal Republic of Germany. Copies of Assorted Technical Information Regarding ICE and the Transrapid Maglev.

57. Engineers Of The Southwest, Turner Collie & Braden, Inc. Lockwood, Andrews & Newman, Inc. and Bovay Engineers, Inc. William P. Hobby Airport Master Plan Update. June 1984.

58. Fiat Ferroviaria. Ellectrotreni d Assetto Variabile ETR 450 Tilting Body Electric Trains.

59. Fiat Ferroviaria Savigliano. Letter June 2. 1988, with Technical Data on ETR-450 and ETR-500.

60. Florida High Speed Rail Corporation. Executive Summary. March 28, 1988.

61. Florida High Speed Rail Corporation. Project Summary. March 28, 1988.

62. The Florida TGV. Executive Summary. March 25, 1988.

63. Fort Worth Transportation Authority. Service Plan And Supporting Documentation. August 16, 1983.

64. French Railway Review. The T.G.V. Vol. 1 No. 4. September 1983. Translated from the French Revue Generale Des Chemins de Fer.

65. French Railway Techniques. TGV Paris South-East. No. 1/1978.

66. Ft Worth Star Telegram. 'Bullet' train feasibility study is timely. March 22, 1988.

67. Gaston de Courtois and Roland Courjault-Rade Consulting Engineers. Very High Speed Rail Service Between Montreal And New York Pre-Feasibility Study, Final Report. Book II. June 1984 (Revised, December 1984).

68. Gaston de Courtois and Roland Courjault-Rade Consulting Engineers. Very High Speed Rail Service Between Montreal And New York. Pre-Feasibility Study. Final Report. Book I. June 1984 (Revised, December 1984).

69. Gaston de Courtois and Roland Courjault-Rade Consulting Engineers. Very High Speed Rail Service Between Montreal And New York. Pre-Feasibility Study. June, 1982.

70. GEC Transportation Projects Limited. Class 91 25kkV BoBo locomotives for British Rail.

71. Geist, Rick. "High-speed rail could connect key U.S. cities". The Dallas Morning News. June 23, 1988.

72. Genest, Bernard-Andre, et al. Comparative Technology Assessment: Montreal - Mirabel - Ottawa High Speed Ground Transport. Canatrans, Inc. Final Report. December 1984.

73. Genest, Bernard-Andre, Peter Jurgen Gaede, et al. Comparative Technology Assessment: Montreal - Mirabel - Ottawa High Speed Ground Transport. TP 5457E. December 1984. Part I.

74. Genest, Bernard-Andre, Peter Jurgen Gaede, et al. Comparative Technology Assessment: Montreal - Mirabel - Ottawa High Speed Ground Transport. TP 5457E. December 1984. Part II.

75. The German High Speed Consortium. Summary Report Feasibility Study 1987. February 1987.

76. The German High Speed Consortium. Technical Report Feasibility Study 1987. February 1987.

77. Gibbons, David. Facts About HST. "A Revolution in Travel".

78. Gilliland, Charles E. Texas Rural Land As An Investment A Retrospective Analysis: 1966-84. March 1986.

79. Gilliland, Charles E. Texas Rural Land Prices, 1986. July 1987.

80. The Greiner Austin Team. Aviation Activity.

81. Head End. The Eagle to Houston? June 1988. Page 11.

82. High Speed Rail Association. Standard Guidelines for Revenue and Ridership Forecasting. September 25, 1986.

83. High Speed Rail Association. Yearbook 1986. Including the Official Proceedings of the Second International Convention On High Speed Rail and Complete Index of Speedlines. Volume 2. 1985.

84. "High Speed Rail Stature". Public Transit. 1985.

85. House Research Organization, Texas House of Representatives. Special Legislative Report. "High Speed for Texas." November 17, 1988.

86. Houston Belt & Terminal Railway Company. Providing Transportation Services Within The Greater Houston Area For Our Owning Lines.

87. Houston Intercontinental Airport 2000 1983 Master Plan Update.

88. HSST Corporation. Cutout View of HSST-300.

89. HSST Corporation. HSST.

90. HSST Corporation. HSST-100 Basic Concept.

91. HSST Corporation. HSST-200 Basic Concept.

92. HSST Corporation. HSST-300 Basic Concept.

93. HSST Corporation. HSST High Speed Surface Transport.

94. HSST Corporation. HSST (1) Imagining Future With HSST Single Beam Track.

95. HSST Corporation. HSST (2) Imagining Future With HSST Double Beam Track.

96. HSST Corporation. HSST Terminal Basic Concept.

97. Ingegneria Ferroviaria. "Technical Information on ETR 500 High Speed Train". February and March 1988. Breda Costruzioni Ferroviarie.

98. Institute of Electrical and Electronics Engineers. International Conference on Maglev and Linear Drives. May 19-21, 1987.

99. "InterCity APT (Class 370) vehicle types". Railnews. November 1980.

100. International Railway Journal. Alsthom TGV Atlantique.

101. International Railway Journal. "FS Orders HS Trains". Page 4.

102. International Railway Journal. "RENFE Upgrades Locomotives for 200 KM/H in Spain". Page 38. July 1988.

103. Japan Railways Group. Letter July 20, 1988, with Technical Data on Shinkansen and MLU-001 Maglev.

104. Japan Railways Group. Shinkansen.

105. Japanese National Railways. Maglev Transportation For Tomorrow. March 1985.

106. Japanese National Railways. Shinkansen. March 1983, Japan.

107. Japanese National Railways. "Transportation for Tomorrow".

108. Japanese Railway Technology Corporation and Japan Railway Technical Service. Dallas-Fort Worth High-Speed Rail Project. June 1985.

109. Joint Center for Urban Mobility Research Rice Center. Cost Recovery For Rail Operations. Final Report. June 1987.

110. Joint Center for Urban Mobility Research Rice Center. High Speed Rail in the U.S. And Abroad. Final Report. June 1987.

111. Joint Center for Urban Mobility Research Rice Center. Japanese National Railways. Final Report. June 1987.

112. Jones, Joseph. High-Speed Trains in France: Paris-Sud Est. Canadian Institute of Guided Ground Transport. Project Report No. 81-4. October 1981.

113. Kizzia, Tom. "Moving people: The search for tomorrow". Railway Age. April 13, 1981.

114. L'Industrie Ferroviaire Francaise. The French Railway Industry. 1984.

115. L'Usine Nouvelle. Les Grands Chantiers De L'Industrie Francaise LE TGV.

116. Management. "High Speeds - The Infrastructure".

117. Michigan Consultants. High Speed Rail Corridor Issue Review. Final Report. January, 1985.

118. Mitsubishi International Corporation. Letter July 22, 1988, with Technical Data on HSST-300 Maglev.

119. Mitsubishi International. HSST System Descriptions For Texas High Speed Rail Study. July 22, 1988.

120. Morrison-Knudsen Engineers. Ohio High Speed Rail Task Force. Final Report. June 1985.

121. National Railroad Passenger Corporation and Amtrak. Rail Corridor Development: An Update. September 1982.

122. Nelligan, Tom. Trains. Tilting toward Boston Can Talgo or LRC tame the Shore Line's curves? August 1988. Page 18.

123. New York State Department Of Transportation. Rail Ridership Study.

124. Ohio High Speed Rail Authority. Bibliography of High Speed Rail Related Work. July, 1988.

125. Ohio High Speed Rail Task Force. Final Report. June 1985.

126. Parsons Brinckerhoff/Gannett Fleming. Pennsylvania High Speed Rail Feasibility Study. Preliminary Report Phase 1. February 1985.

127. Parsons Brinckerhoff Quade & Douglas and Comsis Corp. Proposal For Market Analysis Of High-Speed Rail Services In Ohio. March 12, 1984.

128. Parsons Brinckerhoff Quade & Douglas, Inc. and Deutsche Eisenbahn Consulting GmbH. Intercity Express Dallas - Houston. Feasibility Report. July, 1985.

129. Parsons Brinckerhoff Quade & Douglas, Inc. and The Washington State Transportation Center. High Speed Rail Passenger Service Western Washington Corridor Economic Feasibility Study. Final Report. December 1984.

130. Passenger Train Journal. Amtrak ridership update. February, 1988. Page 12.

131. Passenger Train Journal. The Journal. Page 4.

132. Peat, Marwick, Mitchell & Co. Ohio High Speed Intercity Rail Passenger Program Phase II Working Paper 7 Financing Mechanisms and Capabilities. April 11, 1980.

133. Peat, Marwick, Mitchell & Co. Prefeasibility Study of Very High Speed Rail Intercity Passenger Service Between Montreal and New York via Vermont. Appendix - Market Study. March 25, 1988.

134. Peat, Marwick, Mitchell & Co. Prefeasibility Study of Very High Speed Rail Intercity Passenger Service Between Montreal and New York via Vermont. Final Report. March 1985.

135. Peat, Marwick, Mitchell & Co. Prefeasibility Study of Very High Speed Rail Intercity Passenger Service Between Montreal and New York via Vermont. Technical Appendix. Final Report. March 1985.

136. Peat, Marwick, Mitchell & Co. Supplementary Analysis to the Prefeasibility Study of Very High Speed Rail Intercity Passenger Service Between Montreal and New York via Vermont.

137. Peat Marwick. World. Rpt. Vol. 19, No. 1/1985.

138. Peters, Gordon and New York State Department Of Transportation. New York State's High Speed Empire Corridor. July, 1985.

139. Pope, Gregory T. "Supertrain". Popular Mechanics. June 1988.

140. Powers, Pike. High-Speed Intercity Rail Transportation Bond Financing Act Of 1988. March 24, 1988.

141. Progressive Railroading. "Comment Why Change". July 1988. Frank Richter.

142. "The Quest for Faster Passenger Trains". Progressive Railroading. June , 1988.

143. Rahn, Theo Dipl.-Ing. Dipl.-Wirtsch.-Ing, et al., eds. ICE (Intercity Experimental, High-Tech On Rails. Hestra-Verlag Darmstadt, 1986.

144. Railnews. "Intercity APT, British Rail's Advanced Passenger Train - The Inside Story". November 1980.

145. Railnews. "The Class 91: Intercity's Flagship and Class 91: Power to the Wheels". May 1988.

146. The Rail Report. Up Wins Katy. June 1988. Page 15.

147. Railway Age. "Dukakis Endorses High Speed Rail 'All Over' the U.S." June 1988. Page 21.

148. Railway Gazette International. "Second Generation of High Speed Trains Poised to Roll". July 1985.

149. Railway Gazette International. "The High Speed Armada". April 1988. Pages 215 and 223.

150. Railways. "Hi-Tech Superloco Arrives on Time". March 1988. Pages 1 and 2.

151. Railway Technical Research Institute. Linear Motor Car Maglev.

152. Railway Technical Research Institute. "Linear Motor Car Maglev".

153. Revue Generale Des Chemins De Fer. The Atlantic TGV. Vol. 106

154. Rossi, L. New York State's High Speed Empire Corridor. August 1985.

155. S. 1245 Legislation to Amend Tax Code To Authorize the Issuance by States of Tax-Exempt Bonds For High-Speed Intercity Rail Transportation Projects. March 24, 1988.

156. Sammon, John P. Technical Note Railroads And The Texas Rail Freight Market. Texas Rail Evaluation Study. Rail Systems Program. Texas Transportation Institute, Texas A&M University.

March, 1977.

157. SNCF. A New Generation Of Rolling Stock.

158. SNCF, Department Des Etudes Generales Et Projects. Study Into Potential Speeds Of Amtrak Turboliner Stock On The New York - Boston Line (North-East Corridor). June 1986

159. SNCF, Department Des Etudes Generales Et Projects. Study Of Speed Increases For Turboliners On The New York - Albany Or Hudson Line (State of New York - USA). December 1986.

160. SNCF TGV Atlantique New Line Directorate and Public Relations Directorate. The TGV Atlantique Construction of the New Line. June 1986.

161. Sofrerail. Comparison Between The German I.C.E. And The French T.G.V. Systems. October 1987.

162. Stout, Robert B. and Dennis L. Christiansen. The Technology Of Rail Passenger Service. Passenger Service Evaluation. Technical Report 3. Texas Transportation Institute, Texas A&M University. June 1976.

163. Taylor, Karen. "Eurotunnel: 100 M.P.H. Under The Channel". France Magazine. No. 10, Spring 1988, Page 19.

164. Taylor, Professor Colin. "Newcomers Join the High Speed Club". Railway Gazette International. September 1987. Pages 607 thru 610.

165. Texas State Department Of Highways And Public Transportation. Automatic Recorder Traffic Data. May, 1988.

166. Texas Transportation Institute, Texas A&M University System. Texas Railroads: An Evaluation. Texas A&M University. This report is a product of twenty technical reports. May 1977.

167. Texte De La Conference Prononcee Par M. Ulmann Le 30 MAI 1985 A Chicago.

168. The TGV Company. Letter July 19.

169. The TGV Company. TGV Atlantique Fact Sheet. November 1986.

170. The TGV Company. TGV Florida TGV High-Speed Rail Project.

171. The TGV Company. Track Dedicated to TGV Operations. Specification Sheet for Speeds Up to 186 MPH. November 1986.

172. TR News. Letters High Speed Rail in California Another Point of View. November-December 1987. Page 2.

173. Transmode, Inc. Market Analysis Of High Speed Rail Services In Ohio. April 1985.

174. Transportation Development Centre. Appendices to High Speed Rail Feasibility Report (Canada). February, 1984.

175. Transportation and Distribution Associates, Inc. Ohio High Speed Intercity Rail Passenger Program Phase II Working Paper 6 Railroad Operations. April 28, 1980.

176. Transport Canada. Comparative Technology Assessment. Part II. Final Report.

177. Transrapid International, MagLev System Transrapid. Answer To The Inventory Of High Speed Rail Technology for the Texas High Speed Rail Study. May 19, 1988.

178. Turner Collie & Braden, Inc. Airport Development Plan Interim Report - Part I Issues And Needs Review Draft. May 1988.

179. Turner Collie & Braden, Inc., Pierce Goodwin Alexander & Spencer and SA Garza Engineers. Austin Airport Alternative Development Plan. Final Draft. August 1987.

180. U.S. Department Of Transportation, Federal Railroad Administration and National Railroad Passenger Corporation. Rail Passenger Corridors, Final Evaluation. April 1981.

181. U.S. Department of Transportation. Improved Passenger Equipment Evaluation Program Texas Triangle Feasibility Study. October 1977.

182. URS Corporation. Ohio High Speed Rail Project Summary of Engineering Analyses and Cost Projections. April 15, 1987.

183. VIA Rail Canada, Inc. High-speed passenger rail in Canada. Summary report. February 1984.

184. "The Viewliner". Passenger Train Journal. Vol. 19, No. 3, March 1988.

185. Wilbur Smith and Associates. Los Angeles-San Diego (Lossan) State Rail Corridor Study. Revised. June 1987.

186. Wilbur Smith and Associates, Morrison-Knudsen Engineers, Arthur Bauer & Associates. Los Angeles-San Diego (Lossan) State Rail Corridor Study. Final Report.

187. Wilbur Smith and Associates, Morrison-Knudsen Engineers, Arthur Bauer & Associates. Los Angeles-San Diego (Lossan) State Rail Corridor Study. Summary Report. June 1987.

188. Wilbur Smith and Associates. Rio Grande Rapid Rail Passenger Feasibility Study. New Mexico Transportation Department. Executive Summary. August 1985.

APPENDIX C

RIDERSHIP AND REVENUE

Table C-1

MANUAL VEHICLE CLASSIFICATION COUNT ON I.H. 45
Texas High Speed Rail Feasibiity Study

Count Location: IH 45, North of Fairfield
Date of Count: 5/13/88
Direction of Count: Northbound

PASSENGER CARS PICK-UP OR VAN		PC WITH	PC WITH	COMMERCIAL VEHICLES (TRUCKS & BUSES)						
Hour Beginning	Passenger Cars (1)	ONE-AXLE TRAILER	TWO-AXLE TRAILER	2-Axle	3-Axle	4-Axle	5-Axle	6 or More Axle	COMM. TOTAL	TOTAL VEHICLES
700	171	4	1	9	1	1	33	0	49	220
800	229	4	1	6	6	8	40	0	65	294
900	321	2	8	20	8	3	29	0	70	391
1000	387	12	8	6	2	2	34	0	64	451
1100	363	4	12	9	8	2	38	1	74	437
1200	368	10	11	8	5	1	30	2	67	435
1300	332	8	7	8	7	6	49	4	89	421
1400	291	9	5	10	3	2	23	0	52	343
1500	401	8	6	14	3	2	45	1	79	480
1600	328	4	6	9	2	1	31	1	54	382
1700	287	6	7	10	0	0	25	0	48	335
1800	306	5	9	5	0	0	19	1	39	345
TOTAL	3,784	76	81	114	45	28	396	10	750	4,534
PERCENT	83.5								16.5	100.0

---

(1) Includes private automobiles, pick-ups, and vans.

SOURCE: Wilbur Smith Associates

Table C-2

MANUAL VEHICLE CLASSIFICATION COUNT ON I.H. 45
Texas High Speed Rail Feasibiity Study

Count Location:	IH 45, North of Fairfield
Date of Count:	5/13/88
Direction of Count:	Southbound

PASSENGER CARS PICK-UP OR VAN				COMMERCIAL VEHICLES (TRUCKS & BUSES)						
Hour Beginning	Passenger Cars (1)	PC WITH ONE-AXLE TRAILER	PC WITH TWO-AXLE TRAILER	2-Axle	3-Axle	4-Axle	5-Axle	6 or More Axle	COMM. TOTAL	TOTAL VEHICLES
700	121	1	4	7	1	2	49	0	64	185
800	185	5	6	0	1	1	60	4	77	262
900	319	5	7	4	5	0	74	4	99	418
1000	374	6	5	12	1	8	70	2	104	478
1100	438	4	3	13	4	1	93	1	119	557
1200	402	1	8	12	2	4	63	6	96	498
1300	523	9	4	15	2	2	106	3	141	664
1400	505	3	2	14	7	6	41	1	74	579
1500	568	8	12	13	3	1	68	3	108	676
1600	631	10	4	5	5	4	67	1	96	727
1700	611	8	7	13	5	2	63	1	99	710
1800	624	6	4	19	4	1	52	0	86	710
TOTAL	5,301	66	66	127	40	32	806	26	1,163	6,464
PERCENT	82.0								18.0	100.0

---

(1)- Includes private automobiles, pick-ups, and vans.

SOURCE: Wilbur Smith Associates

Table C-3

MANUAL VEHICLE CLASSIFICATION COUNT ON I.H. 10
Texas High Speed Rail Feasibiity Study

Count Location: IH, East of Columbus
Date of Count: 5/19/88
Direction of Count: Westbound

PASSENGER CARS PICK-UP OR VAN				COMMERCIAL VEHICLES (TRUCKS & BUSES)						
Hour Beginning	Passenger Cars (1)	PC WITH ONE-AXLE TRAILER	PC WITH TWO-AXLE TRAILER	2-Axle	3-Axle	4-Axle	5-Axle	6 or More Axle	COMM. TOTAL	TOTAL VEHICLES
700	227	9	7	17	1	3	60	2	99	326
800	243	5	4	6	1	3	46	2	67	310
900	335	3	7	16	16	0	82	2	126	461
1000	384	8	40	24	4	0	94	0	170	554
1100	346	6	40	17	1	4	115	2	185	531
1200	307	5	7	11	3	0	99	0	125	432
1300	389	3	3	12	2	0	97	0	117	506
1400	407	8	16	17	4	4	89	0	138	545
1500	424	5	3	15	3	8	92	1	127	551
1600	431	1	12	18	0	11	83	1	126	557
1700	400	6	7	13	0	1	83	0	110	510
1800	245	3	10	0	0	0	53	0	66	311
TOTAL	4,138	62	156	166	35	34	993	10	1,456	5,594
PERCENT	74.0								26.0	

---

(1) Includes private automobiles, pick-ups and vans.

SOURCE: Wilbur Smith Associates

Table C-4

MANUAL VEHICLE CLASSIFICATION COUNT ON I.H. 10
Texas High Speed Rail Feasibiity Study

Count Location: IH, East of Columbus
Date of Count: 5/19/88
Direction of Count: Eastbound

PASSENGER CARS PICK-UP OR VAN				COMMERCIAL VEHICLES (TRUCKS & BUSES)						
Hour Beginning	Passenger Cars (1)	PC WITH ONE-AXLE TRAILER	PC WITH TWO-AXLE TRAILER	2-Axle	3-Axle	4-Axle	5-Axle	6 or More Axle	COMM. TOTAL	TOTAL VEHICLES
700	137	1	4	12	3	1	77	5	103	240
800	190	1	8	16	4	3	81	3	116	306
900	261	1	1	11	3	7	87	2	112	373
1000	255	5	11	12	5	0	70	1	104	359
1100	373	6	6	14	8	11	141	1	187	560
1200	383	11	11	10	4	4	111	1	152	535
1300	404	12	3	10	2	5	86	1	119	523
1400	370	2	9	21	6	6	93	0	137	507
1500	412	7	2	16	6	7	94	2	134	546
1600	446	11	12	23	5	4	72	0	127	573
1700	401	4	3	12	8	0	101	0	128	529
1800	429	6	3	13	4	10	65	1	102	531
TOTAL	4,061	67	73	170	58	58	1,078	17	1,521	5,582
PERCENT	72.8								27.2	

---

(1) Includes private automobiles, pick-ups and vans.

SOURCE: Wilbur Smith Associates

Table C-5

MANUAL VEHICLE CLASSIFICATION COUNT ON I.H. 35
Texas High Speed Rail Feasibility Study

Count Location: IH-35 North of Georgetown
Date of Count: 7/19/87
Direction of Count: Southbound

PASSENGER CARRS PICK-UP & VANS		COMMERCIAL VEHICLES (TRUCKS & BUSES)					
Half Hour Beginning	Passenger Cars (1)	Pick Up/ Panel	Van	Other Truck	Other Vehicle	COMM. TOTAL	TOTAL VEHICLES
0630	232	0	10	42	0	52	334
0700	258	0	26	48	1	75	333
0730	292	1	23	46	0	70	362
0800	242	1	23	36	1	61	303
0830	243	7	27	40	1	75	318
0900	230	31	19	53	1	104	334
0930	316	5	20	68	0	93	409
1000	253	6	31	45	0	82	335
1030	280	11	39	47	2	99	379
1100	280	8	48	40	2	98	378
1130	277	4	24	58	1	87	364
1200	268	10	28	54	5	97	360
1230	273	13	27	51	2	93	366
1300	289	9	32	43	2	86	375
1330	288	10	17	52	2	81	369
1400	287	16	17	52	1	86	373
1430	329	2	26	47	3	78	407
1500	334	0	17	49	1	67	401
1530	344	0	13	46	2	61	405
1600	291	2	40	49	1	92	383
1630	373	2	32	58	5	97	470
1700	373	0	22	35	0	57	430
TOTAL	6,397	138	561	1,059	33	1,791	8,188
PERCENT	78.0					22.0	

---

(1) Includes private automobiles, pick-ups, and vans.
SOURCE: Texas Transportation Institute

Table C-6

MANUAL VEHICLE CLASSIFICATION COUNT ON I.H. 35
Texas High Speed Rail Feasibility Study

Count Location: IH-35 North of Georgetown
Date of Count: 7/19/87
Direction of Count: Northbound

PASSENGER CARRS PICK-UP & VANS		COMMERCIAL VEHICLES (TRUCKS & BUSES)					
Half Hour Beginning	Passenger Cars (1)	Pick Up/ Panel	Van	Other Truck	Other Vehicle	COMM. TOTAL	TOTAL VEHICLES
0630	172	12	1	42	1	56	228
0700	233	16	1	37	2	56	289
0730	243	9	10	39	1	59	302
0800	205	13	13	38	0	64	269
0830	265	17	21	33	1	72	337
0900	244	19	30	39	1	89	333
0930	255	9	14	51	2	76	331
1000	243	8	14	52	0	74	317
1030	292	14	14	57	0	85	377
1100	268	3	11	64	1	79	347
1130	282	0	10	50	0	60	342
1200	484	3	23	101	2	129	613
1300	298	1	26	46	1	74	372
1330	292	4	19	55	2	80	372
1400	379	8	33	60	0	101	480
1430	362	3	42	55	6	106	468
1500	352	5	6	55	3	69	421
1530	378	11	38	55	5	109	487
1600	444	19	33	57	3	112	556
1630	398	18	21	36	0	75	473
1700	356	15	14	59	1	89	445
1730	371	7	17	47	0	71	442
1830	612	10	37	91	2	140	752
1900	260	8	17	41	2	68	328
1930	233	3	17	33	1	54	287
TOTAL	7,921	235	482	1,293	37	2,047	9,968
PERCENT	79.5					21.5	

---

(1) Includes private automobiles, pick-ups, and vans.

SOURCE: Texas Transportation Institute

Table C-7

ORIGIN-DESTINATION PATTERNS OF ANNUAL AUTOMOBILE TRAVEL ON I-45 NORTH OF FAIRFIELD

Texas High Speed Rail Feasibility Study

FROM/TO	DALLAS	FT. WORTH	HOUSTON	REST OF STATE	OTHER STATES	TOTAL
Dallas	-	-	678,964	282,464	58,292	1,019,720
Ft. Worth	-		204,724	46,072	22,048	272,844
Houston	600,964	192,192	-	169,416	137,540	1,100,112
Rest of State	189,852	40,092	145,912	337,064	51,636	764,556
Other States	15,808	1,768	104,832	20,124	61,984	204,516
TOTAL	806,624	234,052	1,134,432	855,140	331,500	3,361,748

SOURCE: Wilbur Smith Associates

Table C-8

ORIGIN-DESTINATION PATTERNS OF ANNUAL AUTOMOBILE TRAVEL ON I-10 EAST OF COLUMBUS

Texas High Speed Rail Feasibility Study

TRAVEL OBSERVED BETWEEN MAJOR CITIES	DALLAS	FORT WORTH	HOUSTON	SAN ANTONIO	AUSTIN	REST OF TEXAS	OTHER STATES	TOTAL
Dallas	-	-	-	-	-	-	-	-
Fort Worth	-	-	-	-	-	-	-	-
Houston	-	-	-	954,366	959,876	707,451	128,830	2,750,525
San Antonio	-	-	618,097	-	847	70,416	106,429	795,791
Austin	-	-	754,886	733	-	63,762	67,121	886,503
Rest of Texas	-	-	436,743	74,644	73,437	277,437	66,555	928,819
Other States	-	-	35,856	61,680	44,411	32,771	115,383	290,103
Total	-	-	1,845,583	1,091,424	1,078,573	1,151,840	484,321	5,651,743
ACTUAL TOTAL	-	-	1,845,583	1,091,424	1,078.573	1,151,840	484,321	5,651,743

SOURCE: Wilbur Smith Associates

Table C-9

ORIGIN-DESTINATION PATTERNS OF ANNUAL AUTOMOBILE TRAVEL ON I-35 NORTH OF GEORGETOWN

Texas High Speed Rail Feasibility Study

AVERAGE WEEKLY PASS CARS BETWEEN MAJOR CITIES	DALLAS	FORT WORTH	HOUSTON	SAN ANTONIO	AUSTIN	REST OF TEXAS	OTHER STATES	TOTAL
Dallas	4,578	-	-	109,120	177,034	227,397	1,526	519,656
Fort Worth	-	-	-	69,440	80,123	119,040	5,341	273,945
Houston	-	2,289	-	-	-	3,815	-	6,104
San Antonio	70,966	74,781	-	12,972	9,156	238,843	92,332	499,053
Austin	224,345	158,720	2,289	14,498	908,827	1,365,148	100,726	2,773,792
Rest of Texas	171,692	82,412	7,630	205,268	1,353,702	1,252,976	106,068	3,179,751
Other States	2,289	2,289	-	76,307	144,221	144,221	9,920	378,487
Total	473,872	320,493	9,920	487,607	2,672,303	3,351,443	315,914	7,630,792
ACTUAL TOTAL	7,880	5,329	160	8,110	44,438	55,722	5,259	126,901

SOURCE: Texas Transportation Institute

Table C-10

IMPORTANT SERVICE CHARACTERISTICS FOR A BUSINESS TRIP

Texas High Speed Rail Feasibility Study

		VERY IMPORTANT				LEAST IMPORTANT	
SERVICE CHARACTERISTICS	RANKING (Col 1+Col 2)	1	2	3	4	5	TOTAL
Price for Standard Service	45.5	27.7	17.8	29.7	14.8	9.9	100.0
Speed-Travel Time	99.1	86.1	12.8	.0	.0	.9	100.0
Separture Frequency	99.1	77.2	20.7	.9	.0	.9	100.0
Schedule Reliability	99.1	90.0	8.9	.0	.0	.9	100.0
Service Class (i.e., 1st or 2nd class)	35.6	9.9	25.7	40.5	16.8	6.9	100.0
Comfort Level	54.3	20.7	33.6	38.6	5.9	.9	100.0
Staff Effective and Attitude	58.4	29.7	28.7	31.6	8.9	.9	100.0
Food	30.6	7.9	22.7	39.6	17.8	11.8	100.0
Condition of Facilities and Equipment	80.1	42.5	37.6	15.8	2.9	.9	100.0
Need for Transportation at Destination	87.1	68.3	18.8	7.9	3.9	.9	100.0

SOURCE: Wilbur Smith Associates

Table C-11

BEST MODE OF TRANSPORTATION FOR A BUSINESS TRIP
Texas High Speed Rail Feasibility Study

SERVICE CHARACTERISTICS	AUTO	BUS	TRAIN	AIRLANE	HIGH SPEED RAIL	TOTAL
Price for Standard Service	18.7	1.0	.0	32.2	47.9	100.0
Speed-Travel Time	.0	.0	.0	48.4	51.1	100.0
Departure Frequency	28.5	.0	.0	31.6	39.7	100.0
Schedule Reliability	30.2	.0	.0	23.9	45.8	100.0
Service Class (i.e., 1st and 2nd class)	9.3	.0	.0	39.5	51.0	100.0
Comfort Level	8.2	.0	.0	13.4	78.3	100.0
Staff Effectiveness and Attitude	17.9	.0	.0	46.0	35.9	100.0
Food	42.6	.0	.0	22.4	34.8	100.0
Condition of Facilities and Equipment	16.1	.0	.0	26.8	56.9	100.0
Need for Transportation at Destination	63.9	.0	.0	16.4	19.5	100.0

SOURCE: Wilbur Smith Associates

Table C-12

IMPORTANT SERVICE CHARACTERISTICS FOR A PLEASURE TRIP

Texas High Speed Rail Feasibility Study

		VERY IMPORTANT				LEAST IMPORTANT	
SERVICE CHARACTERISTICS	RANKING (Col 1+Col 2)	1	2	3	4	5	TOTAL
Price for Standard Service	81.0	55.0	26.0	17.0	2.0	.0	100.0
Speed-Travel Time	41.4	20.7	20.7	43.5	11.8	2.9	100.0
Separture Frequency	52.3	21.7	30.6	25.7	15.8	5.9	100.0
Schedule Reliability	68.2	32.6	35.6	23.7	5.9	1.9	100.0
Service Class (i.e., 1st or 2nd class)	28.6	10.8	17.8	39.6	19.8	11.8	100.0
Comfort Level	76.1	30.6	45.5	18.8	4.9	.0	100.0
Staff Effective and Attitude	60.0	31.0	29.0	22.0	149	4.0	100.0
Food	49.5	19.8	29.7	28.6	10.8	10.8	100.0
Condition of Facilities and Equipment	85.0	42.5	42.5	11.8	2.9	.0	100.0
Need for Transportation at Destination	83.0	61.3	21.7	12.8	1.9	1.9	100.0

SOURCE: Wilbur Smith Associates

Table C-13

BEST MODE OF TRANSPORTATION FOR A PLEASURE TRIP
Texas High Speed Rail Feasibility Study

SERVICE CHARACTERISTICS	AUTO	BUS	TRAIN	AIRLANE	HIGH SPEED RAIL	TOTAL
Price for Standard Service	80.6	.0	1.0	3.0	15.3	100.0
Speed-Travel Time	11.0	.0	1.0	38.0	50.0	100.0
Departure Frequency	61.6	.0	.0	14.1	24.2	100.0
Schedule Reliability	59.1	.0	.0	12.2	28.5	100.0
Service Class (i.e., 1st and 2nd class)	26.3	.0	1.0	27.4	45.0	100.0
Comfort Level	25.2	.0	1.0	8.0	65.6	100.0
Staff Effectiveness and Attitude	29.6	.0	.0	42.8	27.4	100.0
Food	69.5	.0	1.0	8.6	20.6	100.0
Condition of Facilities and Equipment	37.6	.0	1.0	17.2	44.0	100.0
Need for Transportation at Destination	82.8	.0	.0	9.0	8.0	100.0

SOURCE: Wilbur Smith Associates

Table C-14

SYSTEM TIME AND FARE SENSITIVITY BY TRIP PURPOSE
Texas High Speed Rail Feasibility Study

RAIL MODE	HSR FARE % OF AIR FARE	RIDERSHIP 1998 (THOUSANDS)(1)			RIDERSHIP 2015 (THOUSANDS)(1)		
		Business	Non-Bus	Total	Business	Non-Bus	Total
HS	100	1,808.9	871.4	2,680.3	3,674.0	1,845.9	5,519.9
	67	1,903.1	2,041.9	3,945.0	3,859.9	4,255.4	8,115.3
	50	1,957.0	3,253.2	5,819.7	3,967.2	6,740.9	10,708.1
VHS	100	2,566.5	1,271.2	3,837.7	5,140.1	2,659.1	7,799.2
	67	2,704.3	3,235.4	5,939.7	5,409.9	6,670.9	12,080.8
	50	2,685.2	4,943.2	7,628.4	5,565.1	10,163.1	15,728.2
UHS	100	3,684.8	1,943.6	5,628.4	7,296.2	4,033.3	11,329.5
	67	3,876.3	4,822.6	8,698.9	7,657.2	9,916.1	17,573.3
	50	3,981.5	6,841.5	10,823.0	7,876.0	14,029.7	21,896.7

---

(1) Ridership estimates do not include induced trips.

SOURCE: Wilbur Smith Associates

Table C-15

TIME AND FARE SENSITIVITY BY TRIP PURPOSE
DALLAS/FORT WORTH TO HOUSTON CORRIDOR
Texas High Speed Rail Feasibility Study

RAIL MODE	HSR FARE % OF AIR FARE	RIDERSHIP 1998 (THOUSANDS)(1)			RIDERSHIP 2015 (THOUSANDS)(1)		
		Business	Non-Bus	Total	Business	Non-Bus	Total
HS	100	581.1	314.8	895.9	1,086.5	629.1	1,715.6
	67	614.5	734.0	1,348.5	1,149.0	1,452.3	2,601.3
	50	633.0	1,190.2	1,823.2	1,184.2	2,351.3	3,535.5
VHS	100	987.6	518.3	1,505.9	1,845.5	1,028.2	2,873.7
	67	1,039.4	1,338.3	2,377.7	1,940.3	2,642.3	4,582.6
	50	1,069.9	1,966.8	3,036.7	1,995.0	3,872.5	5,867.5
UHS	100	1,481.5	829.9	2,311.4	2,756.3	1,642.8	4,399.1
	67	1,550.0	1,965.3	3,515.3	2,882.5	3,871.0	6,753.5
	50	1,588.0	2,611.6	4,199.6	2,953.9	4,930.0	7,883.9

---

(1) Ridership estimates do not include induced trips.

SOURCE: Wilbur Smith Associates

Table C-16

TIME AND FARE SENSITIVITY-SYSTEM
Texas High Speed Rail Feasibility Study

		1998 RIDERSHIP (THOUSANDS)				
		AUTO	AIR	HSR DIVERTED TRIPS	HSR INDUCED TRIPS (1)	TOTAL ESTIMATED HSR TRIPS
1.	HS, HSR 100% of Air	22,083.0	5,175.7	2,680.3	536.1	3,216.4
	VHS, HSR 100% of Air	21,766.0	4,338.5	3,837.7	767.5	4,605.2
	UHS, HSR 100% of Air	20,602.0	3,717.6	5,628.4	1,125.7	6,754.1
2.	HS, HSR 67% of Air	21,211.7	4,791.4	3,945.0	789.0	4,734.0
	VHS, HSR 67% of Air	19,929.2	4,082.5	5,939.7	1,187.9	7,127.6
	UHS, HSR 67% of Air	17,733.9	3,518.7	8,698.9	1,739.8	10,438.7
3.	HS, HSR 50% of Air	20,058.8	4,680.0	5,819.7	1,163.9	6,983.6
	VHS, HSR 50% of Air	18,262.5	3,958.2	7,628.4	1,525.7	9,154.1
	UHS, HSR 50% of Air	15,817.8	3,317.3	10,823.0	2,164.6	12,987.6

		2015 RIDERSHIP (THOUSANDS)				
		AUTO	AIR	HSR DIVERTED TRIPS	HSR INDUCED TRIPS (1)	TOTAL ESTIMATED HSR TRIPS
1.	HS, HSR 100% of Air	44,695.8	10,299.6	5,519.9	1,104.0	6,623.9
	VHS, HSR 100% of Air	44,077.9	8,644.8	7,799.2	1,559.8	9,359.0
	UHS, HSR 100% of Air	41,781.0	7,417.4	11,329.5	2,265.9	13,595.4
2.	HS, HSR 67% of Air	42,897.8	9,507.8	8,115.3	1,623.1	9,738.4
	VHS, HSR 67% of Air	40,334.8	8,117.3	12,080.8	2,416.2	14,497.0
	UHS, HSR 67% of Air	35,945.6	7,012.5	17,573.3	3,514.7	21,088.0
3.	HS, HSR 50% of Air	40,538.7	9,280.0	10,708.1	2,141.6	12,849.7
	VHS, HSR 50% of Air	36,938.3	7,867.8	15,728.2	3,145.6	18,873.8
	UHS, HSR 50% of Air	32,037.7	6,601.7	21,896.7	4,379.3	26,276.0

---

(1) Induced trips include true induced travel plus additional diverted trips due to special modal attractiveness of HSR.

Note: High Speed Rail stations assumed for CBD's and three suburban locations.

SOURCE: Wilbur Smith Associates

Table C-17

TIME AND FARE SENSITIVITY
DALLAS/FORT WORTH TO HOUSTON CORRIDOR
Texas High Speed Rail Feasibility Study

		1998 RIDERSHIP (THOUSANDS)				
		AUTO	AIR	HSR DIVERTED TRIPS	HSR INDUCED TRIPS (1)	TOTAL ESTIMATED HSR TRIPS
1.	HS, HSR 100% of Air	4,566.3	2,363.8	895.9	179.2	1,075.1
	VHS, HSR 100% of Air	4,444.8	1,875.4	1,505.9	301.2	1,807.1
	UHS, HSR 100% of Air	3,958.4	1,559.5	2,316.5	463.3	2,779.8
2.	HS, HSR 67% of Air	4,318.8	2,161.3	1,354.3	270.9	1,625.2
	VHS, HSR 67% of Air	3,686.5	1,764.5	2,377.7	475.5	2,853.2 ✓
	UHS, HSR 67% of Air	2,683.0	1,446.8	3,704.6	740.9	4,445.5
3.	HS, HSR 50% of Air	3,891.4	2,114.6	1,810.4	362.1	2,172.5
	VHS, HSR 50% of Air	3,107.6	1,683.3	3,036.7	607.3	3,644.0
	UHS, HSR 50% of Air	2,300.6	1,330.4	4,203.4	840.7	5,044.1

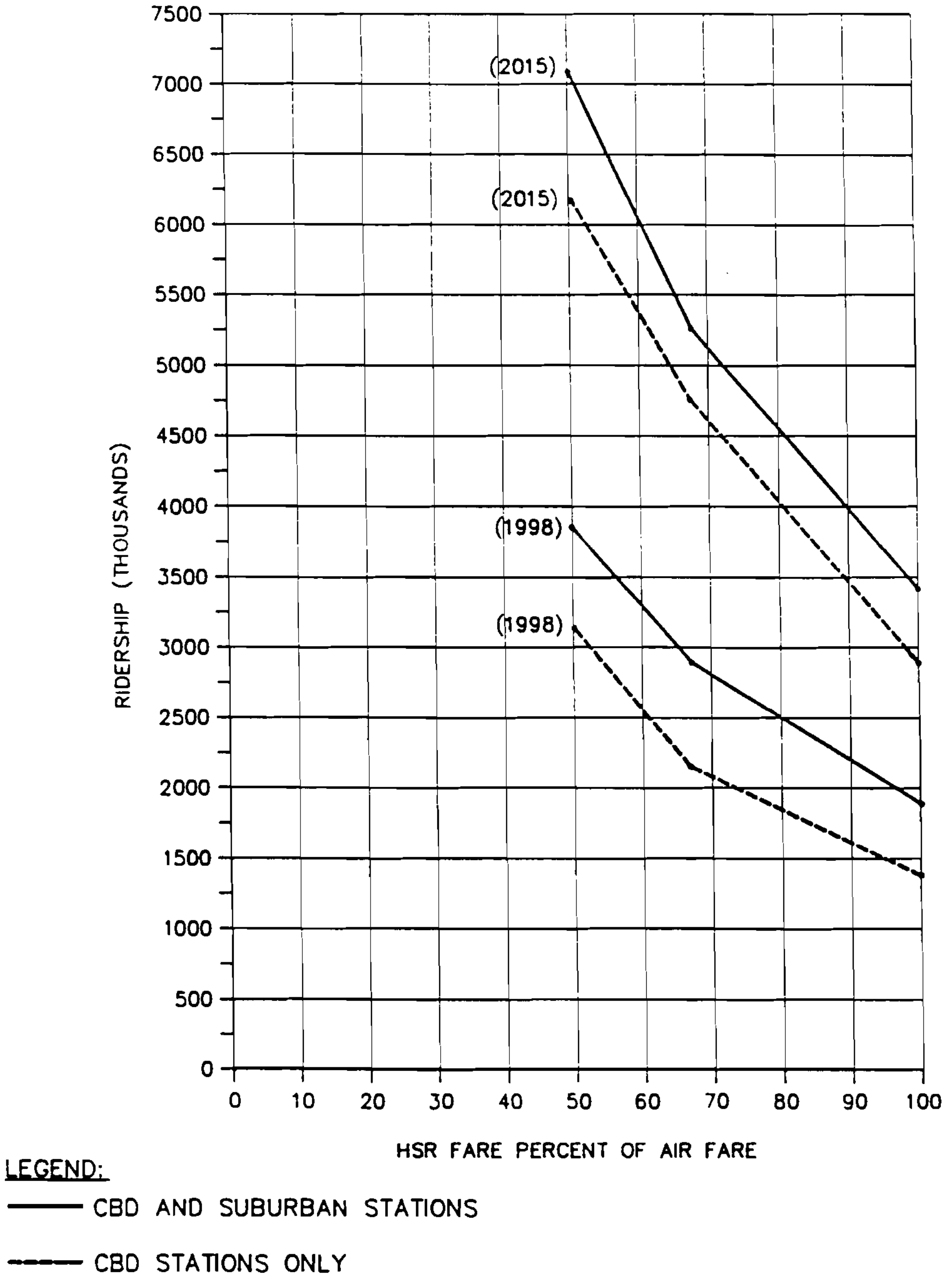
		2015 RIDERSHIP (THOUSANDS)				
		AUTO	AIR	HSR DIVERTED TRIPS	HSR INDUCED TRIPS (1)	TOTAL ESTIMATED HSR TRIPS
1.	HS, HSR 100% of Air	8,729.3	4,506.7	1,715.6	343.1	2,058.7
	VHS, HSR 100% of Air	8,500.9	3,576.7	2,873.5	574.7	3,448.2
	UHS, HSR 100% of Air	7,577.7	2,876.4	4,507.0	901.4	5,408.4
2.	HS, HSR 67% of Air	8,246.2	4,107.5	2,607.4	521.5	3,128.9
	VHS, HSR 67% of Air	7,067.0	3,359.7	4,582.6	916.5	5,499.1
	UHS, HSR 67% of Air	5,448.6	2,755.2	6,757.3	1,315.5	8,108.8
3.	HS, HSR 50% of Air	7,404.9	4,016.6	3,539.6	707.9	4,247.5
	VHS, HSR 50% of Air	5,888.2	3,200.7	5,872.2	1,174.4	7,046.6
	UHS, HSR 50% of Air	4,346.0	2,526.5	8,088.2	1,617.6	9,705.8

---

(1) Induced trips include induced travel plus additional diverted trips due to special modal attractiveness of HSR.

Note: High Speed Rail stations assumed for CBD's and two suburban locations. Base demographic forecasts used in travel forecasts.

SOURCE: Wilbur Smith Associates

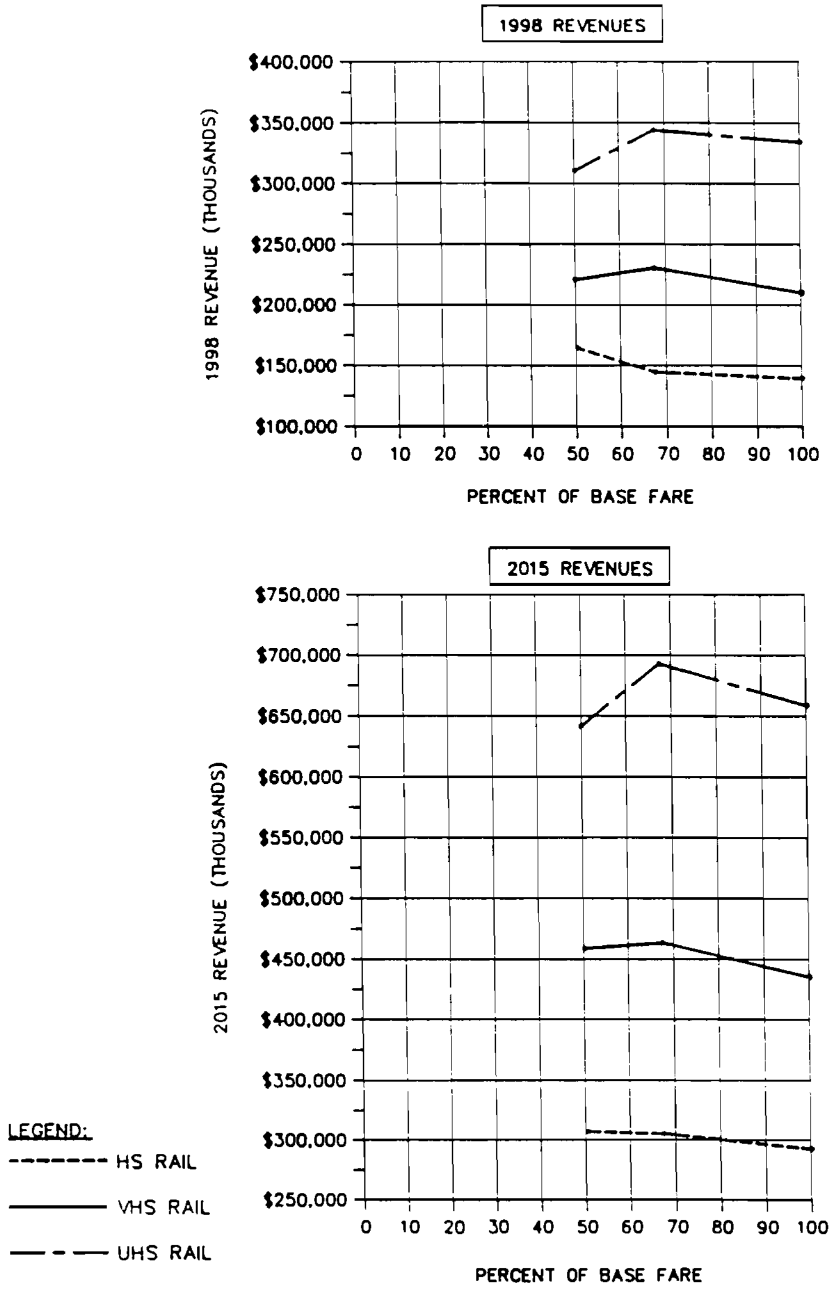


Station Location Sensitivity

Texas High Speed Rail Feasibility Study

FIGURE C-1

Wilbur Smith Associates

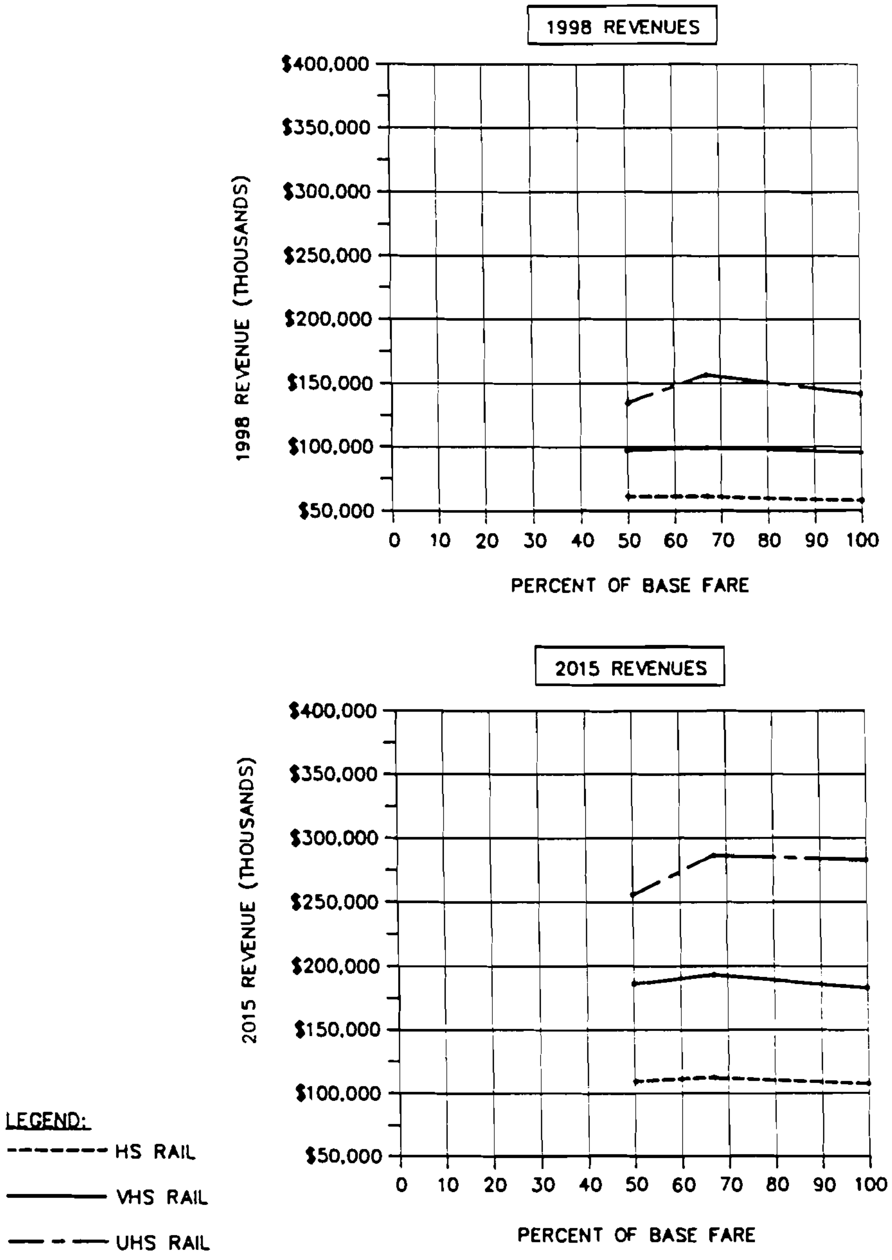


System Revenues With Variations In Time and Fare

Texas High Speed Rail Feasibility Study

Wilbur Smith Associates

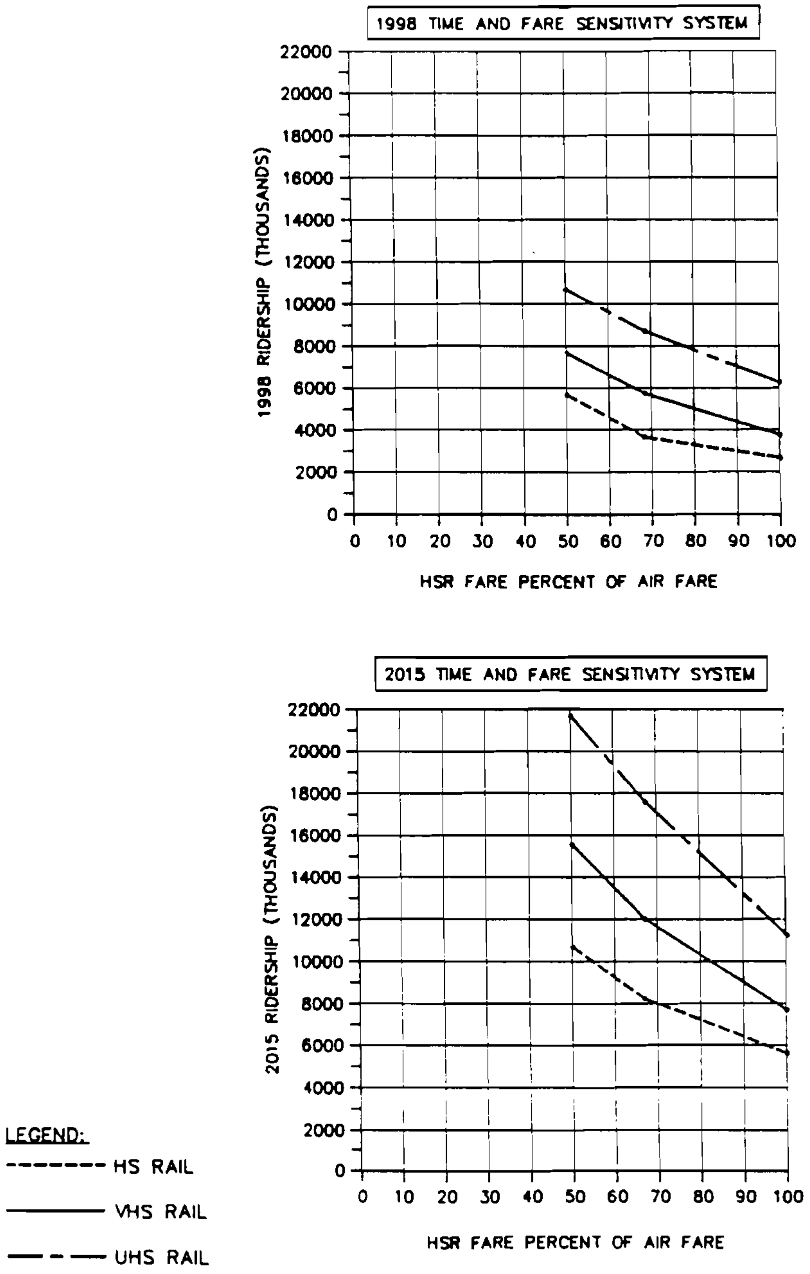
FIGURE C-2



Revenues With Variations
In Time and Fare
Dallas/Ft. Worth–Houston Corridor
Texas High Speed Rail Feasibility Study

Wilbur Smith Associates

FIGURE C-3

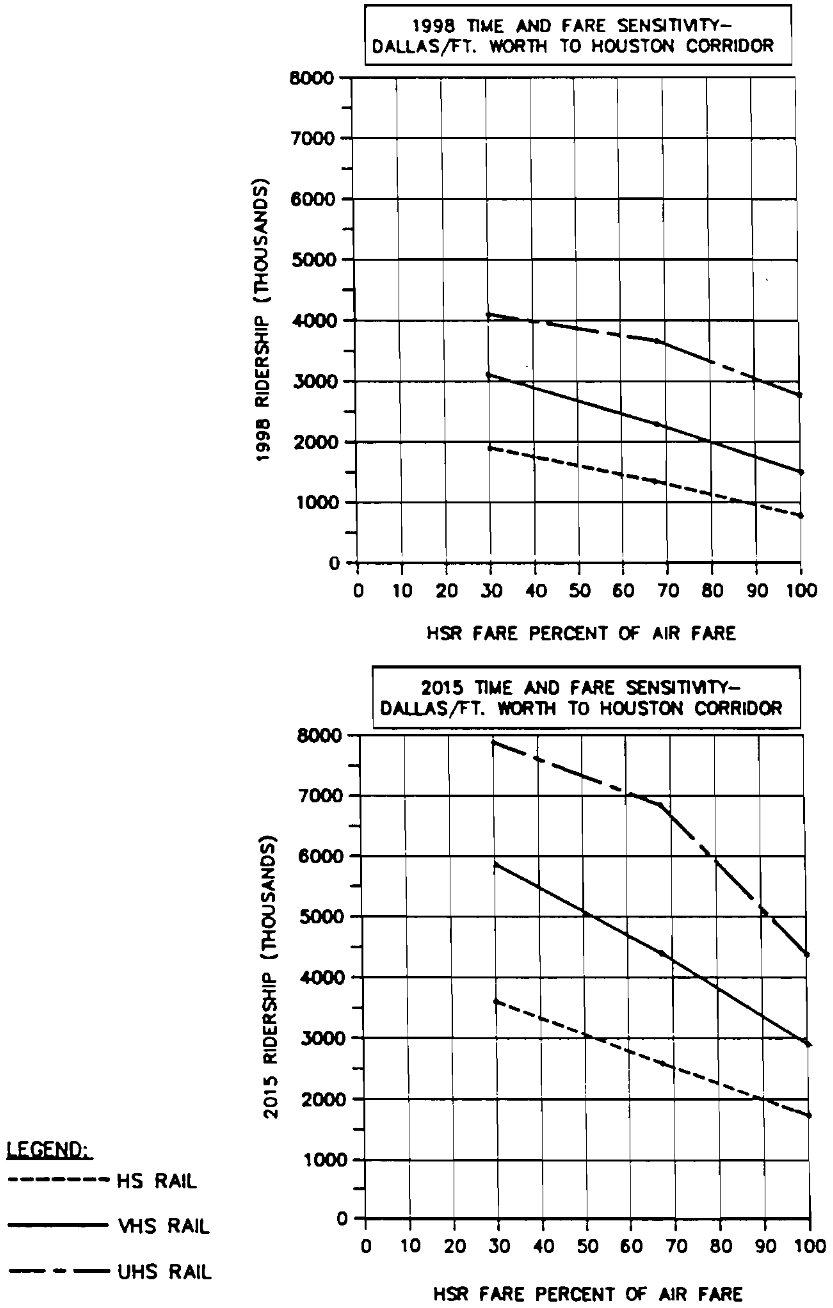


System Time and Fare Sensitivity

Texas High Speed Rail Feasibility Study

Wilbur Smith Associates

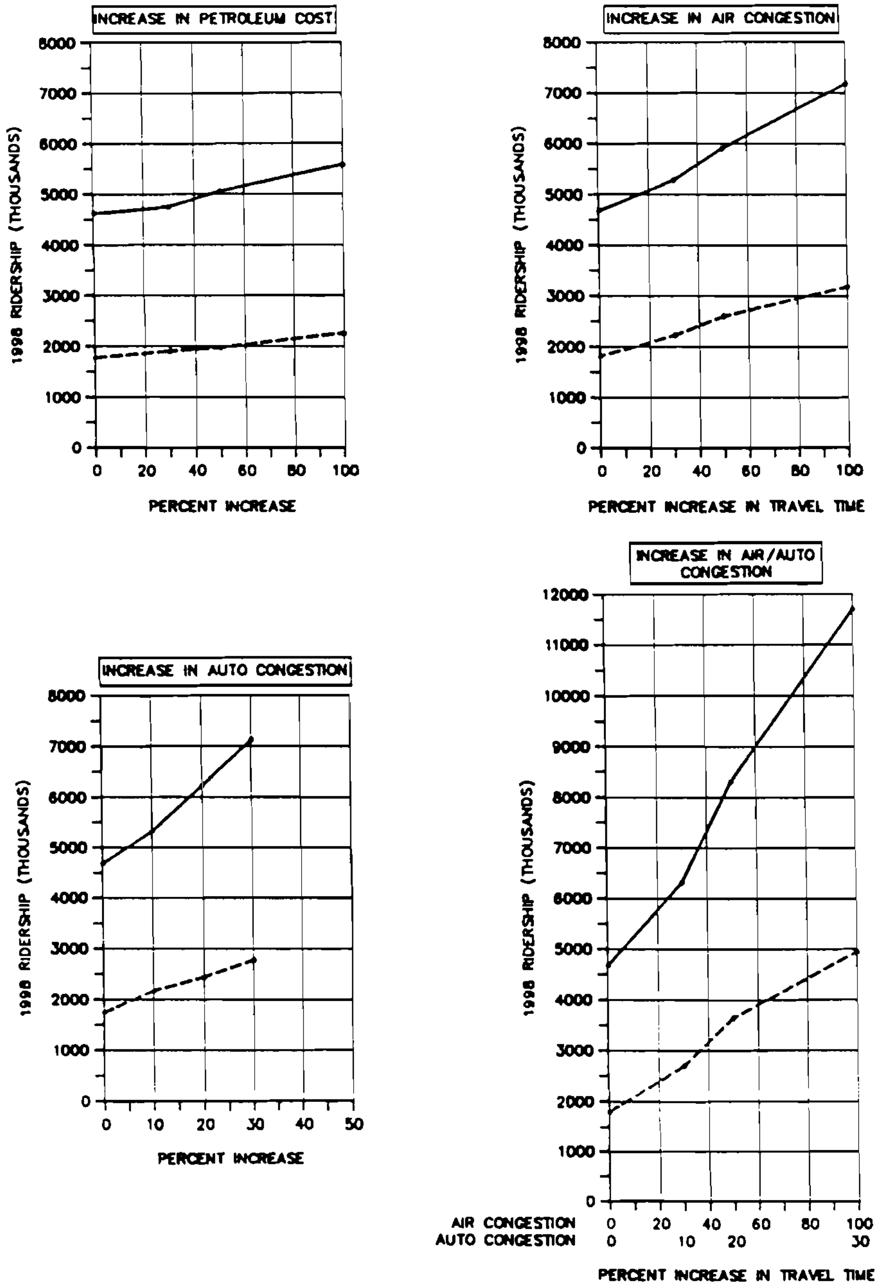
FIGURE C-4



Dallas/Ft. Worth–Houston Corridor
Time and Fare Sensitivity
Texas High Speed Rail Feasibility Study

Wilbur Smith Associates

FIGURE C-5



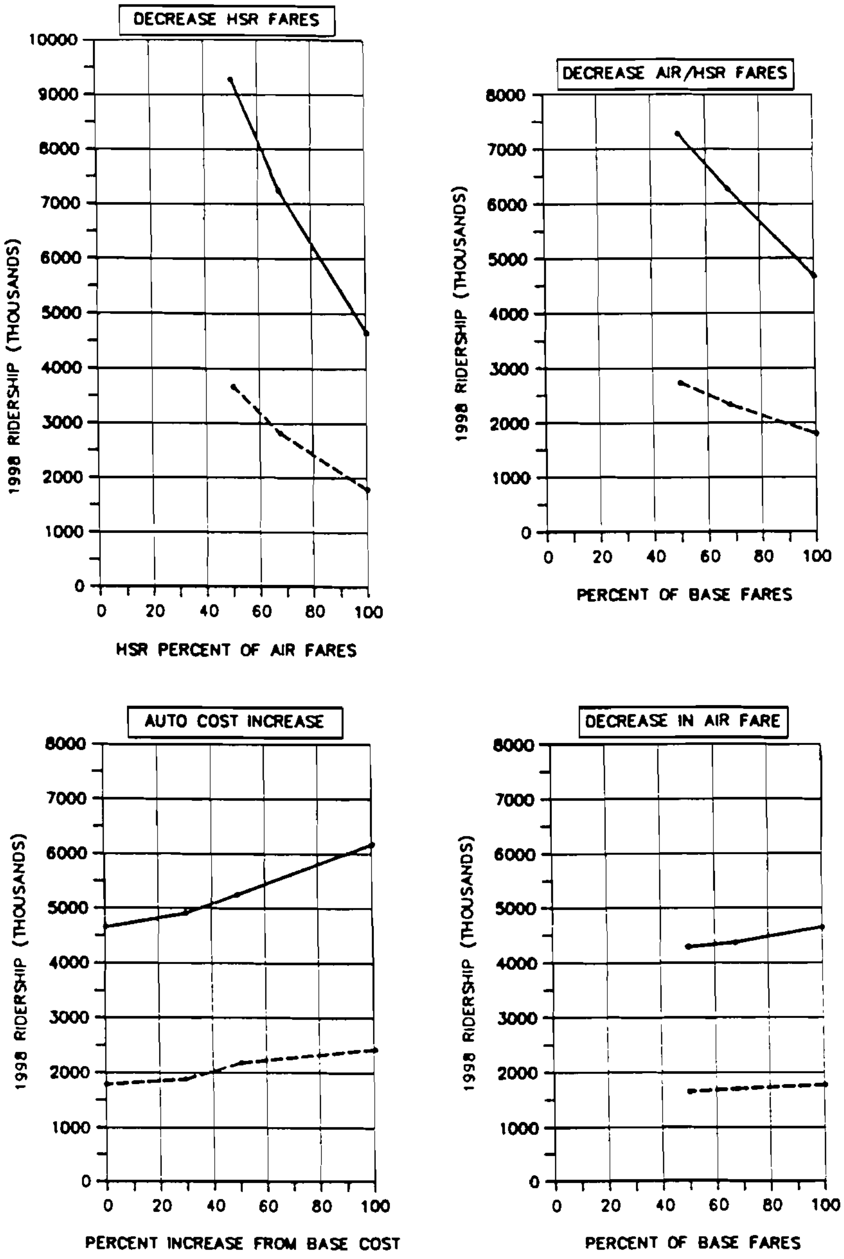
Travel Mode Congestion and
Energy Cost Sensitivity

Texas High Speed Rail Feasibility Study

LEGEND:
——— SYSTEM
---- D/FW–HOUSTON

Wilbur Smith Associates

FIGURE C-6



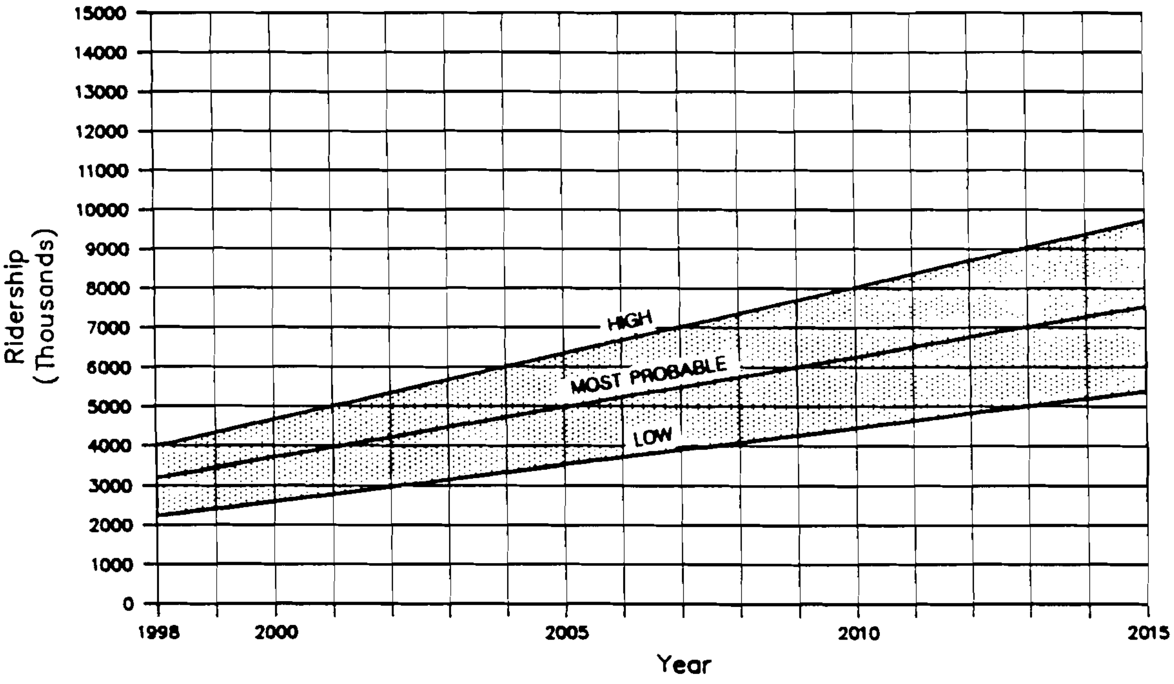
Travel Mode Cost Sensitivity

Texas High Speed Rail Feasibility Study

LEGEND:
——— SYSTEM
---- D/FW–HOUSTON

Wilbur Smith Associates

FIGURE C-7



Estimated HSR Ridership for
Dallas/Fort Worth-Houston Corridor
Texas High Speed Rail Feasibility Study

WILBUR SMITH ASSOCIATES

FIGURE C-8

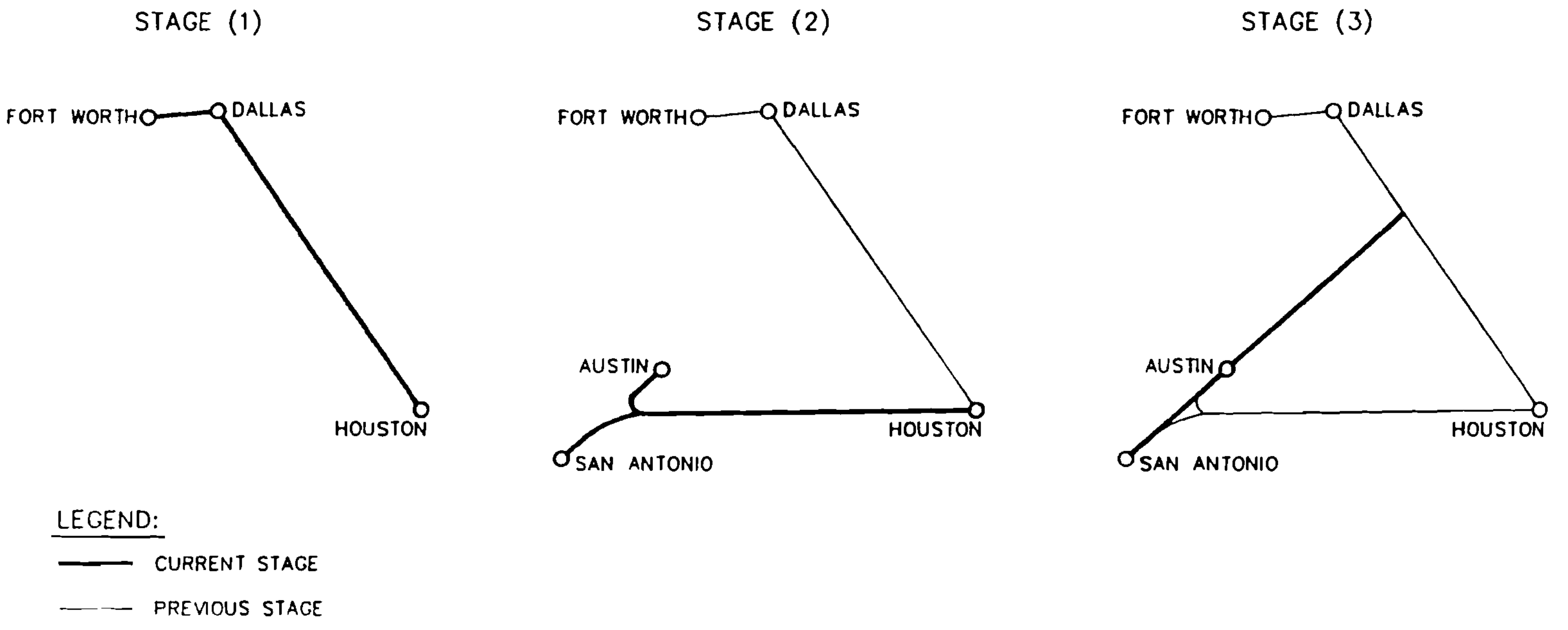


FIGURE C-9

Potential System Staging Plan

Texas High Speed Rail Feasibility Study

Wilbur Smith Associates

APPENDIX D

SYSTEM OPERATIONS

TRIP TIMES
TECHNOLOGY: HS

Route	Route Segment	Length (miles)	Run Time	Recovery Time	Total Time
1 & 2	Fort Worth-Mid City	16	0:17	0:01	0:18
1 & 2	Mid City-Dallas	17	0:18	0:01	0:19
1	Dallas-Houston Beltway	248	2:08	0:06	2:14
1	Houston Beltway-Houston CBD	15	0:16	0:01	0:17
2	Dallas-Austin	229	2:09	0:06	2:15
2	Austin-San Antonio	76	0:57	0:03	1:00
3	Houston Beltway-Houston CBD	15	0:16	0:01	0:17
3	San Antonio-Houston Beltway	199	1:52	0:05	1:57
3	Austin-Houston Beltway	184	1:43	0:05	1:48

TRIP TIMES
TECHNOLOGY: VHS

Route	Route Segment	Length (miles)	Run Time	Recovery Time	Total Time
1 & 2	Fort Worth-Mid City	16	0:17	0:01	0:18
1 & 2	Mid City-Dallas	17	0:18	0:01	0:19
1	Dallas-Houston Beltway	248	1:31	0:04	1:35
1	Houston Beltway-Houston CBD	15	0:16	0:01	0:17
2	Dallas-Austin	229	1:38	0:05	1:43
2	Austin-San Antonio	76	0:52	0:03	0:55
3	Houston Beltway-Houston CBD	15	0:16	0:01	0:17
3	San Antonio-Houston Beltway	199	1:26	0:04	1:30
3	Austin-Houston Beltway	184	1:19	0:04	1:23

TRIP TIMES
TECHNOLOGY: UHS

Route	Route Segment	Length (miles)	Run Time	Recovery Time	Total Time
1 & 2	Fort Worth-Mid City	16	0:17	0:01	0:18
1 & 2	Mid City-Dallas	17	0:18	0:01	0:19
1	Dallas-Houston Beltway	248	1:01	0:03	1:04
1	Houston Beltway-Houston CBD	15	0:16	0:01	0:17
2	Dallas-Austin	229	1:13	0:04	1:17
2	Austin-San Antonio	76	0:46	0:02	0:48
3	Houston Beltway-Houston CBD	15	0:16	0:01	0:17
3	San Antonio-Houston Beltway	199	1:04	0:03	1:07
3	Austin-Houston Beltway	184	0:58	0:03	1:01

SCHEDULE TIMES

Route No.	City Pairs	Length (miles)	Schedule Times (hours:minutes) HS	VHS	UHS
1	Fort Worth-Dallas	33	0:38	0:38	0:38
	Dallas-Houston	263	2:32	1:53	1:22
	Fort Worth-Houston	296	3:13	2:34	2:03
2	Fort Worth-Dallas	33	0:38	0:38	0:38
	Dallas-Austin	229	2:15	1:43	1:17
	Austin-San Antonio	76	1:00	0:55	0:48
	Fort Worth-San Antonio	338	3:59	3:22	2:49
3	San Antonio-Houston	214	2:15	1:48	1:25
	Austin-Houston	199	2:06	1:41	1:19

ROLLING STOCK FLEET DETERMINATIONS
STAND-ALONE SCENARIOS

Technology/Route		City Pairs	1998		2015	
			No. of Peak One-Way Trains	Cars* per Train	No. of Peak One-Way Trains	Cars* per Train
HS	1	Fort Worth-Dallas-Houston	21	5	21	
	2	Houston-San Antonio/Austin	36	4-6	36	6-9
	3	Dallas/Ft. Worth-San Antonio	11	7	15	9
VHS	1	Fort Worth-Dallas-Houston	21	8	34	10
	2	Houston-San Antonio/Austin	36	6	45	9
	3	Dallas/Ft. Worth-San Antonio	11	9	22	10
UHS	1	Fort Worth-Dallas-Houston	21	6	38	6
	2	Houston-San Antonio/Austin	36	4-6	49	6
	3	Dallas/Ft. Worth-San Antonio	11	6	24	6

* Includes restaurant car.

ROLLING STOCK REQUIREMENTS*
STAND-ALONE SCENARIOS

Technology/Route		1998				2015			
		Sets	Locomotives	Coaches	Restaurants	Sets	Locomotives	Coaches	Restaurants
HS	1	17	17	68	17	17	34	102	17
	2	12	24	72	12	15	30	120	15
	3	19	25	76	19	19	38	120	19
VHS	1	17	34	119	17	23	46	207	23
	2	10	20	80	10	17	34	153	17
	3	19	38	95	19	19	38	152	19
UHS**	1	15	75	-	15**	19	95	-	19**
	2	10	50	-	10**	17	85	-	17**
	3	15	62	-	15**	21	105	-	21**

* Requirements include spares for ready reserve and scheduled repairs.

** For UHS - one car of train set is considered one-half restaurant car. All cars are powered.

* Source: Morrison-Knudsen Engineers, Inc.

ROLLING STOCK FLEET DETERMINATIONS
STAGING SCENARIO
VHS TECHNOLOGY

		1998		2015	
Route	City Pairs	No. of Peak One-Way Trains	Cars* per Train	No. of Peak One-Way Trains	Cars* per Train
1	Dallas/Ft. Worth-Houston	21	8	34	10
2	Houston-San Antonio/Austin	36	6	45	9
3	Dallas/Ft. Worth-San Antonio	11	7	15	9

ROLLING STOCK REQUIREMENTS

	1998				2015			
Route	Sets	Locomotives	Coaches	Restaurants	Sets	Locomotives	Coaches	Restaurants
1	17	34	119	17	23	46	207	23
2	10	20	60	10	12	24	96	12
3	19	38	95	19	19	38	152	19
Total	46	92	274	46	54	108	455	54

* Includes restaurant car.

* Source: Morrison-Knudsen Engineers, Inc.

APPENDIX E

CAPITAL AND O&M COSTS

TABLE E-1
TEXAS HIGH SPEED RAIL

INDEPENDENT ALIGNMENT:HS OPTION
COST SUMMARY BY SEGMENT ($000)

SEGMENT	1	2	3	4	5	6	7	8	TOTAL
LENGTH	32.77	65.97	148.53	32.21	126.46	28.64	53.86	130.05	618.49
EARTHWORK	5,004	19,819	51,885	5,736	41,956	8,152	17,349	45,707	195,608
RAILROAD RECONSTRUCTION	14,273	5,033	0	11,855	2,764	5,825	6,476	0	46,225
TRACKWORK	37,511	72,921	162,840	35,774	139,483	31,720	59,836	142,196	682,282
STRUCTURES	100,008	81,990	117,110	56,865	143,316	39,747	78,943	100,170	718,149
RIGHT-OF-WAY	17,500	13,723	3,601	29,764	12,800	16,724	11,044	3,153	108,307
ELECTRIFICATION	0	0	0	0	0	0	0	0	0
STATIONS	10,000	5,000	0	20,000	10,000	0	10,000	0	55,000
MAINTENANCE FACILITIES	8,500	8,500	3,000	50,500	9,500	1,000	8,500	9,500	99,000
TRAIN CONTROL	16,203	34,406	88,871	3,000	61,866	16,239	26,514	63,830	310,929
ROLLING STOCK (1997)	0	0	137,700	0	157,200	0	0	153,900	448,800
ENGINEERING	18,810	21,725	38,458	19,214	37,952	10,746	19,680	32,810	199,395
CONSTRUCTION MANAGEMENT	6,270	7,242	12,819	6,405	12,651	3,582	6,560	10,937	66,465
RIGHT OF WAY ACQUISITION	4,375	3,431	900	7,441	3,200	4,181	2,761	788	27,077
CONTINGENCIES	11,923	13,690	30,859	12,328	31,634	6,896	12,383	28,150	147,862
TOTAL	250,377	287,480	648,043	258,882	664,320	144,811	260,045	591,140	3,105,098
ROLLING STOCK (2007)	0	0	85,000		69,300	0	0	101,000	255,300

SEGMENT DESCRIPTION:

1: FORT WORTH - DALLAS UNION STATION
2: DALLAS UNION STATION - CORSICANA JUNCTION
3: CORSICANA JUNCTION - HOUSTON 610 JUNCTION
4: HOUSTON 610 JUNCTION - HOUSTON DOWNTOWN
5: AUSTIN SW JUNCTION - AUSTIN DOWNTOWN
6: AUSTIN SW JUNCTION - SAN MARCOS
7: SAN MARCOS - SAN ANTONIO
8: SAN MARCOS - HOUSTON 610 JUNCTION

TABLE E-2
TEXAS HIGH SPEED RAIL

EXISTING ALIGNMENT:HS OPTION
COST SUMMARY BY SEGMENT ($000)

SEGMENT	1	2	3	4	5	6	7	8	9	TOTAL
LENGTH	32.77	54.60	203.92	5.00	156.75	0.72	27.27	52.73	152.31	686.07
EARTHWORK	5,004	16,333	64,077	611	48,438	0	7,940	16,951	49,588	208,943
RAILROAD RECONSTRUCTION	14,273	14,561	54,038	0	39,452	627	9,694	11,468	29,857	173,968
TRACKWORK	37,511	61,172	223,739	5,930	172,814	973	30,043	58,821	166,695	757,698
STRUCTURES	100,008	90,014	206,939	16,072	201,852	5,168	36,118	80,785	160,709	897,665
RIGHT-OF-WAY	17,500	15,745	23,028	10,000	41,314	3,040	13,530	10,592	15,207	149,956
ELECTRIFICATION	0	0	0	0	0	0	0	0	0	0
STATIONS	10,000	5,000	10,000	10,000	10,000	0	0	10,000	10,000	65,000
MAINTENANCE FACILITIES	8,500	8,500	3,000	51,500	9,500	0	1,000	8,500	9,500	100,000
TRAIN CONTROL	16,203	29,005	102,619	3,000	77,087	0	15,748	26,023	77,087	346,772
ROLLING STOCK (1997)	0	0	137,700		157,200	0	0	0	153,900	448,800
ENGINEERING	18,810	21,630	61,870	8,740	54,041	883	10,267	20,083	46,678	243,000
CONSTRUCTION MANAGEMENT	6,270	7,210	20,623	2,913	18,014	294	3,422	6,694	15,559	81,000
RIGHT OF WAY ACQUISITION	4,375	3,936	5,757	2,500	10,329	760	3,383	2,648	3,802	37,489
CONTINGENCIES	11,923	13,655	45,669	5,563	42,002	587	6,557	12,628	36,929	175,515
TOTAL	250,377	286,762	959,059	116,830	882,041	12,332	137,702	265,192	775,511	3,685,806
ROLLING STOCK (2007)	0	0	85,000		69,300	0	0	0	101,000	255,300

SEGMENT DESCRIPTION

1: FORT WORTH - DALLAS UNION STATION
2: DALLAS UNION STATION - CORSICANA JUNCTION
3: CORSICANA JUNCTION - HOUSTON 610 JUNCTION
4: HOUSTON 610 JUNCTION - HOUSTON DOWNTOWN
5: CORSICANA JUNCTION - AUSTIN SW JUNCTION
6: AUSTIN SW JUNCTION - AUSTIN DOWNTOWN
7: AUSTIN SW JUNCTION - SAN MARCOS
8: SAN MARCOS - SAN ANTONIO
9: SAN MARCOS - HOUSTON 610 JUNCTION

TABLE E-3
TEXAS HIGH SPEED RAIL

INDEPENDENT ALIGNMENT:VHS OPTION
COST SUMMARY BY SEGMENT ($000)

SEGMENT	1	2	3	4	5	6	7	8	TOTAL
LENGTH	32.77	65.97	148.53	32.21	126.46	28.64	53.86	130.05	618.49
EARTHWORK	5,004	19,819	51,885	5,736	41,956	8,152	17,349	45,707	195,608
RAILROAD RECONSTRUCTION	18,208	6,420	0	15,124	3,526	7,431	8,262	0	58,972
TRACKWORK	37,511	72,921	162,840	35,774	139,483	31,720	59,836	142,196	682,282
STRUCTURES	100,008	81,990	117,110	56,865	143,316	39,747	78,943	100,170	718,149
RIGHT-OF-WAY	17,500	13,723	3,601	29,764	12,800	16,724	11,044	3,153	108,307
ELECTRIFICATION	23,136	46,575	104,862	22,740	89,281	20,220	38,025	91,815	436,654
STATIONS	10,000	5,000	0	20,000	10,000	0	10,000	0	55,000
MAINTENANCE FACILITIES	1,000	17,000	5,000	57,500	4,000	1,000	17,000	4,000	106,500
TRAIN CONTROL	18,120	39,660	98,822	5,000	69,054	18,790	29,440	70,986	349,872
ROLLING STOCK (1997)	0	0	277,700	0	191,000	0	0	305,900	774,600
ENGINEERING	20,744	27,280	48,971	22,365	46,207	12,940	24,291	41,222	244,021
CONSTRUCTION MANAGEMENT	6,915	9,093	16,324	7,455	15,402	4,313	8,097	13,741	81,340
RIGHT OF WAY ACQUISITION	4,375	3,431	900	7,441	3,200	4,181	2,761	788	27,077
CONTINGENCIES	13,126	17,146	44,401	14,288	38,461	8,261	15,252	40,984	191,919
TOTAL	275,647	360,058	932,415	300,053	807,686	173,478	320,300	860,663	4,030,300
ROLLING STOCK (2007)	0	0	154,600		150,700	0	0	57,000	362,300

SEGMENT DESCRIPTION

1: FORT WORTH - DALLAS UNION STATION
2: DALLAS UNION STATION - CORSICANA JUNCTION
3: CORSICANA JUNCTION - HOUSTON 610 JUNCTION
4: HOUSTON 610 JUNCTION - HOUSTON DOWNTOWN
5: AUSTIN SW JUNCTION - AUSTIN DOWNTOWN
6: AUSTIN SW JUNCTION - SAN MARCOS
7: SAN MARCOS - SAN ANTONIO
8: SAN MARCOS - HOUSTON 610 JUNCTION

TABLE E-4
TEXAS HIGH SPEED RAIL

EXISTING ALIGNMENT:VHS OPTION
COST SUMMARY BY SEGMENT ($000)

SEGMENT	1	2	3	4	5	6	7	8	9	TOTAL
LENGTH	32.77	54.60	203.92	5.00	156.75	0.72	27.27	52.73	152.31	686.07
EARTHWORK	5,004	16,333	64,077	611	48,438	0	7,940	16,951	49,588	208,943
RAILROAD RECONSTRUCTION	18,208	18,577	68,939	0	50,331	800	12,367	14,630	38,090	221,941
TRACKWORK	37,511	61,172	223,739	5,930	172,814	973	30,043	58,821	166,695	757,698
STRUCTURES	100,008	90,014	206,939	16,072	201,852	5,168	36,118	80,785	160,709	897,665
RIGHT-OF-WAY	17,500	15,745	23,028	10,000	41,314	3,040	13,530	10,592	15,207	149,956
ELECTRIFICATION	28,000	37,750	142,500		107,250	0	24,500	36,750	107,250	484,000
STATIONS	10,000	5,000	10,000	10,000	10,000	0	0	10,000	10,000	65,000
MAINTENANCE FACILITIES	1,000	17,000	5,000	57,500	4,000	0	1,000	17,000	4,000	106,500
TRAIN CONTROL	18,120	33,050	114,110	5,000	85,730	0	18,370	28,970	85,730	389,080
ROLLING STOCK (1997)	0	0	307,700		191,000	0	0	0	305,900	804,600
ENGINEERING	21,182	26,518	77,250	9,460	64,956	898	12,948	24,705	57,354	295,270
CONSTRUCTION MANAGEMENT	7,061	8,839	25,750	3,153	21,652	299	4,316	8,235	19,118	98,423
RIGHT OF WAY ACQUISITION	4,375	3,936	5,757	2,500	10,329	760	3,383	2,648	3,802	37,489
CONTINGENCIES	13,398	16,697	63,739	6,011	50,483	597	8,226	15,504	51,172	225,828
TOTAL	281,367	350,631	1,338,528	126,238	1,060,147	12,535	172,741	325,590	1,074,615	4,742,395
ROLLING STOCK (2007)	0	0	154,600		150,700	0	0	0	57,000	362,300

SEGMENT DESCRIPTION

1: FORT WORTH - DALLAS UNION STATION
2: DALLAS UNION STATION - CORSICANA JUNCTION
3: CORSICANA JUNCTION - HOUSTON 610 JUNCTION
4: HOUSTON 610 JUNCTION - HOUSTON DOWNTOWN
5: CORSICANA JUNCTION - AUSTIN SW JUNCTION
6: AUSTIN SW JUNCTION - AUSTIN DOWNTOWN
7: AUSTIN SW JUNCTION - SAN MARCOS
8: SAN MARCOS - SAN ANTONIO
9: SAN MARCOS - HOUSTON 610 JUNCTION

TABLE E-5
TEXAS HIGH SPEED RAIL

INDEPENDENT ALIGNMENT:UHS OPTION
COST SUMMARY BY SEGMENT ($000)

SEGMENT	1	2	3	4	5	6	7	8	TOTAL
LENGTH	33.00	65.97	148.53	32.21	126.46	28.64	53.86	130.05	618.72
EARTHWORK	21,252	31,924	65,353	20,743	57,756	14,650	25,738	57,222	294,638
RAILROAD RECONSTRUCTION	18,219	6,420	0	15,124	3,526	7,431	8,262	0	58,982
TRACKWORK	0	0	0	0	0	0	0	0	0
STRUCTURES	139,172	289,809	656,497	138,632	56,591	124,685	234,274	570,203	2,709,863
RIGHT-OF-WAY	17,500	13,723	3,601	29,764	12,800	16,724	11,044	3,153	108,307
ELECTRIFICATION	164,500	328,950	887,600	0	623,450	148,200	270,050	639,750	3,062,500
STATIONS	20,000	10,000	0	25,000	10,000	0	10,000	0	75,000
MAINTENANCE FACILITIES	1,000	17,000	19,000	44,000	3,000	16,000	2,000	3,000	105,000
TRAIN CONTROL	20,965	46,925	114,935	12,000	80,025	23,435	34,305	82,555	415,145
ROLLING STOCK (1997)	0	0	495,000		330,000	0	0	423,500	1,248,500
ENGINEERING	36,235	67,028	201,779	25,674	150,943	31,601	53,611	160,144	727,014
CONSTRUCTION MANAGEMENT	12,078	22,343	67,260	8,558	50,314	10,534	17,870	53,381	242,338
RIGHT OF WAY ACQUISITION	4,375	3,431	900	7,441	3,200	4,181	2,761	788	27,077
CONTINGENCIES	22,765	41,878	125,596	16,347	94,080	19,872	33,496	99,685	453,718
TOTAL	478,061	879,430	2,637,520	343,284	1,975,685	417,311	703,410	2,093,382	9,528,082
ROLLING STOCK (2007)			132,000		231,000			269,500	632,500

SEGMENT DESCRIPTION

1: FORT WORTH - DALLAS UNION STATION
2: DALLAS UNION STATION - CORSICANA JUNCTION
3: CORSICANA JUNCTION - HOUSTON 610 JUNCTION
4: HOUSTON 610 JUNCTION - HOUSTON DOWNTOWN
5: AUSTIN SW JUNCTION - AUSTIN DOWNTOWN
6: AUSTIN SW JUNCTION - SAN MARCOS
7: SAN MARCOS - SAN ANTONIO
8: SAN MARCOS - HOUSTON 610 JUNCTION

TABLE E-6
TEXAS HIGH SPEED RAIL

EXISTING ALIGNMENT:UHS OPTION
COST SUMMARY BY SEGMENT ($000)

SEGMENT	1	2	3	4	5	6	7	8	9	TOTAL
LENGTH	32.77	54.60	203.92	5.00	156.75	0.72	27.27	52.73	152.31	686.07
EARTHWORK	21,104	25,228	98,050	3,220	74,988	464	13,712	25,241	72,116	334,123
RAILROAD RECONSTRUCTION	18,208	18,577	68,939	0	50,331	800	12,367	14,630	38,090	221,941
TRACKWORK	0	0	0	0	0	0	0	0	0	0
STRUCTURES	139,172	231,793	865,667	21,226	665,471	3,055	115,776	223,834	646,577	2,912,570
RIGHT-OF-WAY	17,500	15,745	23,028	10,000	41,314	3,040	13,530	10,592	15,207	149,956
ELECTRIFICATION	164,500	274,150	1,021,700		769,800	0	144,100	266,000	769,800	3,410,050
STATIONS	10,000	5,000	10,000	10,000	10,000	0	0	10,000	10,000	65,000
MAINTENANCE FACILITIES	1,000	17,000	20,000	44,000	4,000	0	16,000	2,000	4,000	108,000
TRAIN CONTROL	20,965	39,940	132,705	12,000	99,695	0	22,800	33,675	99,695	461,475
ROLLING STOCK (1997)	0	0	495,000		330,000	0	0	0	423,500	1,248,500
ENGINEERING	35,320	56,469	201,608	9,040	154,404	662	30,446	52,737	148,994	689,680
CONSTRUCTION MANAGEMENT	11,773	18,823	67,203	3,013	51,468	221	10,149	17,579	49,665	229,893
RIGHT OF WAY ACQUISITION	4,375	3,936	5,757	2,500	10,329	760	3,383	2,648	3,802	37,489
CONTINGENCIES	22,196	35,333	150,483	5,750	113,090	450	19,113	32,947	114,072	493,434
TOTAL	466,114	741,994	3,160,138	120,749	2,374,889	9,452	401,375	691,883	2,395,518	10,362,112
ROLLING STOCK (2007)	0	0	132,000		231,000	0	0	0	269,500	632,500

SEGMENT DESCRIPTION

1: FORT WORTH - DALLAS UNION STATION
2: DALLAS UNION STATION - CORSICANA JUNCTION
3: CORSICANA JUNCTION - HOUSTON 610 JUNCTION
4: HOUSTON 610 JUNCTION - HOUSTON DOWNTOWN
5: CORSICANA JUNCTION - AUSTIN SW JUNCTION
6: AUSTIN SW JUNCTION - AUSTIN DOWNTOWN
7: AUSTIN SW JUNCTION - SAN MARCOS
8: SAN MARCOS - SAN ANTONIO
9: SAN MARCOS - HOUSTON 610 JUNCTION

TABLE E-7
TEXAS HIGH SPEED RAIL

INDEPENDENT ALIGNMENT:HS OPTION
STAND-ALONE SCENARIO
COST SUMMARY ($000)

ITEM	HOUSTON TO DALLAS/FT WORTH	HOUSTON TO AUSTIN/SAN ANTONIO	DALLAS TO AUSTIN/SAN ANTONIO
LENGTH	279.48	244.76	307.70
EARTHWORK	82,444	76,943	92,280
RAILROAD RECONSTRUCTION	31,160	24,156	34,370
TRACKWORK	309,047	269,526	341,472
STRUCTURES	355,973	275,725	444,004
RIGHT-OF-WAY	64,588	60,684	71,790
ELECTRIFICATION	0	0	0
STATIONS	35,000	30,000	35,000
MAINTENANCE FACILITIES	70,500	69,500	36,000
TRAIN CONTROL	142,480	109,583	155,228
ROLLING STOCK (1997)	137,700	153,900	157,200
ENGINEERING	98,207	82,451	108,913
CONSTRUCTION MANAGEMENT	32,736	27,484	36,304
RIGHT OF WAY ACQUISITION	16,147	15,171	17,947
CONTINGENCIES	68,799	59,756	76,525
TOTAL COST ($000)	1,444,781	1,254,878	1,607,032
COST PER MILE ($000)	5,170	5,127	5,223
ROLLING STOCK (2007)	85,000	101,000	69,300

TABLE E-8
TEXAS HIGH SPEED RAIL

EXISTING ALIGNMENT:HS OPTION
STAND-ALONE SCENARIO
COST SUMMARY ($000)

ITEM	HOUSTON TO DALLAS/FT WORTH	HOUSTON TO AUSTIN/SAN ANTONIO	DALLAS TO AUSTIN/SAN ANTONIO
LENGTH	296.29	238.03	324.84
EARTHWORK	86,026	75,091	94,667
RAILROAD RECONSTRUCTION	82,871	51,645	90,074
TRACKWORK	328,353	262,462	361,334
STRUCTURES	413,033	298,852	513,945
RIGHT-OF-WAY	66,273	52,369	101,721
ELECTRIFICATION	0	0	0
STATIONS	35,000	30,000	35,000
MAINTENANCE FACILITIES	71,500	70,500	36,000
TRAIN CONTROL	150,827	121,858	164,066
ROLLING STOCK (1997)	137,700	153,900	157,200
ENGINEERING	111,049	86,650	125,713
CONSTRUCTION MANAGEMENT	37,016	28,883	41,904
RIGHT OF WAY ACQUISITION	16,568	13,092	25,430
CONTINGENCIES	76,811	62,265	87,353
TOTAL COST ($000)	1,613,028	1,307,567	1,834,406
COST PER MILE ($000)	5,444	5,493	5,647
ROLLING STOCK (2007)	85,000	101,000	69,300

TABLE E-9
TEXAS HIGH SPEED RAIL

INDEPENDENT ALIGNMENT:VHS OPTION
STAND-ALONE SCENARIO
COST SUMMARY ($000)

ITEM	HOUSTON TO DALLAS/FT WORTH	HOUSTON TO AUSTIN/SAN ANTONIO	DALLAS TO AUSTIN/SAN ANTONIO
LENGTH	279.48	244.76	307.70
EARTHWORK	82,444	76,943	92,280
RAILROAD RECONSTRUCTION	39,753	30,817	43,847
TRACKWORK	309,047	269,526	341,472
STRUCTURES	355,973	275,725	444,004
RIGHT-OF-WAY	64,588	60,684	71,790
ELECTRIFICATION	197,313	172,801	217,236
STATIONS	35,000	30,000	35,000
MAINTENANCE FACILITIES	80,500	79,500	40,000
TRAIN CONTROL	161,602	124,216	175,064
ROLLING STOCK (1997)	277,700	305,900	191,000
ENGINEERING	119,360	100,819	131,462
CONSTRUCTION MANAGEMENT	39,787	33,606	43,821
RIGHT OF WAY ACQUISITION	16,147	15,171	17,947
CONTINGENCIES	88,961	78,785	92,246
TOTAL COST ($000)	1,868,174	1,654,494	1,937,169
COST PER MILE ($000)	6,684	6,760	6,296
ROLLING STOCK (2007)	154,600	57,000	150,700

TABLE E-10
TEXAS HIGH SPEED RAIL

EXISTING ALIGNMENT:VHS OPTION
STAND-ALONE SCENARIO
COST SUMMARY ($000)

ITEM	HOUSTON TO DALLAS/FT WORTH	HOUSTON TO AUSTIN/SAN ANTONIO	DALLAS TO AUSTIN/SAN ANTONIO
LENGTH	296.29	238.03	324.84
EARTHWORK	86,026	75,091	94,667
RAILROAD RECONSTRUCTION	105,724	65,887	114,912
TRACKWORK	328,353	262,462	361,334
STRUCTURES	413,033	298,852	513,945
RIGHT-OF-WAY	66,273	52,369	101,721
ELECTRIFICATION	208,250	168,500	234,250
STATIONS	35,000	30,000	35,000
MAINTENANCE FACILITIES	80,500	79,500	40,000
TRAIN CONTROL	170,280	138,070	184,240
ROLLING STOCK (1997)	307,700	305,900	191,000
ENGINEERING	134,409	105,366	151,206
CONSTRUCTION MANAGEMENT	44,803	35,122	50,402
RIGHT OF WAY ACQUISITION	16,568	13,092	25,430
CONTINGENCIES	99,846	81,510	104,905
TOTAL COST ($000)	2,096,765	1,711,720	2,203,013
COST PER MILE ($000)	7,077	7,191	6,782
ROLLING STOCK (2007)	154,600	57,000	150,700

TABLE E-11
TEXAS HIGH SPEED RAIL

INDEPENDENT ALIGNMENT:UHS OPTION
STAND-ALONE SCENARIO
COST SUMMARY ($000)

ITEM	HOUSTON TO DALLAS/FT WORTH	HOUSTON TO AUSTIN/SAN ANTONIO	DALLAS TO AUSTIN/SAN ANTONIO
LENGTH	279.71	244.76	307.93
EARTHWORK	139,272	118,353	151,320
RAILROAD RECONSTRUCTION	39,763	30,817	43,858
TRACKWORK	0	0	0
STRUCTURES	1,224,111	1,067,794	1,344,531
RIGHT-OF-WAY	64,588	60,684	71,790
ELECTRIFICATION	1,381,050	1,058,000	1,535,150
STATIONS	55,000	35,000	50,000
MAINTENANCE FACILITIES	81,000	65,000	39,000
TRAIN CONTROL	194,825	152,295	205,655
ROLLING STOCK	495,000	423,500	330,000
ENGINEERING	330,715	271,030	339,417
CONSTRUCTION MANAGEMENT	110,238	90,343	113,139
RIGHT OF WAY ACQUISITION	16,147	15,171	17,947
CONTINGENCIES	206,585	169,399	212,090
TOTAL COST ($000)	4,338,295	3,557,386	4,453,897
COST PER MILE ($000)	15,510	14,534	14,464
ROLLING STOCK (2007)	132,000	269,500	231,000

TABLE E-12
TEXAS HIGH SPEED RAIL

EXISTING ALIGNMENT:UHS OPTION
STAND-ALONE SCENARIO
COST SUMMARY ($000)

ITEM	HOUSTON TO DALLAS/FT WORTH	HOUSTON TO AUSTIN/SAN ANTONIO	DALLAS TO AUSTIN/SAN ANTONIO
LENGTH	296.29	238.03	324.84
EARTHWORK	147,602	114,754	160,737
RAILROAD RECONSTRUCTION	105,724	65,887	114,912
TRACKWORK	0	0	0
STRUCTURES	1,257,858	1,010,467	1,379,101
RIGHT-OF-WAY	66,273	52,369	101,721
ELECTRIFICATION	1,460,350	1,179,900	1,618,550
STATIONS	35,000	30,000	35,000
MAINTENANCE FACILITIES	82,000	66,000	40,000
TRAIN CONTROL	205,610	168,170	217,075
ROLLING STOCK (1997)	495,000	423,500	330,000
ENGINEERING	302,437	241,879	330,039
CONSTRUCTION MANAGEMENT	100,812	80,626	110,013
RIGHT OF WAY ACQUISITION	16,568	13,092	25,430
CONTINGENCIES	213,762	172,332	223,129
TOTAL COST ($000)	4,488,996	3,618,977	4,685,707
COST PER MILE ($000)	15,151	15,204	14,425
ROLLING STOCK (2007)	132,000	269,500	231,000

MORRISON-KNUDSEN ENGINEERS, INC.
TEXAS HIGH SPEED RAIL STUDY
COST ESTIMATE (HS OPTION)
OPERATIONS AND MAINTENANCE COSTS -- FIXED COSTS
(INDEPENDENT ALIGNMENT BY LICHLITER/JAMESON & ASSOC)

TABLE E - 13

INDEPENDENT ALIGNMENT
TECHNOLOGY : HS

COSTS PER YEAR - STAND ALONE SCENARIO

ITEM	UNIT COST	BASIS OF QUANTITY		ROUTE SEGMENT															
				COMMON TO ALL		HOUSTON-CORSICANA		DALLAS-CORSICANA		DALLAS-FORT WORTH		CORSICANA-AUSTIN		AUSTIN-SAN MARCOS		SAN MARCOS-SAN ANT		SAN MARCOS-HOUSTON	TOTAL (*)
		REFER.	RATE	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT
ROUTE DATA																			
ROUTE-MILES (RTE-MI)				0		181		66		33		126		29		54		130	
TRACK-MILE (TRK-MI)				0		362		132		66		252		58		108		260	
FIXED OPERATING COSTS																			
ADMINISTRATION	$1,000,000	LS	1	1	$1,003,000														
INSURANCE	$5,000,000	LS	1	1	$5,000,000														
TRAFFIC CONTROL	$1,000,000	LS	1	1	$1,000,000														
ELECTRICAL DEMAND CHARGE	NOT APPLICABLE																		
STAFF FOR PASS. STATIONS	$1,000,000					2	$2,000,000	1	$1,000,000	2	$2,000,000	0	$0	1	$1,000,000	1	$1,000,000	0	$0
SUBTOTAL					$7,000,000		$2,000,000		$1,000,000		$2,000,000		$0		$1,000,000		$1,000,000		$0
MAINTENANCE OF FIXED FACILITIES																			
RIGHT OF WAY AND TRACK	$8,000	TRK-MI	1	0	$0	362	$2,896,000	132	$1,056,000	66	$528,000	252	$2,016,000	58	$464,000	108	$864,000	260	$2,080,000
SIGNALLING	$20,000	RTE-MI	1	0	$0	181	$3,620,000	66	$1,320,000	33	$660,000	126	$2,520,000	29	$580,000	54	$1,080,000	130	$2,600,000
BUILDINGS	$4,000,000	CAP.COST	1.0%	1	$40,000		$0		$0		$0		$0		$0		$0		$0
PASSENGER STATIONS	$10,000,000	CAP.COST	1.0%		$0	2	$200,000	1	$100,000	2	$200,000	1	$100,000	0	$0	1	$100,000	0	$0
MAINTENANCE FACILITIES	$40,000,000	CAP.COST	0.5%	1	$200,000		$0		$0		$0		$0		$0		$0		$0
ELECTRIFICATION	NOT APPLICABLE				$0		$0		$0		$0		$0		$0		$0		$0
SUBTOTAL					$240,000		$6,716,000		$2,476,000		$1,388,000		$4,636,000		$1,044,000		$2,044,000		$4,680,390
TOTAL					$7,240,000		$8,716,000		$3,476,000		$3,388,000		$4,636,000		$2,044,000		$3,044,000		$4,680,390

TOTAL (*) column:

ITEM	Q'TY	AMOUNT
ROUTE-MILES (RTE-MI)	619	
TRACK-MILE (TRK-MI)	1238	
ADMINISTRATION		$1,000,000
INSURANCE		$5,000,000
TRAFFIC CONTROL		$1,000,000
ELECTRICAL DEMAND CHARGE		$0
STAFF FOR PASS. STATIONS	7	$7,000,000
SUBTOTAL		$14,000,000
RIGHT OF WAY AND TRACK	1238	$9,904,000
SIGNALLING	619	$12,380,000
BUILDINGS	1	$40,000
PASSENGER STATIONS	7	$700,000
MAINTENANCE FACILITIES	1	$200,000
ELECTRIFICATION	2	$0
SUBTOTAL		$23,225,868
TOTAL		$37,225,868
		SAY $37,200,000

(*) CAUTION : AS EACH ROUTE, OR GROUP OF SEGMENTS IS EXAMINED AS A STAND ALONE BASIS, THERE IS DUPLICATION IN MILEAGE, STATIONS, ETC. AND TOTALS ARE MISLEADING. FOR EXAMPLE, HOUSTON PASSENGER STATIONS ARE IN BOTH H-D AND H-SAN MARCOS ROUTES.

MORRISON-KNUDSEN ENGINEERS, INC.
TEXAS HIGH SPEED RAIL STUDY
COST ESTIMATE VHS OPTION
OPERATIONS AND MAINTENANCE COSTS -- FIXED COSTS
(INDEPENDENT ALIGNMENT BY LICHLITER/JAMESON & ASSOC)

TABLE E-14

INDEPENDENT ALIGNMENT
TECHNOLOGY : VHS

COSTS PER YEAR - STAND ALONE SCENARIO

		BASIS OF QUANTITY		ROUTE SEGMENT															
				COMMON TO ALL		HOUSTON-CORSICANA		DALLAS-CORSICANA		DALLAS-FORT WORTH		CORSICANA-AUSTIN		AUSTIN-SAN MARCOS		SAN MARCOS-SAN ANT		SAN MARCOS-HOUSTON	TOTAL (*)
ITEM	UNIT COST	REFER.	RATE	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT
ROUTE DATA																			
ROUTE-MILES (RTE-MI)				0		181		66	= 247 +	33	= 280	126		29		54		130		619	
TRACK-MILE (TRK-MI)				0		362		132		66	miles	252		58		108		260		1238	
FIXED OPERATING COSTS																			
ADMINISTRATION	$1,000,000	LS	1	1	$1,000,000		$0		$0		$0		$0		$0		$0		$0		$1,000,000
INSURANCE	$5,000,000	LS	1	1	$5,000,000		$0		$0		$0		$0		$0		$0		$0		$5,000,000
TRAFFIC CONTROL	$1,000,000	LS	1	1	$1,000,000		$0		$0		$0		$0		$0		$0		$0		$1,000,000
ELECTRICAL DEMAND CHARGE	$23,000	RTE-MI	1	0	$0	181	$4,163,000	66	$1,518,000	33	$759,000	126	$2,898,000	29	$667,000	54	$1,242,000	130	$2,990,000	619	$14,237,000
STAFF FOR PASS. STATIONS	$1,000,000				$0	2	$2,000,000	1	$1,000,000	2	$2,000,000	0	$0	1	$1,000,000	1	$1,000,000	0	$0	7	$7,000,000
SUBTOTAL					$7,000,000		$6,163,000		$2,518,000		$2,759,000		$2,898,000		$1,667,000		$2,262,000		$2,990,000		$28,237,000
MAINTENANCE OF FIXED FACILITIES																			
RIGHT OF WAY AND TRACK	$8,000	TRK-MI	1	0	$0	362	$2,896,000	132	$1,056,000	66	$528,000	252	$2,016,000	58	$464,000	108	$864,000	260	$2,080,000	1238	$9,904,000
SIGNALLING	$20,000	RTE-MI	1	0	$0	181	$3,620,000	66	$1,320,000	33	$660,000	126	$2,520,000	29	$580,000	54	$1,080,000	130	$2,600,000	619	$12,380,000
ADMINISTRATION BUILDING	$4,000,000	CAP.COST	1.0%	1	$40,000		$0		$0		$0		$0		$0		$0		$0	1	$40,000
PASSENGER STATIONS	$10,000,000	CAP.COST	1.0%		$0	2	$200,000	1	$100,000	2	$200,000	0	$0	1	$100,000	1	$100,000	0	$0	7	$700,000
MAINTENANCE FACILITIES	$40,000,000	CAP.COST	0.5%	1	$200,000		$0		$0		$0		$0		$0		$0		$0	1	$200,000
ELECTRIFICATION	$1,000,000	CAP.COST	2.0%		$0	$143	$2,860,000	$38	$760,000	$25	$500,000	$107	$2,140,000	$25	$500,000	$37	$740,000	$107	$2,140,000	$442	$9,640,000
SUBTOTAL					$240,000		$9,576,000		$3,236,000		$1,888,000		$6,676,000		$1,644,000		$2,784,000		$6,820,497		$32,866,348
TOTAL					$7,240,000		$15,739,000		$5,754,000		$4,647,000		$9,574,000		$3,311,000		$5,026,000		$9,810,497		$41,103,348

(*) CAUTION : AS EACH ROUTE, OR GROUP OF SEGMENTS IS EXAMINED AS A STAND ALONE BASIS, THERE IS DUPLICATION IN MILEAGE, STATIONS, ETC. AND TOTALS ARE MISLEADING. FOR EXAMPLE, HOUSTON PASSENGER STATIONS ARE IN BOTH H-D AND H-SAN MARCOS ROUTES.

SAY $41,100,00

MORRISON-KNUDSEN ENGINEERS, INC.
TEXAS HIGH SPEED RAIL STUDY
COST ESTIMATE UNS OPTION
OPERATIONS AND MAINTENANCE COSTS -- FIXED COSTS
(INDEPENDENT ALIGNMENT BY LICHLITER/JAMESON & ASSOC)

TABLE E - 15

INDEPENDENT ALIGNMENT
TECHNOLOGY : UNS

COSTS PER YEAR - STAND ALONE SCENARIO

ROUTE SEGMENT

ITEM	UNIT COST	BASIS OF QUANTITY		BASE		HOUSTON-CORSICANA		DALLAS-CORSICANA		DALLAS-FORT WORTH		CORSICANA-AUSTIN		AUSTIN-SAN MARCOS		SAN MARCOS-SAN ANT		SAN MARCOS-HOUSTON		TOTAL (*)	
		REFER.	RATE	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT
ROUTE DATA																					
ROUTE-MILES (RTE-MI)				0		181		66		33		126		29		54		130		619	
TRACK-MILE (TRK-MI)				0		362		132		66		252		58		108		260		1238	
FIXED OPERATING COSTS																					
ADMINISTRATION	$1,000,000	LS	1	1	$1,000,000																$1,000,000
INSURANCE	$5,000,000	LS	1	1	$5,000,000																$5,000,000
TRAFFIC CONTROL	$1,000,000	LS	1	1	$1,000,000																$1,000,000
ELECTRICAL DEMAND CHARGE	$25,000	RTE-MI	1	0	$0	181	$4,525,000	66	$1,650,000	33	$825,000	126	$3,150,000	29	$725,000	54	$1,350,000	130	$3,250,000	619	$15,475,000
STAFF FOR PASS. STATIONS	$1,000,000				$0	2	$2,000,000	1	$1,000,000	2	$2,000,000	0	$0	1	$1,000,000	1	$1,000,000	0	$0	7	$7,000,000
SUBTOTAL					$7,000,000		$6,525,000		$2,650,000		$2,825,000		$3,150,000		$1,725,000		$2,350,000		$3,250,000		$29,675,000
MAINTENANCE OF FIXED FACILITIES																					
RIGHT OF WAY	$5,000	RTE-MI	1	0	$0	181	$905,000	66	$330,000	33	$165,000	126	$630,000	29	$145,000	54	$270,000	130	$650,000	619	$3,095,000
GUIDEWAY STRUCTURE	$5,000	TRK-MI	1	0	$0	362	$1,810,000	132	$660,000	66	$330,000	252	$1,260,000	58	$290,000	108	$540,000	260	$1,300,000	1238	$6,190,000
SIGNALLING	$20,000	RTE-MI	1	0	$0	181	$3,620,000	66	$1,320,000	33	$660,000	126	$2,520,000	29	$580,000	54	$1,080,000	130	$2,600,000	619	$12,380,000
BUILDINGS	$4,000,000	CAP.COST	1.0%	1	$40,000		$0		$0		$0		$0		$0		$0		$0	1	$40,000
PASSENGER STATIONS	$10,000,000	CAP.COST	1.0%		$0	2	$200,000	1	$100,000	2	$200,000	0	$0	1	$100,000	1	$100,000	0	$0	7	$700,000
MAINTENANCE FACILITIES	$40,000,000	CAP.COST	0.5%	1	$200,000		$0		$0		$0		$0		$0		$0		$0	1	$200,000
ELECTRIFICATION	$1,000,000	CAP.COST	2.0%	$0	$0	1022	$20,440,000	$274	$5,480,000	$165	$3,300,000	$770	$15,400,000	$144	$2,880,000	$264	$5,320,000	$770	$15,400,000	3411	$68,220,000
SUBTOTAL					$240,000		$26,975,000		$7,890,000		$4,655,000		$19,810,000		$3,995,000		$7,310,000		$19,950,000		$90,825,000
TOTAL					$7,240,000		$33,500,000		$10,540,000		$7,480,000		$22,960,000		$5,720,000		$9,660,000		$23,200,000		$120,300,000
																			SAY		$120,300,000

(*) CAUTION : AS EACH ROUTE, OR GROUP OF SEGMENTS IS EXAMINED AS A STAND ALONE BASIS, THERE IS DUPLICATION IN MILEAGE, STATIONS, ETC. AND TOTALS ARE MISLEADING. FOR EXAMPLE, HOUSTON PASSENGER STATIONS ARE IN BOTH H-D AND H-SAN MARCOS ROUTES.

MORRISON-KNUDSEN ENGINEERS, INC.
TEXAS HIGH SPEED RAIL STUDY
COST ESTIMATE
OPERATIONS AND MAINTENANCE COSTS -- VARIABLE COSTS
(INDEPENDENT ALIGNMENT BY LICHLITER/JAMESON & ASSOC)

TABLE E-16

INDEPENDENT ALIGNMENT
COSTS PER YEAR - STAND ALONE SCENARIO

			ROUTE ROUTE NO. 1 FORT WORTH-DALLAS-HOUSTON		ROUTE NO. 2 FORT WORTH-DALLAS-AUSTIN-SAN ANT.		ROUTE NO. 3 HOUSTON-AUSTIN-SAN ANTONIO		TOTAL (*)	
	UNIT COST		QUANTITY	AMOUNT	QUANTITY	AMOUNT	QUANTITY	AMOUNT	QUANTITY	AMOUNT
TECHNOLOGY : HS										
THOUSAND TRAIN-MILES (k-TRN-MI) PER YEAR (1998)			4045		2331		3875		10251	
THOUSAND TRAIN-MILES (k-TRN-MI) PER YEAR (2008)			4045		3178		3875		11098	
ROUTINE SERVICING	$1,000 k-TRN-MI		4045	$4,045,000	2331	$2,331,000	3875	$3,875,000	10251	$10,251,000
CLEANING	$500 k-TRN-MI		4045	$2,022,500	2331	$1,165,500	3875	$1,937,500	10251	$5,125,500
MAJOR REPAIR	$1,000 k-TRN-MI		4045	$4,045,000	2331	$2,351,000	3875	$3,875,000	10251	$10,251,000
DIESEL FUEL	$1,000 k-GALLON	2.5 k-GALLON/TRN-MI	10112.5	$10,112,500	5827.5	$5,827,500	9687.5	$9,687,500	25628	$25,627,500
TRAIN CREW	$1,000 k-TRN-MI		4043	$4,045,000	2331	$2,331,000	3875	$3,875,000	10251	$10,251,000
		TOTAL (1998)		$24,270,000		$13,990,000		$23,250,000		$61,510,000
		TOTAL (2008)		$24,270,000		$19,070,000		$23,250,000		$66,590,00
TECHNOLOGY : VHS										
THOUSAND TRAIN-MILES (k-TRN-MI) PER YEAR (1998)			4045		2330		4018		10393	
THOUSAND TRAIN-MILES (k-TRN-MI) PER YEAR (2008)			6549		4662		5022		16233	
ROUTINE SERVICING	$1,000 k-TRN-MI		4045	$4,045,000	2330	$2,330,000	4018	$4,018,000	10393	$10,393,000
CLEANING	$500 k-TRN-MI		4045	$2,022,500	2330	$1,165,000	4018	$2,009,000	10393	$5,196,500
MAJOR REPAIR	$500 k-TRN-MI		4045	$2,022,500	2330	$1,165,000	4018	$2,009,000	10393	$5,196,500
ENERGY	$27,000 $/GWh	0.040 GWh/k-TRN-MI	162	$4,368,600	93	$2,516,400	161	$4,339,440	416	$11,224,440
TRAIN CREW	$1,000 k-TRN-MI		4045	$4,045,000	2330	$2,330,000	4018	$4,018,000	10393	$10,393,000
		TOTAL (1998)		$16,500,000		$9,510,000		$16,390,000		$42,400,000
		TOTAL (2008)		$26,710,000		$19,030,000		$20,490,000		$66,230,000
TECHNOLOGY : UHS										
THOUSAND TRAIN-MILES (k-TRN-MI) PER YEAR (1998)			4045		2331		4018		10394	
THOUSAND TRAIN-MILES (k-TRN-MI) PER YEAR (2008)			7320		5086		5580		17986	
ROUTINE SERVICING	$1,000 k-TRN-MI		4045	$4,045,000	2331	$2,331,000	4018	$4,018,000	10394	$10,394,000
CLEANING	$500 k-TRN-MI		4045	$2,022,500	2331	$1,165,500	4018	$2,009,000	10394	$5,197,000
MAJOR REPAIR	$1,000 k-TRN-MI		4045	$4,045,000	2351	$2,331,000	4018	$4,018,000	10394	$10,394,000
ENERGY	$27,000 $/GWh	0.065 GWh/k-TRN-MI	263	$7,098,975	152	$4,090,905	261	$7,051,590	676	$18,261,470
TRAIN CREW	$1,000 k-TRN-MI		4045	$4,045,000	2331	$2,331,000	4018	$4,018,000	10394	$10,394,000
		TOTAL (1998)		$21,260,000		$12,250,000		$21,110,000		$54,620,000
		TOTAL (2008)		$38,470,000		$26,730,000		$29,320,000		$94,520,000

(*) CAUTION : AS EACH ROUTE, OR GROUP OF SEGMENTS IS EXAMINED AS A STAND ALONE BASIS, THERE IS DUPLICATION IN MILEAGE, STATIONS, ETC. AND TOTALS ARE MISLEADING. FOR EXAMPLE, HOUSTON PASSENGER STATIONS ARE IN BOTH H-D AND H-SAN MARCOS ROUTES.

MORRISON-KNUDSEN ENGINEERS, INC.
TEXAS HIGH SPEED RAIL STUDY
COST ESTIMATE
OPERATIONS AND MAINTENANCE COSTS -- FIXED COSTS

TABLE E - 17

EXISTING ALIGNMENT
TECHNOLOGY : HS

COSTS PER YEAR - STAND ALONE SCENARIO

				ROUTE SEGMENT																	
		BASIS OF QUANTITY		COMMON TO ALL		HOUSTON-CORSICANA		DALLAS-CORSICANA		DALLAS-FORT WORTH		CORSICANA-AUSTIN		AUSTIN-SAN MARCOS		SAN MARCOS-SAN ANT		SAN MARCOS-HOUSTON		TOTAL (*)	
ITEM	UNIT COST	REFER.	RATE	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT
ROUTE DATA																					
ROUTE-MILES (RTE-MI)				0		209		55		33		137		28		53		157		692	
TRACK-MILE (TRK-MI)				0		418		110		66		314		56		106		314		1384	
FIXED OPERATING COSTS																					
ADMINISTRATION	$1,000,000	LS	1	1	$1,000,000																$1,000,000
INSURANCE	$5,000,000	LS	1	1	$5,000,000																$5,000,000
TRAFFIC CONTROL	$1,000,000	LS	1	1	$1,000,000																$1,000,000
ELECTRICAL DEMAND CHARGE	NOT APPLICABLE																				$0
STAFF FOR PASS. STATIONS	$1,000,000					2	$2,000,000	1	$1,000,000	2	$2,000,000	0	$0	1	$1,000,000	1	$1,000,000	2	$2,000,000	9	$9,000,000
SUBTOTAL					$7,000,000		$2,000,000		$1,000,000		$2,000,000		$0		$1,000,000		$1,000,000		$2,000,000		$16,000,000
MAINTENANCE OF FIXED FACILITIES																					
RIGHT OF WAY AND TRACK	$8,000	TRK-MI	1	0	$0	418	$3,344,000	110	$880,000	66	$528,000	314	$2,512,000	56	$448,000	106	$848,000	314	$2,512,000	1384	$11,072,000
SIGNALLING	$20,000	RTE-MI	1	0	$0	209	$4,180,000	55	$1,100,000	33	$660,000	157	$3,140,000	28	$560,000	53	$1,060,000	157	$3,140,000	692	$13,840,000
BUILDINGS	$4,000,000	CAP.COST	1.0%	1	$40,000		$0		$0		$0		$0		$0		$0		$0	1	$40,000
PASSENGER STATIONS	$10,000,000	CAP.COST	1.0%		$0	2	$200,000	1	$100,000	2	$200,000	0	$0	1	$100,000	1	$100,000	2	$200,000	9	$900,000
MAINTENANCE FACILITIES	$40,000,000	CAP.COST	0.5%	1	$200,000		$0		$0		$0		$0		$0		$0		$0	1	$200,000
ELECTRIFICATION		NOT APPLICABLE			$0		$0		$0		$0		$0		$0		$0		$0	2	$0
SUBTOTAL					$240,000		$7,724,000		$2,080,000		$1,388,000		$5,652,000		$1,108,000		$2,008,000		$5,852,473		$26,054,089
TOTAL					$7,240,000		$9,724,000		$3,080,000		$3,388,000		$5,652,000		$2,108,000		$3,008,000		$7,852,473		$42,054,089
																				SAY	$42,100,000

(*) CAUTION : AS EACH ROUTE, OR GROUP OF SEGMENTS IS EXAMINED AS A STAND ALONE BASIS, THERE IS DUPLICATION IN MILEAGE, STATIONS, ETC. AND TOTALS ARE MISLEADING. FOR EXAMPLE, HOUSTON PASSENGER STATIONS ARE IN BOTH H-D AND H-SAN MARCOS ROUTES.

MORRISON-KNUDSEN ENGINEERS, INC.
TEXAS HIGH SPEED RAIL STUDY
COST ESTIMATE
OPERATIONS AND MAINTENANCE COSTS -- FIXED COSTS

TABLE E-18

EXISTING ALIGNMENT
TECHNOLOGY : VHS

COSTS PER YEAR - STAND ALONE SCENARIO

ITEM	UNIT COST	BASIS OF QUANTITY		ROUTE SEGMENT															
				COMMON TO ALL		HOUSTON-CORSICANA		DALLAS-CORSICANA		DALLAS-FORT WORTH		CORSICANA-AUSTIN		AUSTIN-SAN MARCOS		SAN MARCOS-SAN ANT		SAN MARCOS-HOUSTON		TOTAL (*)	
		REFER.	RATE	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT
ROUTE DATA																					
ROUTE-MILES (RTE-MI)				0		209		55		33		157		28		53		157		492	
TRACK-MILE (TRK-MI)				0		418		110		66		314		56		106		314		1384	
FIXED OPERATING COSTS																					
ADMINISTRATION	$1,000,000	LS	1	1	$1,000,000		$0		$0		$0		$0		$0		$0		$0		$1,000,00
INSURANCE	$5,000,000	LS	1	1	$5,000,000		$0		$0		$0		$0		$0		$0		$0		$5,000,00
TRAFFIC CONTROL	$1,000,000	LS	1	1	$1,000,000		$0		$0		$0		$0		$0		$0		$0		$1,000,00
ELECTRICAL DEMAND CHARGE	$23,000	RTE-MI	1	0	$0	209	$4,807,000	55	$1,265,000	33	$759,000	157	$3,611,000	28	$644,000	53	$1,219,000	157	$3,611,000	492	$15,916,00
STAFF FOR PASS. STATIONS	$1,000,000				$0	2	$2,000,000	1	$1,000,000	2	$2,000,000	0	$0	1	$1,000,000	1	$1,000,000	2	$2,000,000	9	$9,000,00
SUBTOTAL					$7,000,000		$6,807,000		$2,265,000		$2,759,000		$3,611,000		$1,644,000		$2,219,000		$5,611,000		$31,916,00
MAINTENANCE OF FIXED FACILITIES																					
RIGHT OF WAY AND TRACK	$8,000	TRK-MI	1	0	$0	418	$3,344,000	110	$880,000	66	$528,000	314	$2,512,000	56	$448,000	106	$848,000	314	$2,512,000	1384	$11,072,00
SIGNALLING	$20,000	RTE-MI	1	0	$0	209	$4,180,000	55	$1,100,000	33	$660,000	157	$3,140,000	28	$560,000	53	$1,060,000	157	$3,140,000	692	$13,840,00
ADMINISTRATION BUILDING	$4,000,000	CAP.COST	1.0%	1	$40,000		$0		$0		$0		$0		$0		$0		$0	1	$40,00
PASSENGER STATIONS	$10,000,000	CAP.COST	1.0%		$0	2	$200,000	1	$100,000	2	$200,000	0	$0	1	$100,000	1	$100,000	2	$200,000	9	$900,00
MAINTENANCE FACILITIES	$40,000,000	CAP.COST	0.5%	1	$200,000		$0		$0		$0		$0		$0		$0		$0	1	$200,00
ELECTRIFICATION	$1,000,000	CAP.COST	2.0%		$0	$143	$2,860,000	$38	$760,000	$25	$500,000	$107	$2,140,000	$25	$500,000	$37	$740,000	$107	$2,140,000	$482	$9,640,00
SUBTOTAL					$240,000		$10,584,000		$2,840,000		$1,888,000		$7,792,000		$1,608,000		$2,748,000		$7,992,580		$35,694,56
TOTAL					$7,240,000		$17,391,000		$5,105,000		$4,647,000		$11,403,000		$3,252,000		$4,967,000		$13,603,580		$67,610,56
																				SAY	$67,600,00

(*) CAUTION : AS EACH ROUTE, OR GROUP OF SEGMENTS IS EXAMINED AS A STAND ALONE BASIS, THERE IS DUPLICATION IN MILEAGE, STATIONS, ETC. AND TOTALS ARE MISLEADING. FOR EXAMPLE, HOUSTON PASSENGER STATIONS ARE IN BOTH H-D AND H-SAN MARCOS ROUTES.

MORRISON-KNUDSEN ENGINEERS, INC.
TEXAS HIGH SPEED RAIL STUDY
COST ESTIMATE
OPERATIONS AND MAINTENANCE COSTS -- FIXED COSTS

TABLE E-19

EXISTING ALIGNMENT
TECHNOLOGY : UHS

COSTS PER YEAR - STAND ALONE SCENARIO

ITEM	UNIT COST	BASIS OF QUANTITY		BASE		ROUTE SEGMENT														TOTAL (*)	
						HOUSTON-CORSICANA		DALLAS-CORSICANA		DALLAS-FORT WORTH		CORSICANA-AUSTIN		AUSTIN-SAN MARCOS		SAN MARCOS-SAN ANT		SAN MARCOS-HOUSTON			
		REFER.	RATE	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT	Q'TY	AMOUNT
ROUTE DATA																					
ROUTE-MILES (RTE-MI)				0		209		55		33		157		28		53		157		692	
TRACK-MILE (TRK-MI)				0		418		110		66		314		56		106		314		1384	
FIXED OPERATING COSTS																					
ADMINISTRATION	$1,000,000	LS	1	1	$1,000,000																$1,000,00
INSURANCE	$5,000,000	LS	1	1	$5,000,000																$5,000,00
TRAFFIC CONTROL	$1,000,000	LS	1	1	$1,000,000																$1,000,00
ELECTRICAL DEMAND CHARGE	$25,000	RTE-MI	1	0	$0	209	$5,225,000	55	$1,375,000	33	$825,000	157	$3,925,000	28	$700,000	53	$1,325,000	157	$3,925,000	692	$17,300,00
STAFF FOR PASS. STATIONS	$1,000,000				$0	2	$2,000,000	1	$1,000,000	2	$2,000,000	0	$0	1	$1,000,000	1	$1,000,000	2	$2,000,000	9	$9,000,00
SUBTOTAL					$7,000,000		$7,225,000		$2,375,000		$2,825,000		$3,925,000		$1,700,000		$2,325,000		$5,925,000		$33,300,00
MAINTENANCE OF FIXED FACILITIES																					
RIGHT OF WAY	$5,000	RTE-MI	1	0	$0	209	$1,045,000	55	$275,000	33	$165,000	157	$785,000	28	$140,000	53	$265,000	157	$785,000	692	$3,460,00
GUIDEWAY STRUCTURE	$5,000	TRK-MI	1	0	$0	418	$2,090,000	110	$550,000	66	$330,000	314	$1,570,000	56	$280,000	106	$530,000	314	$1,570,000	1384	$6,920,00
SIGNALLING	$20,000	RTE-MI	1	0	$0	209	$4,180,000	55	$1,100,000	33	$660,000	157	$3,140,000	28	$560,000	53	$1,060,000	157	$3,140,000	692	$13,840,00
BUILDINGS	$4,000,000	CAP.COST	1.0%	1	$40,000		$0		$0		$0		$0		$0		$0		$0	1	$40,00
PASSENGER STATIONS	$10,000,000	CAP.COST	1.0%		$0	2	$200,000	2	$200,000	1	$100,000	2	$200,000	1	$100,000	1	$100,000	1	$100,000	10	$1,000,00
MAINTENANCE FACILITIES	$40,000,000	CAP.COST	0.5%	1	$200,000		$0		$0		$0		$0		$0		$0		$0	1	$200,00
ELECTRIFICATION	$1,000,000	CAP.COST	2.0%	$0	$0	1022	$20,440,000	$274	$5,480,000	$165	$3,300,000	$770	$15,400,000	$144	$2,880,000	$266	$5,320,000	$770	$15,400,000	3411	$68,220,00
SUBTOTAL					$240,000		$27,955,000		$7,605,000		$4,555,000		$21,095,000		$3,960,000		$7,275,000		$20,995,000		$93,680,00
TOTAL					$7,240,000		$35,180,000		$9,980,000		$7,380,000		$25,020,000		$5,660,000		$9,600,000		$26,920,000		$126,980,00
																				SAY	$127,000,00

(*) CAUTION : AS EACH ROUTE, OR GROUP OF SEGMENTS IS EXAMINED AS A STAND ALONE BASIS, THERE IS DUPLICATION IN MILEAGE, STATIONS, ETC. AND TOTALS ARE MISLEADING. FOR EXAMPLE, HOUSTON PASSENGER STATIONS ARE IN BOTH H-D AND H-SAN MARCOS ROUTES.

APPENDIX F

ENVIRONMENTAL

TABLE F-1

FEDERAL ENVIRONMENTAL REGULATIONS

ISSUE/RESOURCE	LAW/REGULATION	AGENCY
Air Quality	Clean Air Act of 1970, Amendments of 1977	U. S. Environmental Protection Agency, Region VI
Biological Resources (Includes Threatened and Endangered Species)	U. S. Fish and Wildlife Coordination Act of 1958	U. S. Fish and Wildlife Wildlife Service (Department of Interior)
	Endangered Species Act	U. S. Fish and Wildlife Service (DOI), National Marine Fisheries (Department of Commerce)
Historic and Archeological Preservation	National Historic Preservation Act of 1966, Section 106	Advisory Council on on Historic Preservation
	Department of Transportation Act of 1966, Section 4(f)	U.S. Department of Transportation
Parks, Recreation Areas, Wildlife Refuge, etc.	Land and Water Conservation Fund Act of 1965	U. S. Department of Interior
	Department of Transportation Act of 1966, Section 4(f)	U.S. Department of Transportation
Farmland	Farmland Protection Policy Act (Farmland Conversion Impact Rating Form AD - 1006)	Soil Conservation Service (U.S. Department of Agriculture)
Floodplains	Clean Water Act, Section 404 (33 USC 1344)	U. S. Army Corps of Engineers
	Rivers and Harbors Act of 1899, Section 10, (33 USC 403)	U. S. Army Corps of Engineers
	Executive Order 11988 "Floodplain Management"	All Federal Agencies
	Watershed Protection and Flood Protection Act of 1954	U.S. Army Corps of Engineers
	National Flood Insurance Act of 1968 (amended 1973)	Federal Emergency Management Agency
Hazardous Wastes	Resource Conservation and Recovery Act (RCRA)	U.S. Environmental Protection Agency, Region VI

TABLE F-1 (Continued)

FEDERAL ENVIRONMENTAL REGULATIONS

ISSUE/RESOURCE	LAW/REGULATION	AGENCY
	Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)	U.S. Environmental Protection Agency, Region VI
Navigable Waters (Bridges)	Section 9 of the River and Harbors Act of 1899	U. S. Coast Guard (Department of Transportation)
	General Bridge Act of 1946	U. S. Coast Guard
	Bridge Administration Program (Title 33 Code of Federal Regulations Parts 114, 115)	U. S. Coast Guard
Noise and Vibration	Title 40 Code of Federal Regulations, Part 201 (40 CFR 201)	Federal Railroad Administration (U. S. Department of Transportation)
	Title 49 Code of Federal Regulations, Part 210 (49 CFR 210)	U. S. Environmental Protection Agency
Relocation (Land Acquisition and Displacement)	Uniform Relocation Assistance and Real Estate Property Acquisitions Policies Act of 1979, as amended	All Federal Agencies
Water Quality	Safe Drinking Water Act of 1974	U.S. Environmental Protection Agency (Texas Department of Health)
	Clean Water Act of 1977	U.S. Environmental Protection Agency, U.S. Army Corps of Engineers
	Water Quality Act of 1987	U.S. Environmental Protection Agency
Wetlands	Section 404 of Clean Water Act	U.S. Army Corps of Engineers
	Executive Order 11990 "Protection of Wetlands"	All Federal Agencies
Wild and Scenic Rivers	Wild and Scenic Rivers Act of 1968	National Park Service, U.S. Fish and Wildlife Service, Bureau of Land Management or Forest Service

TABLE F-2

STATE ENVIRONMENTAL REGULATIONS

ISSUE/RESOURCE	LAW/REGULATION	AGENCY
Air Quality	Texas Clean Air Act	Texas Air Control Board
Historic and Archeological Preservation	"Antiquities Code of Texas", Texas Natural Resources Code, Title 9, Chapter 191	Antiquities Committee
	Texas Administrative Code, Title 13, Part IV, "Antiquities Committee"	Antiquities Committee
	"Texas Historical Commission," Texas Civil Statutes, Article 6145	Texas Historical Commission
	Texas Administrative Code, Title 13, Part II, "Texas Historical Commission"	Texas Historical Commission
	Texas Parks and Wildlife Code Chapter 26, "Protection of Public Parks and Recreation Lands"	Texas Parks and Wildlife Department and Local Authority
Parks, Recreation Areas, Wildlife Refuge, etc.	Texas Parks and Wildlife Code, Chapter 26, "Protection of Public Parks and Recreation Lands"	Texas Parks and Wildlife Department
Hazardous Wastes	Texas Water Code Chapter 26, Subchapter G, "Coastal Oil and Hazardous Spill Prevention Control" (Texas Hazardous Substances Spill Control Act	Texas Water Commission
	"Solid Waste Disposal Act", Texas Civil Statutes, Article 4477-7	Texas Water Commission and Texas Department of Health
	"State of Texas Oil and Hazardous Substances Spill Contingency Plan", Texas Water Commission	Texas Water Commission

TABLE F-2 (Continued)

STATE ENVIRONMENTAL REGULATIONS

ISSUE/RESOURCE	LAW/REGULATION	AGENCY
	Texas Administrative Code Title 31, Chapter 335, "Industrial Solid Waste and Municipal Hazardous Waste"	Texas Water Commission
Natural Resources (Wetlands, etc.)	Texas Parks and Wildlife Code Chapter 86, "Marl, Sand, Shell, Gravel and Mudshell".	Texas Parks and Wildlife Department
Wild and Scenic Rivers	Texas Outdoor Recreation Plan	Texas Parks and Wildlife Department

APPENDIX G

FINANCIAL

TEXAS TURNPIKE AUTHORITY
TEXAS HIGH SPEED RAIL FEASIBILITY STUDY
PRELIMINARY FINANCIAL ANALYSIS

Summary of Findings

Case A: Financial Analyses of Each Corridor and Each Technology

Technology	Corridor	Total Capital Costs (000's)	Dollar Amount Note Issues (000's)	Annual Debt Service Coverage (2005)	Annual Debt Service Coverage (2015)
HS	Fort Worth-Dallas-Houston	$1,272,082	$1,580,310	0.45x	0.50x
HS	Houston-San Antonio-Austin	1,070,982	1,332,405	0.49x	0.55x
HS	Fort Worth-Austin-San Antonio	1,414,839	1,757,550	0.38x	0.45x
VHS	Fort Worth-Dallas-Houston	1,555,474	1,927,620	0.83x	0.98x
VHS	Houston-San Antonio-Austin	1,318,594	1,635,830	0.71x	0.87x
VHS	Fort Worth-Austin-San Antonio	1,771,172	2,120,850	0.39x	0.42x
UHS	Fort Worth-Dallas-Houston	3,788,294	4,677,010	0.45x	0.49
UHS	Houston-San Antonio-Austin	3,098,886	3,828,490	0.45x	0.51x
UHS	Fort Worth-Austin-San Antonio	4,073,897	5,025,645	0.27x	0.32x

Case B: State Subsidy Required for Each Corridor to Achieve 1.25x Debt Coverage - VHS Technology

Corridor	State Subsidy (000's)	Public Entity Capital Costs (000's)	Dollar Amount Note Issues (000's)	Annual Debt Service Coverage (2005)	Annual Debt Debt Service Coverage (2015)
Fort Worth-Dallas-Houston	$ 595,222	$960,251	$1,110,150	1.15x	1.25x
Houston-San Antonio-Austin	666,777	651,819	742,470	1.15x	1.25x
Fort Worth-Austin-San Antonio	1,448,390	262,780	279,755	1.13x	1.23x

Case C: Staging of HSR System - VHS Technology

Staging Scenario	Public Entity Capital Costs (000's)	Dollar Amount Note Issues (000's)	Annual Debt Service Coverage (2005)	Annual Debt Service Coverage (2015)
Complete Total System 1991-1997	$3,200,702	$3,958,250	0.87x	1.00x
Staging Scenario	3,200,702	3,958,265	0.75x	0.99x

Case D: Staging of HSR System - VHS Technology - Inflated Revenues and Costs

Corridor	Public Entity Capital Costs (000's)	Dollar Amount Note Issues (000's)	Annual Debt Service Coverage (2005)	Annual Debt Service Coverage (2015)
Total HSR System	$3,719,108	$4,596,800	1.24x	1.26x

SUMMARY OF STAGING SCENARIO
TOTAL SYSTEM
VHS

TEXAS TURNPIKE AUTHORITY - TEXAS HIGH SPEED RAIL
SUMMARY OF STAGING SCENARIO - TOTAL SYSTEM (VHS OPTION)
ESTIMATED ANNUAL CASH FLOW - PUBLIC ENTITY FINANCING
WITH REVENUES AND COSTS INFLATED AT 2.0% PER YEAR

	CONSTRUCTION PERIOD													
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
CAPITAL EXPENDITURES: (e)	$0	$0	$58,983	$356,780	$457,913	$494,881	$375,998	$255,975	$341,157	$364,879	$266,657	$161,025	$215,529	$219,839
REVENUES:														
PASSENGER								128,145	146,687	165,228	183,770	296,957	331,376	365,794
SUPPLEMENTAL								10,018	11,339	12,660	13,981	20,683	22,808	24,933
TOTAL REVENUES								138,163	158,025	177,888	197,751	317,640	354,184	390,727
EXPENDITURES:														
MAINT. & OPERATING								49,880	51,875	53,950	56,108	97,320	101,213	105,261
ADVERTISING								2,763	3,161	3,558	3,955	6,353	7,084	7,815
AGENCY COMMISSIONS								5,126	5,867	6,609	7,351	11,878	13,255	14,632
NET DEBT SERVICE								61,789	77,003	93,558	106,253	159,264	190,018	213,335
TOTAL EXPENDIURES								119,558	137,907	157,675	173,667	274,816	311,570	341,043
ANNUAL GROSS CASH FLOW								18,604	20,119	20,213	24,084	42,825	42,614	49,684
GROSS ANNUAL DEBT SERVICE COVERGE								1.30	1.26	1.22	1.23	1.27	1.22	1.23
SOURCE OF CONTRIBUTION REPAYMENT								0	0	0	0	0	0	0
ANNUAL DEBT SERVICE COVERAGE								1.30	1.26	1.22	1.23	1.27	1.22	1.23
DOLLARS AVAILABLE FOR FRANCHISEES								12,425	12,419	10,857	13,459	26,898	23,612	28,350
NET ANNUAL DEBT SERVICE COVERAGE								1.10	1.10	1.10	1.10	1.10	1.10	1.10
ANNUAL NET CASH FLOW								6,179	7,700	9,356	10,625	15,926	19,002	21,334
CUMULATIVE NET CASH FLOW								6,179	13,879	23,235	33,860	49,787	68,789	90,122

(a) The capital expenditures do not include the cost of the stations at $55 million
or the costs of the rolling stock at $1,136,900,000 which is financed by private enterprise.

TEXAS TURNPIKE AUTHORITY - TEXAS HIGH SPEED RAIL
SUMMARY OF STAGING SCENARIO - TOTAL SYSTEM (VHS OPTION)
ESTIMATED ANNUAL CASH FLOW - PUBLIC ENTITY FINANCING
WITH REVENUES AND COSTS INFLATED AT 2.0% PER YEAR

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
CAPITAL EXPENDITURES:	$149,491	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
REVENUES:													
PASSENGER	400,213	524,561	566,206	607,851	649,496	691,141	732,786	774,431	816,076	857,721	899,366	922,469	945,572
SUPPLEMENTAL	27,057	35,290	38,313	41,336	44,359	47,382	50,405	53,428	56,452	59,475	62,498	64,200	65,902
TOTAL REVENUES	427,270	559,851	604,519	649,187	693,855	738,523	783,191	827,859	872,528	917,196	961,864	986,669	1,011,474
EXPENDITURES:													
MAINT. & OPERATING	109,472	138,924	144,481	150,260	156,271	162,522	169,023	175,784	182,815	190,127	197,733	201,755	205,939
ADVERTISING	8,545	11,197	12,090	12,984	13,877	14,770	15,664	16,557	17,451	18,344	19,237	19,733	20,229
AGENCY COMMISSIONS	16,009	20,982	22,648	24,314	25,980	27,646	29,311	30,977	32,643	34,309	35,975	36,899	37,823
NET DEBT SERVICE	236,653	289,971	336,003	364,177	392,355	420,533	448,703	476,863	505,063	533,233	561,413	576,893	592,373
TOTAL EXPENDIURES	370,678	461,075	515,223	551,735	588,483	625,471	662,700	700,180	737,971	776,013	814,357	835,280	856,364
ANNUAL GROSS CASH FLOW	56,592	98,776	89,296	97,452	105,372	113,053	120,491	127,679	134,557	141,183	147,507	151,389	155,110
GROSS ANNUAL DEBT SERVICE COV.	1.24	1.34	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.26	1.26	1.26	1.26
SOURCE OF CONTRIBUTION REPAY.	0	27,952	6,231	6,788	7,304	7,776	8,208	8,605	8,915	9,200	9,426	9,597	9,716
ANNUAL DEBT SERVICE COVERAGE	1.24	1.24	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
DOLLARS AVAIL. FOR FRANCH.	32,926	41,827	49,464	54,246	58,833	63,223	67,413	71,388	75,135	78,660	81,940	84,103	86,157
NET ANNUAL DEBT SERVICE COV.	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
ANNUAL NET CASH FLOW	23,665	28,997	33,600	36,418	39,235	42,053	44,870	47,686	50,506	53,323	56,141	57,689	59,237
CUMULATIVE NET CASH FLOW	113,787	142,785	176,385	212,803	252,038	294,091	338,962	386,648	437,154	490,477	546,619	604,308	663,545

TEXAS TURNPIKE AUTHORITY - TEXAS HIGH SPEED RAIL
SUMMARY OF STAGING SCENARIO - TOTAL SYSTEM (VHS OPTION)
ESTIMATED ANNUAL CASH FLOW - PUBLIC ENTITY FINANCING
WITH REVENUES AND COSTS INFLATED AT 2.0% PER YEAR

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
CAPITAL EXPENDITURES:	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
REVENUES:												
PASSENGER	968,676	991,779	999,005	1,006,232	1,013,459	1,020,685	1,020,685	1,020,685	1,020,685	1,020,685	1,020,685	1,020,685
SUPPLEMENTAL	67,604	69,306	70,204	71,102	72,000	72,899	72,899	72,899	72,899	72,899	72,899	72,899
TOTAL REVENUES	1,036,279	1,061,084	1,069,209	1,077,334	1,085,459	1,093,584	1,093,584	1,093,584	1,093,584	1,093,584	1,093,584	1,093,584
EXPENDITURES:												
MAINT. & OPERATING	210,290	214,815	216,485	218,222	220,028	221,907	221,907	221,907	221,907	221,907	221,907	221,907
ADVERTISING	20,726	21,222	21,384	21,547	21,709	21,872	21,872	21,872	21,872	21,872	21,872	21,872
AGENCY COMMISSIONS	38,747	39,671	39,960	40,249	40,538	40,827	40,827	40,827	40,827	40,827	40,827	40,827
NET DEBT SERVICE	607,853	623,333	628,193	633,048	637,908	642,768	642,768	642,768	642,768	642,768	642,768	642,768
TOTAL EXPENDIURES	877,615	899,041	906,022	913,065	920,183	927,373	927,373	927,374	927,374	927,374	927,374	927,374
ANNUAL GROSS CASH FLOW	158,664	162,044	163,187	164,269	165,276	166,211	166,211	166,210	166,210	166,210	166,210	166,210
GROSS ANNUAL DEBT SERVICE COV.	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26
SOURCE OF CONTRIBUTION REPAY.	9,771	9,763	9,692	9,559	9,351	9,071	9,071	9,071	9,071	9,071	9,071	9,071
ANNUAL DEBT SERVICE COVERAGE	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24
DOLLARS AVAIL. FOR FRANCH.	88,108	89,948	90,676	91,405	92,134	92,863	92,863	92,862	92,862	92,862	92,862	92,862
NET ANNUAL DEBT SERVICE COV.	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
ANNUAL NET CASH FLOW	60,785	62,333	62,819	63,305	63,791	64,277	64,277	64,277	64,277	64,277	64,277	64,277
CUMULATIVE NET CASH FLOW	724,330	786,664	849,483	912,788	976,578	1,040,855	1,105,132	1,169,409	1,233,685	1,297,962	1,362,239	1,426,516

TEXAS TURNPIKE AUTHORITY - TEXAS HIGH SPEED RAIL
SUMMARY OF STAGING SCENARIO - TOTAL SYSTEM (VHS OPTION)
ESTIMATED ANNUAL CASH FLOW - PUBLIC ENTITY FINANCING
WITH REVENUES AND COSTS INFLATED AT 2.0% PER YEAR

	2030	2031	TOTAL
CAPITAL EXPENDITURES:	$0	$0	$3,719,106
REVENUES:			
PASSENGER	1,020,685	1,020,685	25,171,163
SUPPLEMENTAL	72,899	72,899	1,768,823
TOTAL REVENUES	1,093,584	1,093,584	26,939,986
EXPENDITURES:			
MAINT. & OPERATING	221,907	221,907	5,777,717
ADVERTISING	21,872	21,872	538,800
AGENCY COMMISSIONS	40,827	40,827	1,006,847
NET DEBT SERVICE	642,768	391,058	15,298,985
TOTAL EXPENDIURES	927,374	675,664	22,622,348
ANNUAL GROSS CASH FLOW	166,210	417,920	4,317,639
GROSS ANNUAL DEBT SERVICE COVERAGE	1.26	2.07	N/A
SOURCE OF CONTRIBUTION REPAYAYMENT	9,071	9,071	249,493
ANNUAL DEBT SERVICE COVERAGE	1.24	2.05	N/A
DOLLARS AVAILABLE FOR FRANCHISEES	92,862	369,743	2,538,247
NET ANNUAL DEBT SERVICE COVERAGE	1.10	1.10	N/A
ANNUAL NET CASH FLOW	64,277	39,106	1,529,898
CUMULATIVE NET CASH FLOW	1,490,793	1,529,898	1,529,898

STAGING SCENARIO - STAGE 1
FORT WORTH-DALLAS-HOUSTON SEGMENT
VHS

TEXAS TURNPIKE AUTHORITY - TEXAS HIGH SPEED RAIL
FORT WORTH - DALLAS - HOUSTON SEGMENT (VHS OPTION)
SOURCES AND USES OF FUNDS - NOTE ISSUES AND LONG-TERM REPLACEMENT ISSUE
WITH REVENUES AND COSTS INFLATED AT 2.0% PER YEAR

	NOTE ISSUES			
	ISSUE 1 (JAN. 1993)	ISSUE 2 (JAN. 1994)	ISSUE 3 (JAN. 1996)	TOTAL NOTE ISSUES
SOURCES:				
BOND ISSUE PROCEEDS	$86,755,000	$1,054,295,000	$894,115,000	$2,035,165,000
FUND EARNINGS:				
EARNINGS ON CONSTRUCTION FUNDS AT 8.0%	289,133	57,509,730	46,263,754	104,062,617
EARNINGS ON CAPITALIZED INTEREST AT 8.0%	5,992,640	53,442,430	16,421,002	75,856,072
TOTAL SOURCES	$93,036,773	$1,165,247,160	$956,799,756	$2,215,083,689
USES:				
GROSS CONSTRUCTION COSTS	$58,983,000	$814,693,000	$784,679,000	$1,658,355,000
CAPITALIZED INTEREST FUND				
FUNDED FROM BOND PROCEEDS	26,974,259	283,931,970	144,519,698	455,425,927
FUNDED FROM CAP INT EARNINGS	5,992,641	53,442,430	16,421,002	75,856,073
UNDERWRITER'S DISCOUNT AND ISSUANCE COSTS (@ 1.25%)	1,084,438	13,178,688	11,176,438	25,439,564
ROUNDING AMOUNT	2,435	1,072	3,618	7,125
TOTAL USES	$93,036,773	$1,165,247,160	$956,799,756	$2,215,083,689

	REPLACEMENT ISSUE (JULY 1998)
SOURCES:	
BOND ISSUE PROCEEDS	2,315,825,300
TOTAL SOURCES	$2,315,825,300
USES:	
REPLACEMENT FUND TO REDEEM NOTE ISSUES AT MATURITY	2,035,165,000
RESERVE FUND (EQUAL TO AVG ANN D/S)	251,709,900
UNDERWRITER'S DISCOUNT AND ISSUANCE COSTS (@ 1.25%)	28,947,816
ROUNDING AMOUNT	2,584
TOTAL USES	$2,315,825,300

TEXAS TURNPIKE AUTHORITY - TEXAS HIGH SPEED RAIL
FORT WORTH - DALLAS - HOUSTON SEGMENT (VHS OPTION)
ESTIMATED ANNUAL CASH FLOW - PUBLIC ENTITY FINANCING
WITH REVENUES AND COSTS INFLATED AT 2.0% PER YEAR

	CONSTRUCTION PERIOD													
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
CAPITAL EXPENDITURES: (a)	$0	$0	$58,983	$356,780	$457,913	$467,071	$317,608	$0	$0	$0	$0	$0	$0	$0
REVENUES:														
PASSENGER								128,145	146,687	165,228	183,770	202,312	220,854	239,395
SUPPLEMENTAL								10,018	11,339	12,660	13,981	15,302	16,623	17,945
TOTAL REVENUES								138,163	158,025	177,888	197,751	217,614	237,477	257,340
EXPENDITURES:														
MAINT. & OPERATING								49,880	51,875	53,950	56,108	58,353	60,687	63,114
ADVERTISING								2,763	3,161	3,558	3,955	4,352	4,750	5,147
AGENCY COMMISSIONS								5,126	5,867	6,609	7,351	8,092	8,834	9,576
NET DEBT SERVICE								61,789	77,003	93,558	106,253	118,953	131,648	144,343
TOTAL EXPENDIURES								119,558	137,907	157,675	173,667	189,751	205,919	222,180
ANNUAL GROSS CASH FLOW								18,604	20,119	20,213	24,084	27,864	31,558	35,160
ANNUAL DEBT SERVICE COVERAGE								1.30	1.26	1.22	1.23	1.23	1.24	1.24
DOLLARS AVAILABLE FOR FRANCHISEES								12,425	12,419	10,857	13,459	15,968	18,394	20,726
NET ANNUAL DEBT SERVICE COVERAGE								1.10	1.10	1.10	1.10	1.10	1.10	1.10
ANNUAL NET CASH FLOW								6,179	7,700	9,356	10,625	11,895	13,165	14,434
CUMULATIVE NET CASH FLOW								6,179	13,879	23,235	33,860	45,756	58,921	73,355

(a) The capital expenditures do not include the cost of the stations at $35 million or the costs of the rolling stock at $432,300,000 which is financed by private enterprise.

TEXAS TURNPIKE AUTHORITY - TEXAS HIGH SPEED RAIL
FORT WORTH - DALLAS - HOUSTON SEGMENT (VHS OPTION)
ESTIMATED ANNUAL CASH FLOW - PUBLIC ENTITY FINANCING
WITH REVENUES AND COSTS INFLATED AT 2.0% PER YEAR

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
CAPITAL EXPENDITURES:	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
REVENUES:														
PASSENGER	257,937	276,479	295,021	313,562	332,104	350,646	369,188	387,729	406,271	424,813	443,355	443,355	443,355	443,355
SUPPLEMENTAL	19,266	20,587	21,908	23,229	24,551	25,872	27,193	28,514	29,835	31,157	32,478	32,478	32,478	32,478
TOTAL REVENUES	277,203	297,066	316,929	336,792	356,655	376,518	396,381	416,243	436,106	455,969	475,832	475,832	475,832	475,832
EXPENDITURES:														
MAINT. & OPERATING	65,639	68,264	70,995	73,835	76,788	79,859	83,054	86,376	89,831	93,424	97,161	97,161	97,161	97,161
ADVERTISING	5,544	5,941	6,339	6,736	7,133	7,530	7,928	8,325	8,722	9,119	9,517	9,517	9,517	9,517
AGENCY COMMISSIONS	10,317	11,059	11,801	12,542	13,284	14,026	14,768	15,509	16,251	16,993	17,734	17,734	17,734	17,734
NET DEBT SERVICE	157,038	169,738	182,433	195,128	207,828	220,523	233,218	245,913	258,613	271,308	284,003	284,003	284,003	284,003
TOTAL EXPENDIURES	238,539	255,003	271,568	288,241	305,034	321,939	338,967	356,123	373,417	390,845	408,415	408,415	408,415	408,415
ANNUAL GROSS CASH FLOW	38,664	42,063	45,361	48,551	51,621	54,579	57,413	60,120	62,689	65,125	67,417	67,417	67,417	67,417
ANNUAL DEBT SERVICE COV.	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.24	1.24	1.24	1.24	1.24	1.24	1.24
DOLLARS AVAIL. FOR FRANCH.	22,961	25,089	27,118	29,038	30,838	32,526	34,091	35,529	36,828	37,994	39,016	39,017	39,017	39,017
NET ANNUAL DEBT SER. COV.	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
ANNUAL NET CASH FLOW	15,704	16,974	18,243	19,513	20,783	22,052	23,322	24,591	25,861	27,131	28,400	28,400	28,400	28,400
CUMULATIVE NET CASH FLOW	89,059	106,033	124,276	143,789	164,572	186,624	209,946	234,537	260,398	287,529	315,930	344,330	372,730	401,131

TEXAS TURNPIKE AUTHORITY - TEXAS HIGH SPEED RAIL
FORT WORTH - DALLAS - HOUSTON SEGMENT (VHS OPTION)
ESTIMATED ANNUAL CASH FLOW - PUBLIC ENTITY FINANCING
WITH REVENUES AND COSTS INFLATED AT 2.0% PER YEAR

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
CAPITAL EXPENDITURES:	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
REVENUES:													
PASSENGER	443,355	443,355	443,355	443,355	443,355	443,355	443,355	443,355	443,355	443,355	443,355	443,355	443,355
SUPPLEMENTAL	32,478	32,478	32,478	32,478	32,478	32,478	32,478	32,478	32,478	32,478	32,478	32,478	32,478
TOTAL REVENUES	475,832	475,832	475,832	475,832	475,832	475,832	475,832	475,832	475,832	475,832	475,832	475,832	475,832
EXPENDITURES:													
MAINT. & OPERATING	97,161	97,161	97,161	97,161	97,161	97,161	97,161	97,161	97,161	97,161	97,161	97,161	97,161
ADVERTISING	9,517	9,517	9,517	9,517	9,517	9,517	9,517	9,517	9,517	9,517	9,517	9,517	9,517
AGENCY COMMISSIONS	17,734	17,734	17,734	17,734	17,734	17,734	17,734	17,734	17,734	17,734	17,734	17,734	17,734
NET DEBT SERVICE	284,003	284,003	284,003	284,003	284,003	284,003	284,003	284,003	284,003	284,003	284,004	284,003	32,292
TOTAL EXPENDIURES	408,415	408,415	408,415	408,415	408,415	408,415	408,415	408,415	408,415	408,415	408,415	408,415	156,704
ANNUAL GROSS CASH FLOW	67,417	67,417	67,417	67,417	67,417	67,417	67,417	67,417	67,417	67,417	67,417	67,417	319,128
ANNUAL DEBT SERVICE COVERAGE	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	10.88
DOLLARS AVAILABLE FOR FRANCH.	39,017	39,017	39,017	39,017	39,017	39,017	39,017	39,017	39,017	39,017	39,017	39,017	315,899
NET ANNUAL DEBT SERVICE COV.	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
ANNUAL NET CASH FLOW	28,400	28,400	28,400	28,400	28,400	28,400	28,400	28,400	28,400	28,400	28,400	28,400	3,229
CUMULATIVE NET CASH FLOW	429,531	457,931	486,332	514,732	543,132	571,533	599,933	628,333	656,734	685,134	713,534	741,935	745,164

TEXAS TURNPIKE AUTHORITY - TEXAS HIGH SPEED RAIL
FORT WORTH - DALLAS - HOUSTON SEGMENT (VHS OPTION)
DETAIL OF ESTIMATED CAPITAL COSTS (000'S)
WITH REVENUES AND COSTS INFLATED AT 2.0% PER YEAR AND GOVERNMENTAL CONTRIBUTION OF $99,721,000

DETAIL OF CAPITAL COSTS

CAPITAL COSTS FINANCEABLE THROUGH PUBLIC ENTITY (TAX-EXEMPT)

COST DESCRIPTION		1988 TOTAL CONST. COSTS DOLLAR AMOUNT	INFLATED CONST. COSTS DOLLAR AMOUNT	PUBLIC ENTITY INFLATED CONST. COSTS DOLLAR AMOUNT	GOVERNMENTAL INFLATED CONST. COSTS DOLLAR AMOUNT
EARTHWORK		$82,444	$93,788	$93,788	
RAILROAD RECONSTRUCTION		39,752	45,222	45,222	
TRACKWORK		309,046	351,571	351,571	
STRUCTURES		355,973	404,956	404,956	
RIGHT-OF-WAY		64,588	70,057	21,393	$48,664
ELECTRIFICATION		197,313	224,464	224,464	
MAINTENANCE FACILITIES		80,500	91,577	91,577	
TRAIN CONTROL		161,602	183,839	183,839	
ENGINEERING:					
PRELIMINARY ENGINEERING AND R.O.W. DETERMINATION	26,524				
FINAL DESIGN, SPECIFICATIONS & ESTIMATES	92,836	119,360	128,624	80,994	47,630
CONSTRUCTION MANAGEMENT		39,787	45,262	45,262	
RIGHT-OF-WAY ACQUISITION		16,147	17,514	14,087	3,427
CONTINGENCIES		88,961	101,202	101,202	
TOTAL		$1,555,473	$1,758,076	$1,658,355	$99,721

CAPITAL COSTS FINANCEABLE THROUGH PRIVATE ENTERPRISE

COST DESCRIPTION	DOLLAR AMOUNT
STATIONS	$35,000
ROLLING STOCK:	
1997 PURCHASE	277,700
2007 PURCHASE	154,600
TOTAL	$467,300

TEXAS TURNPIKE AUTHORITY - TEXAS HIGH SPEED RAIL
FORT WORTH - DALLAS - HOUSTON SEGMENT (VHS OPTION)
PROJECTED DISBURSEMENTS OF ESTIMATED CAPITAL COSTS (000'S)
WITH REVENUES AND COSTS INFLATED AT 2.0% PER YEAR AND GOVERNMENTAL CONTRIBUTION OF $99,721,000

CAPITAL COSTS FINANCEABLE THROUGH PUBLIC ENTITY (TAX-EXEMPT)

COST DESCRIPTION	1993	1994	1995	1996	1997	TOTAL DISBURSEMENTS
EARTHWORK		$18,205	$27,854	$28,411	$19,319	$93,788
RAILROAD CONSTRUCTION		8,778	13,430	13,699	9,315	45,222
TRACKWORK		68,242	104,411	106,499	72,419	351,571
STRUCTURES		78,605	120,265	122,670	83,416	404,956
RIGHT-OF-WAY		21,393				21,393
ELECTRIFICATION		43,570	66,662	67,995	46,237	224,464
MAINTENANCE FACILITIES		17,776	27,197	27,741	18,864	91,577
TRAIN CONTROL		35,684	54,597	55,689	37,868	183,839
ENGINEERING:						
PRELIMINARY ENGINEERING AND R.O.W. DETERMINATION	$50,244	30,750				80,994
FINAL DESIGN, SPECIFICATIONS & ESTIMATES		8,786	13,442	13,711	9,323	45,262
CONSTRUCTION MANAGEMENT	8,739	5,348				14,087
RIGHT-OF-WAY ACQUISITION		19,644	30,055	30,656	20,846	101,202
CONTINGENCIES						
YEARLY TOTAL	$58,983	$356,780	$457,913	$467,071	$317,608	$1,658,356

STAGING SCENARIO - STAGE 2
HOUSTON-SAN ANTONIO/AUSTIN SEGMENT
VHS

TEXAS TURNPIKE AUTHORITY - TEXAS HIGH SPEED RAIL
STAGING SCENARIO-HOUSTON-SAN ANTONIO/AUSTIN SEGMENT (VHS OPTION)
SOURCES AND USES OF FUNDS - NOTE ISSUES AND LONG-TERM REPLACEMENT ISSUE
WITH REVENUES AND COSTS INFLATED AT 2.0% PER YEAR

	NOTE ISSUES			
	ISSUE 1 (JAN. 1996)	ISSUE 2 (JAN. 1998)	ISSUE 3 (JAN. 2000)	TOTAL NOTE ISSUES
SOURCES:				
BOND ISSUE PROCEEDS	$129,690,000	$766,950,000	$666,805,000	$1,563,445,000
FUND EARNINGS:				
EARNINGS ON CONSTRUCTION FUNDS AT 8.0%	6,819,898	42,129,368	34,044,497	82,993,763
EARNINGS ON CAPITALIZED INTEREST AT 8.0%	13,565,191	38,876,853	13,829,505	66,271,549
TOTAL SOURCES	$150,075,089	$847,956,221	$714,679,002	$1,712,710,312
USES:				
GROSS CONSTRUCTION COSTS	$86,200,000	$592,943,000	$577,428,000	$1,256,571,000
CAPITALIZED INTEREST FUND				
FUNDED FROM BOND PROCEEDS	48,686,009	206,547,147	115,086,128	370,319,284
FUNDED FROM CAP INT EARNINGS	13,565,191	38,876,853	13,829,505	66,271,549
UNDERWRITER'S DISCOUNT AND ISSUANCE COSTS (@ 1.25%)	1,621,125	9,586,875	8,335,063	19,543,063
ROUNDING AMOUNT	2,764	2,346	306	5,416
TOTAL USES	$150,075,089	$847,956,221	$714,679,002	$1,712,710,312

	REPLACEMENT ISSUE (JULY 2002)
SOURCES:	
BOND ISSUE PROCEEDS	1,783,411,595
TOTAL SOURCES	$1,783,411,595
USES:	
REPLACEMENT FUND TO REDEEM NOTE ISSUES AT MATURITY	1,563,445,000
RESERVE FUND (EQUAL TO AVG ANN D/S)	197,670,700
UNDERWRITER'S DISCOUNT AND ISSUANCE COSTS (@ 1.25%)	22,292,645
ROUNDING AMOUNT	3,250
TOTAL USES	$1,783,411,595

TEXAS TURNPIKE AUTHORITY - TEXAS HIGH SPEED RAIL
STAGING SCENARIO-HOUSTON-SAN ANTONIO/AUSTIN SEGMENT (VHS OPTION)
ESTIMATED ANNUAL CASH FLOW - PUBLIC ENTITY FINANCING
WITH REVENUES AND COSTS INFLATED AT 2.0% PER YEAR

	CONSTRUCTION PERIOD													
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
CAPITAL EXPENDITURES: (a)	$0	$27,810	$58,390	$255,975	$336,968	$343,707	$233,721	$0	$0	$0	$0	$0	$0	$0
REVENUES:														
PASSENGER								94,645	110,522	126,399	142,276	158,152	174,029	189,906
SUPPLEMENTAL								5,381	6,184	6,988	7,792	8,595	9,399	10,202
TOTAL REVENUES								100,026	116,706	133,387	150,067	166,747	183,428	200,108
EXPENDITURES:														
MAINT. & OPERATING								38,968	40,526	42,147	43,833	45,587	47,410	49,306
ADVERTISING								2,001	2,334	2,668	3,001	3,335	3,669	4,002
AGENCY COMMISSIONS								3,786	4,421	5,056	5,691	6,326	6,961	7,596
NET DEBT SERVICE								40,311	58,370	68,992	79,614	90,238	100,861	111,481
TOTAL EXPENDIURES								85,065	105,651	118,863	132,140	145,485	158,901	172,386
ANNUAL GROSS CASH FLOW								14,961	11,055	14,524	17,927	21,262	24,527	27,722
ANNUAL DEBT SERVICE COVERAGE								1.37	1.19	1.21	1.23	1.24	1.24	1.25
DOLLARS AVAILABLE FOR FRANCHISEES								10,930	5,218	7,625	9,966	12,239	14,441	16,574
NET ANNUAL DEBT SERVICE COVERAGE								1.10	1.10	1.10	1.10	1.10	1.10	1.10
ANNUAL NET CASH FLOW								4,031	5,837	6,899	7,961	9,024	10,086	11,148
CUMULATIVE NET CASH FLOW								4,031	9,868	16,767	24,729	33,752	43,839	54,987

(a) The capital expenditures do not include the cost of the stations at $10 million or the costs of the rolling stock at $362,900,000 which is financed by private enterprise.

PAGE 2
TEXAS TURNPIKE AUTHORITY - TEXAS HIGH SPEED RAIL
STAGING SCENARIO-HOUSTON-SAN ANTONIO/AUSTIN SEGMENT (VHS OPTION)
ESTIMATED ANNUAL CASH FLOW - PUBLIC ENTITY FINANCING
WITH REVENUES AND COSTS INFLATED AT 2.0% PER YEAR

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CAPITAL EXPENDITURES:	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
REVENUES:														
PASSENGER	205,782	221,659	237,536	253,412	269,289	285,166	301,042	316,919	332,796	348,673	364,549	364,549	364,549	364,549
SUPPLEMENTAL	11,006	11,810	12,613	13,417	14,221	15,024	15,828	16,632	17,435	18,239	19,042	19,042	19,042	19,042
TOTAL REVENUES	216,788	233,469	250,149	266,829	283,510	300,190	316,870	333,551	350,231	366,911	383,592	383,592	383,592	383,592
EXPENDITURES:														
MAINT. & OPERATING	51,279	53,330	55,463	57,682	59,989	62,388	64,884	67,479	70,178	72,986	75,905	75,905	75,905	75,905
ADVERTISING	4,336	4,669	5,003	5,337	5,670	6,004	6,337	6,671	7,005	7,338	7,672	7,672	7,672	7,672
AGENCY COMMISSIONS	8,231	8,866	9,501	10,136	10,772	11,407	12,042	12,677	13,312	13,947	14,582	14,582	14,582	14,582
NET DEBT SERVICE	122,101	132,726	143,346	153,966	164,591	175,211	185,836	196,456	207,081	217,701	228,321	228,321	228,321	228,321
TOTAL EXPENDIURES	185,947	199,592	213,314	227,121	241,022	255,010	269,099	283,283	297,576	311,972	326,480	326,480	326,480	326,480
ANNUAL GROSS CASH FLOW	30,841	33,877	36,835	39,708	42,488	45,180	47,771	50,267	52,655	54,939	57,112	57,112	57,112	57,112
ANNUAL DEBT SERVICE COV.	1.25	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.25	1.25	1.25	1.25	1.25	1.25
DOLLARS AVAIL. FOR FRANCH.	18,631	20,604	22,501	24,312	26,029	27,659	29,187	30,622	31,947	33,169	34,279	34,279	34,279	34,279
NET ANNUAL DEBT SERV. COV.	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
ANNUAL NET CASH FLOW	12,210	13,273	14,335	15,397	16,459	17,521	18,584	19,646	20,708	21,770	22,832	22,832	22,832	22,832
CUMULATIVE NET CASH FLOW	67,197	80,469	94,804	110,201	126,660	144,181	162,765	182,410	203,118	224,889	247,721	270,553	293,385	316,217

TEXAS TURNPIKE AUTHORITY - TEXAS HIGH SPEED RAIL
STAGING SCENARIO-HOUSTON-SAN ANTONIO/AUSTIN SEGMENT (VHS OPTION)
ESTIMATED ANNUAL CASH FLOW - PUBLIC ENTITY FINANCING
WITH REVENUES AND COSTS INFLATED AT 2.0% PER YEAR

	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
CAPITAL EXPENDITURES:	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
REVENUES:											
PASSENGER	364,549	364,549	364,549	364,549	364,549	364,549	364,549	364,549	364,549	364,549	364,549
SUPPLEMENTAL	19,042	19,042	19,042	19,042	19,042	19,042	19,042	19,042	19,042	19,042	19,042
TOTAL REVENUES	383,592	383,592	383,592	383,592	383,592	383,592	383,592	383,592	383,592	383,591	383,591
EXPENDITURES:											
MAINT. & OPERATING	75,905	75,905	75,905	75,905	75,905	75,905	75,905	75,905	75,905	75,905	75,905
ADVERTISING	7,672	7,672	7,672	7,672	7,672	7,672	7,672	7,672	7,672	7,672	7,672
AGENCY COMMISSIONS	14,582	14,582	14,582	14,582	14,582	14,582	14,582	14,582	14,582	14,582	14,582
NET DEBT SERVICE	228,321	228,321	228,321	228,321	228,321	228,321	228,321	228,321	228,323	228,325	30,650
TOTAL EXPENDIURES	326,480	326,480	326,480	326,480	326,480	326,480	326,480	326,480	326,482	326,484	128,809
ANNUAL GROSS CASH FLOW	57,112	57,112	57,112	57,112	57,112	57,112	57,112	57,112	57,110	57,107	254,782
ANNUAL DEBT SERVICE COVERAGE	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	9.31
DOLLARS AVAILABLE FOR FRANCH.	34,279	34,279	34,279	34,279	34,279	34,279	34,279	34,279	34,278	34,275	251,717
NET ANNUAL DEBT SERVICE COV.	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
ANNUAL NET CASH FLOW	22,832	22,832	22,832	22,832	22,832	22,832	22,832	22,832	22,832	22,832	3,065
CUMULATIVE NET CASH FLOW	339,049	361,881	384,713	407,546	430,378	453,210	476,042	498,874	521,706	544,539	547,604

TEXAS TURNPIKE AUTHORITY - TEXAS HIGH SPEED RAIL
STAGING SCENARIO - HOUSTON-AUSTIN/SAN ANTONIO (VHS OPTION) (STAGE 2)
DETAIL OF ESTIMATED CAPITAL COSTS (000'S)
WITH REVENUES AND COSTS INFLATED AT 2.0% PER YEAR AND GOVERNMENTAL CONTRIBUTION OF $14,957,000

DETAIL OF CAPITAL COSTS

CAPITAL COSTS FINANCEABLE THROUGH PUBLIC ENTITY (TAX-EXEMPT)

COST DESCRIPTION		1988 TOTAL CONST. COSTS DOLLAR AMOUNT	INFLATED CONST. COSTS DOLLAR AMOUNT	PUBLIC ENTITY INFLATED CONST. COSTS DOLLAR AMOUNT	GOVERNMENTAL INFLATED CONST. COSTS DOLLAR AMOUNT
EARTHWORK		$71,208	$87,684	$87,684	
RAILROAD RECONSTRUCTION		15,694	19,325	19,325	
TRACKWORK		233,752	287,837	287,837	
STRUCTURES		218,860	269,499	269,499	
RIGHT-OF-WAY		30,920	36,303	29,200	$7,103
ELECTRIFICATION		150,060	184,781	184,781	
MAINTENANCE FACILITIES		22,000	27,090	27,090	
TRAIN CONTROL		119,216	146,800	146,800	
ENGINEERING:					
PRELIMINARY ENGINEERING AND R.O.W. DETERMINATION	17,434				
FINAL DESIGN, SPECIFICATIONS & ESTIMATES	61,020	78,454	91,513	83,659	7,854
CONSTRUCTION MANAGEMENT		26,150	32,201	32,201	
RIGHT-OF-WAY ACQUISITION		7,730	9,076	9,076	
CONTINGENCIES		64,496	79,419	79,419	
TOTAL		$1,038,540	$1,271,528	$1,256,571	$14,957

CAPITAL COSTS FINANCEABLE THROUGH PRIVATE ENTERPRISE

COST DESCRIPTION	DOLLAR AMOUNT
STATIONS	
ROLLING STOCK:	$10,000
1997 PURCHASE	305,900
2007 PURCHASE	57,000
TOTAL	$372,900

TEXAS TURNPIKE AUTHORITY - TEXAS HIGH SPEED RAIL
STAGING SCENARIO - HOUSTON-AUSTIN/SAN ANTONIO (VHS OPTION) (STAGE 2-1995 THROUGH 2001)
PROJECTED DISBURSEMENTS OF ESTIMATED CAPITAL COSTS (000'S)
WITH REVENUES AND COSTS INFLATED AT 2.0% PER YEAR AND GOVERNMENTAL CONTRIBUTION OF $14,957,000

CAPITAL COSTS FINANCEABLE THROUGH PUBLIC ENTITY (TAX-EXEMPT)

COST DESCRIPTION	1996	1997	1998	1999	2000	2001	TOTAL DISBURSEMENTS
EARTHWORK			17,020	$26,041	$26,561	$18,062	$87,684
RAILROAD CONSTRUCTION			3,751	5,739	5,854	3,981	19,325
TRACKWORK			55,871	85,483	87,192	59,291	287,837
STRUCTURES			52,312	80,037	81,637	55,513	269,499
RIGHT-OF-WAY		18,114	11,086				29,200
ELECTRIFICATION			35,867	54,877	55,974	38,062	184,781
MAINTENANCE FACILITIES			5,258	8,045	8,206	5,580	27,090
TRAIN CONTROL			28,495	43,597	44,469	30,239	146,800
ENGINEERING:							
PRELIMINARY ENGINEERING AND R.O.W. DETERMINATION	12,015						12,015
FINAL DESIGN, SPECIFICATIONS & ESTIMATES	14,019	$35,747	21,877				71,644
CONSTRUCTION MANAGEMENT			6,250	9,563	9,754	6,633	32,201
RIGHT-OF-WAY ACQUISITION	1,776	4,528	2,771				9,076
CONTINGENCIES			15,416	23,586	24,058	16,359	79,419
YEARLY TOTAL	$27,810	$58,390	$255,975	$336,968	$343,707	$233,721	$1,256,570

TEXAS TURNPIKE AUTHORITY - TEXAS HIGH SPEED RAIL
STAGING SCENARIO - HOUSTON-AUSTIN/SAN ANTONIO (VHS OPTION) (STAGE 2-1995 THROUGH 2001)
YEARLY OPERATING AND MAINTENANCE EXPENDITURES (000'S)

YEAR	OPERATING AND MAINTENANCE EXPENDITURES (a)
1998	
1999	
2000	
2001	
2002	38,968
2003	40,526
2004	42,147
2005	43,833
2006	45,587
2007	47,410
2008	49,306
2009	51,279
2010	53,330
2011	55,463
2012	57,682
2013	59,989
2014	62,388
2015	64,884
2016	67,479
2017	70,178
2018	72,986
2019	75,905
2020	75,905
2021	75,905
2022	75,905
2023	75,905
2024	75,905
2025	75,905
2026	75,905
2027	75,905
2028	75,905
2029	75,905
2030	75,905
2031	75,905

(a) Operating and maintenance expenditures increase at 2.0% per year to estimate increased operating expenditures as ridership increases and an additional 2.0% per year to reflect inflation through year 2019 and remain constant thereafter.

TEXAS TURNPIKE AUTHORITY - TEXAS HIGH SPEED RAIL
STAGING SCENARIO - HOUSTON-AUSTIN/SAN ANTONIO (VHS OPTION) (STAGE 2-1995 THROUGH 2001)
PROJECTED YEARLY PASSENGER AND SUPPLEMENTAL REVENUES INFLATED 2.0% PER YEAR FROM 1988

YEAR	PASSENGER REVENUE (a)	SUPPLEMENTAL REVENUE (b)	TOTAL REVENUES
1998			
1999			
2000			
2001			
2002	94,645	5,381	100,026
2003	110,522	6,184	116,706
2004	126,399	6,988	133,387
2005	142,276	7,792	150,067
2006	158,152	8,595	166,747
2007	174,029	9,399	183,428
2008	189,906	10,202	200,108
2009	205,782	11,006	216,788
2010	221,659	11,810	233,469
2011	237,536	12,613	250,149
2012	253,412	13,417	266,829
2013	269,289	14,221	283,510
2014	285,166	15,024	300,190
2015	301,042	15,828	316,870
2016	316,919	16,632	333,551
2017	332,796	17,435	350,231
2018	348,673	18,239	366,911
2019	364,549	19,042	383,592
2020	364,549	19,042	383,592
2021	364,549	19,042	383,592
2022	364,549	19,042	383,592
2023	364,549	19,042	383,592
2024	364,549	19,042	383,592
2025	364,549	19,042	383,592
2026	364,549	19,042	383,592
2027	364,549	19,042	383,592
2028	364,549	19,042	383,592
2029	364,549	19,042	383,592
2030	364,549	19,042	383,592
2031	364,549	19,042	383,592

(a) Passenger revenues increase on a straight line basis in years 2002 through 2019 and remain constant thereafter.
(b) Supplemental revenues increase on a straight line basis in years 2002 through 2019 and remain constant thereafter.

TEXAS TURNPIKE AUTHORITY - TEXAS HIGH SPEED RAIL
STAGING SCENARIO-HOUSTON-SAN ANTONIO/AUSTIN SEGMENT (VHS OPTION)
ESTIMATED DEBT SERVICE REQUIRMENTS
WITH REVENUES AND COSTS INFLATED AT 2.0% PER YEAR

	NOTE ISSUE 1 - JANUARY 1, 1996				NOTE ISSUE 2 - JANUARY 1, 1998				NOTE ISSUE 3 - JANUARY 1, 2000		
YEAR	GROSS DEBT SERVICE	CAPITALIZED INTEREST	NET DEBT SERVICE	YEAR	GROSS DEBT SERVICE	CAPITALIZED INTEREST	NET DEBT SERVICE	YEAR	GROSS DEBT SERVICE	CAPITALIZED INTEREST	NET DEBT SERVICE
1991				1991				1991			
1992				1992				1992			
1993				1993				1993			
1994				1994				1994			
1995				1995				1995			
1996	5,187,600	5,187,600	0	1996				1996			
1997	10,375,200	10,375,200	0	1997				1997			
1998	10,375,200	10,375,200	0	1998	30,678,000	30,678,000	0	1998			
1999	10,375,200	10,375,200	0	1999	61,356,000	61,356,000	0	1999			
2000	10,375,200	10,375,200	0	2000	61,356,000	61,356,000	0	2000	26,672,200	26,672,200	0
2001	10,375,200	10,375,200	0	2001	61,356,000	61,356,000	0	2001	53,344,400	53,344,400	0
2002	10,375,200	5,187,600	5,187,600	2002	61,356,000	30,678,000	30,678,000	2002	53,344,400	48,899,033	4,445,367
	$67,438,800	$62,251,200	$5,187,600		$276,102,000	$245,424,000	$30,678,000		$133,361,000	$128,915,633	$4,445,367

TEXAS TURNPIKE AUTHORITY - TEXAS HIGH SPEED RAIL
STAGING SCENARIO-HOUSTON-SAN ANTONIO/AUSTIN SEGMENT (VHS OPTION)
ESTIMATED DEBT SERVICE REQUIRMENTS
WITH REVENUES AND COSTS INFLATED BY 2.0% PER YEAR

LONG TERM REPLACEMENT ISSUE - JULY 1, 2002

YEAR	GROSS DEBT SERVICE	RESERVE FUND EARNINGS	NET DEBT SERVICE	YEAR	TOTAL NET DEBT SERVICE
1991				1991	
1992				1992	$0
1993				1993	0
1994				1994	0
1995				1995	0
1996				1996	0
1997				1997	0
1998				1998	0
1999				1999	0
2000				2000	0
2001				2001	0
2002				2002	40,310,967
2003	74,318,000	15,948,072	58,369,928	2003	58,369,928
2004	84,940,000	15,948,072	68,991,928	2004	68,991,928
2005	95,562,400	15,948,072	79,614,328	2005	79,614,328
2006	106,185,600	15,948,072	90,237,528	2006	90,237,528
2007	116,809,400	15,948,072	100,861,328	2007	100,861,328
2008	127,429,400	15,948,072	111,481,328	2008	111,481,328
2009	138,049,400	15,948,072	122,101,328	2009	122,101,328
2010	148,674,400	15,948,072	132,726,328	2010	132,726,328
2011	159,294,400	15,948,072	143,346,328	2011	143,346,328
2012	169,914,400	15,948,072	153,966,328	2012	153,966,328
2013	180,539,400	15,948,072	164,591,328	2013	164,591,328
2014	191,159,400	15,948,072	175,211,328	2014	175,211,328
2015	201,784,400	15,948,072	185,836,328	2015	185,836,328
2016	212,404,400	15,948,072	196,456,328	2016	196,456,328
2017	223,029,400	15,948,072	207,081,328	2017	207,081,328
2018	233,649,400	15,948,072	217,701,328	2018	217,701,328
2019	244,269,400	15,948,072	228,321,328	2019	228,321,328
2020	244,269,400	15,948,072	228,321,328	2020	228,321,328
2021	244,269,400	15,948,072	228,321,328	2021	228,321,328
2022	244,269,400	15,948,072	228,321,328	2022	228,321,328
2023	244,269,400	15,948,072	228,321,328	2023	228,321,328
2024	244,269,400	15,948,072	228,321,328	2024	228,321,328
2025	244,269,400	15,948,072	228,321,328	2025	228,321,328
2026	244,269,400	15,948,072	228,321,328	2026	228,321,328
2027	244,269,400	15,948,072	228,321,328	2027	228,321,328
2028	244,269,400	15,948,072	228,321,328	2028	228,321,328
2029	244,269,400	15,948,072	228,321,328	2029	228,321,328
2030	244,269,400	15,948,072	228,321,328	2030	228,321,328
2031	244,270,800	15,948,072	228,322,728	2031	228,322,728
2032	244,273,000	15,948,072	228,324,928	2032	228,324,928
2033	244,269,000	213,618,772	30,650,228	2033	30,650,228
	$6,127,789,400	$692,060,932	$5,435,728,468		$5,476,039,435

STAGING SCENARIO - STAGE 3
FORT WORTH-AUSTIN-SAN ANTONIO SEGMENT
VHS

TEXAS TURNPIKE AUTHORITY - TEXAS HIGH SPEED RAIL
STAGING SCENARIO - FORT WORTH-AUSTIN-SAN ANTONIO SEGMENT (VHS OPTION) (STAGE 3 1999 THROUGH 2005)
SOURCES AND USES OF FUNDS - NOTE ISSUES AND LONG-TERM REPLACEMENT ISSUE
WITH REVENUES AND COSTS INFLATED AT 2.0% PER YEAR

	NOTE ISSUES			
	ISSUE 1 (JULY 1999)	ISSUE 2 (JAN. 2002)	ISSUE 3 (JAN. 2004)	TOTAL NOTE ISSUES
SOURCES:				
BOND ISSUE PROCEEDS	$88,945,000	$496,620,000	$412,625,000	$998,190,000
FUND EARNINGS:				
EARNINGS ON CONSTRUCTION FUNDS AT 8.0%	5,992,712	26,868,103	21,775,291	54,636,106
EARNINGS ON CAPITALIZED INTEREST AT 8.0%	10,724,462	28,127,797	6,108,579	44,960,838
TOTAL SOURCES	$105,662,174	$551,615,900	$440,508,870	$1,097,786,944
USES:				
GROSS CONSTRUCTION COSTS	$58,297,000	$376,554,000	$369,330,000	$804,181,000
CAPITALIZED INTEREST FUND				
FUNDED FROM BOND PROCEEDS	35,526,938	140,723,003	59,911,421	236,161,362
FUNDED FROM CAP INT EARNINGS	10,724,462	28,127,797	6,108,579	44,960,838
UNDERWRITER'S DISCOUNT AND ISSUANCE COSTS (@ 1.25%)	1,111,813	6,207,750	5,157,813	12,477,376
ROUNDING AMOUNT	1,961	3,350	1,057	6,368
TOTAL USES	$105,662,174	$551,615,900	$440,508,870	$1,097,786,944

	REPLACEMENT ISSUE (JULY 2006)
SOURCES:	
BOND ISSUE PROCEEDS	1,131,036,135
TOTAL SOURCES	$1,131,036,135
USES:	
REPLACEMENT FUND TO REDEEM NOTE ISSUES AT MATURITY	998,190,000
RESERVE FUND (EQUAL TO AVG ANN D/S)	118,705,400
UNDERWRITER'S DISCOUNT AND ISSUANCE COSTS (@ 1.25%)	14,137,952
ROUNDING AMOUNT	2,783
TOTAL USES	$1,131,036,135

TEXAS TURNPIKE AUTHORITY - TEXAS HIGH SPEED RAIL
STAGING SCENARIO - FORT WORTH-AUSTIN-SAN ANTONIO SEGMENT (VHS OPTION) (STAGE 3 1999 THROUGH 2005)
ESTIMATED ANNUAL CASH FLOW - PUBLIC ENTITY FINANCING
WITH REVENUES AND COSTS INFLATED AT 2.0% PER YEAR

	CONSTRUCTION PERIOD													
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
CAPITAL EXPENDITURES: (a)	$4,189	$21,172	$32,936	$161,025	$215,529	$219,839	$149,491	$0	$0	$0	$0	$0	$0	$0
REVENUES:														
PASSENGER								89,930	97,157	104,383	111,610	118,836	126,063	133,289
SUPPLEMENTAL								6,108	7,006	7,904	8,802	9,701	10,599	11,497
TOTAL REVENUES								96,038	104,162	112,287	120,412	128,537	136,662	144,787
EXPENDITURES:														
MAINT. & OPERATING								25,074	26,076	27,120	28,204	29,332	30,506	31,726
ADVERTISING								1,921	2,083	2,246	2,408	2,571	2,733	2,896
AGENCY COMMISSIONS								3,597	3,886	4,175	4,464	4,753	5,043	5,332
NET DEBT SERVICE								29,995	52,709	57,567	62,425	67,283	72,138	76,983
TOTAL EXPENDIURES								60,587	84,755	91,108	97,502	103,940	110,419	116,936
ANNUAL GROSS CASH FLOW								35,451	19,408	21,179	22,910	24,597	26,242	27,850
GROSS ANNUAL DEBT SERVICE COVERAGE								2.18	1.37	1.37	1.37	1.37	1.36	1.36
SOURCE OF CONTRIBUTION REPAYMENT								27,952	6,231	6,788	7,304	7,776	8,208	8,605
ANNUAL DEBT SERVICE COVERAGE								1.25	1.25	1.25	1.25	1.25	1.25	1.25
DOLLARS AVAILABLE FOR FRANCHISEES								4,499	7,906	8,635	9,364	10,092	10,821	11,547
NET ANNUAL DEBT SERVICE COVERAGE								1.10	1.10	1.10	1.10	1.10	1.10	1.10
ANNUAL NET CASH FLOW								3,000	5,271	5,757	6,243	6,728	7,214	7,698
CUMULATIVE NET CASH FLOW								3,000	8,270	14,027	20,270	26,998	34,212	41,910

(a) The capital expenditures do not include the cost of the stations at $10 million
or the costs of the rolling stock at $341,700,000 which is financed by private enterprise.

PAGE 2
TEXAS TURNPIKE AUTHORITY - TEXAS HIGH SPEED RAIL
STAGING SCENARIO - FORT WORTH-AUSTIN-SAN ANTONIO SEGMENT (VHS OPTION) (STAGE 3 1999 THROUGH 2005)
ESTIMATED ANNUAL CASH FLOW - PUBLIC ENTITY FINANCING
WITH REVENUES AND COSTS INFLATED AT 2.0% PER YEAR

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
CAPITAL EXPENDITURES:	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
REVENUES:														
PASSENGER	140,516	147,742	154,969	162,195	169,422	176,649	183,875	191,102	198,328	205,555	212,781	212,781	212,781	212,781
SUPPLEMENTAL	12,396	13,294	14,192	15,091	15,989	16,887	17,785	18,684	19,582	20,480	21,379	21,379	21,379	21,379
TOTAL REVENUES	152,911	161,036	169,161	177,286	185,411	193,536	201,661	209,785	217,910	226,035	234,160	234,160	234,160	234,160
EXPENDITURES:														
MAINT. & OPERATING	32,995	34,315	35,687	37,115	38,600	40,143	41,749	43,419	45,156	46,962	48,841	48,841	48,841	48,841
ADVERTISING	3,058	3,221	3,383	3,546	3,708	3,871	4,033	4,196	4,358	4,521	4,683	4,683	4,683	4,683
AGENCY COMMISSIONS	5,621	5,910	6,199	6,488	6,777	7,066	7,355	7,644	7,933	8,222	8,511	8,511	8,511	8,511
NET DEBT SERVICE	81,858	86,713	91,573	96,433	101,288	106,148	111,008	115,868	120,723	125,583	130,443	130,443	130,443	130,443
TOTAL EXPENDIURES	123,532	130,158	136,842	143,581	150,372	157,228	164,145	171,127	178,170	185,288	192,478	192,478	192,478	192,478
ANNUAL GROSS CASH FLOW	29,380	30,878	32,319	33,705	35,038	36,308	37,515	38,659	39,740	40,747	41,682	41,682	41,682	41,682
GROSS ANNUAL DEBT COVERAGE	1.36	1.36	1.35	1.35	1.35	1.34	1.34	1.33	1.33	1.32	1.32	1.32	1.32	1.32
SOURCE OF CONTRIB. REPAY.	8,915	9,200	9,426	9,597	9,716	9,771	9,763	9,692	9,559	9,351	9,071	9,071	9,071	9,071
ANNUAL DEBT SERVICE COV.	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
DOLLARS AVAIL. FOR FRANCH.	12,279	13,007	13,736	14,465	15,193	15,922	16,651	17,380	18,108	18,837	19,566	19,566	19,566	19,566
NET ANNUAL DEBT SERV. COV.	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
ANNUAL NET CASH FLOW	8,186	8,671	9,157	9,643	10,129	10,615	11,101	11,587	12,072	12,558	13,044	13,044	13,044	13,044
CUMULATIVE NET CASH FLOW	50,096	58,767	67,924	77,568	87,696	98,311	109,412	120,999	133,071	145,629	158,674	171,718	184,762	197,807

TEXAS TURNPIKE AUTHORITY - TEXAS HIGH SPEED RAIL
STAGING SCENARIO - FORT WORTH-AUSTIN-SAN ANTONIO SEGMENT (VHS OPTION) (STAGE 3 1999 THROUGH 2005)
ESTIMATED ANNUAL CASH FLOW - PUBLIC ENTITY FINANCING
WITH REVENUES AND COSTS INFLATED AT 2.0% PER YEAR

	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
CAPITAL EXPENDITURES:	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
REVENUES:											
PASSENGER	212,781	212,781	212,781	212,781	212,781	212,781	212,781	212,781	212,781	212,781	212,781
SUPPLEMENTAL	21,379	21,379	21,379	21,379	21,379	21,379	21,379	21,379	21,379	21,379	21,379
TOTAL REVENUES	234,160	234,160	234,160	234,160	234,160	234,160	234,160	234,160	234,160	234,160	234,160
EXPENDITURES:											
MAINT. & OPERATING	48,841	48,841	48,841	48,841	48,841	48,841	48,841	48,841	48,841	48,841	48,841
ADVERTISING	4,683	4,683	4,683	4,683	4,683	4,683	4,683	4,683	4,683	4,683	4,683
AGENCY COMMISSIONS	8,511	8,511	8,511	8,511	8,511	8,511	8,511	8,511	8,511	8,511	8,511
NET DEBT SERVICE	130,443	130,443	130,443	130,443	130,443	130,443	130,443	130,443	130,439	130,442	11,738
TOTAL EXPENDIURES	192,478	192,478	192,478	192,478	192,478	192,478	192,478	192,478	192,475	192,478	73,774
ANNUAL GROSS CASH FLOW	41,682	41,682	41,682	41,682	41,682	41,682	41,682	41,682	41,685	41,682	160,386
GROSS ANNUAL DEBT COVERAGE	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	14.66
SOURCE OF CONTRIBUTION REPAY.	9,071	9,071	9,071	9,071	9,071	9,071	9,071	9,071	9,075	9,072	157,452
ANNUAL DEBT SERVICE COVERAGE	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
DOLLARS AVAILABLE FOR FRANCH.	19,566	19,566	19,566	19,566	19,566	19,566	19,566	19,566	19,566	19,566	1,761
NET ANNUAL DEBT SERVICE COV.	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
ANNUAL NET CASH FLOW	13,044	13,044	13,044	13,044	13,044	13,044	13,044	13,044	13,044	13,044	1,174
CUMULATIVE NET CASH FLOW	210,851	223,895	236,939	249,984	263,028	276,072	289,117	302,161	315,205	328,249	329,423

TEXAS TURNPIKE AUTHORITY - TEXAS HIGH SPEED RAIL
STAGING SCENARIO - FORT WORTH-AUSTIN-SAN ANTONIO SEGMENT (VHS OPTION) (STAGE 3)
DETAIL OF ESTIMATED CAPITAL COSTS (000'S)
WITH REVENUES AND COSTS INFLATED AT 2.0% PER YEAR

DETAIL OF CAPITAL COSTS

CAPITAL COSTS FINANCEABLE THROUGH PUBLIC ENTITY (TAX-EXEMPT)

COST DESCRIPTION		1988 TOTAL CONST. COSTS DOLLAR AMOUNT	INFLATED CONST. COSTS DOLLAR AMOUNT	PUBLIC ENTITY INFLATED CONST. COSTS DOLLAR AMOUNT	GOVERNMENTAL INFLATED CONST. COSTS DOLLAR AMOUNT
EARTHWORK		$41,956	$55,922	$55,922	
RAILROAD RECONSTRUCTION		3,526	4,700	4,700	
TRACKWORK		139,483	185,914	185,914	
STRUCTURES		143,316	191,023	191,023	
RIGHT-OF-WAY		12,800	16,267	16,267	
ELECTRIFICATION		89,281	119,001	119,001	
MAINTENANCE FACILITIES		4,000	5,332	5,332	
TRAIN CONTROL		69,054	92,041	92,041	
ENGINEERING:					
PRELIMINARY ENGINEERING AND R.O.W. DETERMINATION	10,268				
FINAL DESIGN, SPECIFICATIONS & ESTIMATES	35,939	46,207	58,072	58,072	
CONSTRUCTION MANAGEMENT		15,402	20,529	20,529	
RIGHT-OF-WAY ACQUISITION		3,200	4,116	4,116	
CONTINGENCIES		38,461	51,264	51,264	
TOTAL		$606,686	$804,181	$804,181	$0

CAPITAL COSTS FINANCEABLE THROUGH PRIVATE ENTERPRISE

COST DESCRIPTION	DOLLAR AMOUNT
STATIONS	$10,000
ROLLING STOCK:	
1997 PURCHASE	191,000
2007 PURCHASE	150,700
TOTAL	$351,700

TEXAS TURNPIKE AUTHORITY - TEXAS HIGH SPEED RAIL
STAGING SCENARIO - FORT WORTH-AUSTIN-SAN ANTONIO SEGMENT (VHS OPTION) (STAGE 3)
PROJECTED DISBURSEMENTS OF ESTIMATED CAPITAL COSTS (000'S)
WITH REVENUES AND COSTS INFLATED AT 2.0% PER YEAR

CAPITAL COSTS FINANCEABLE THROUGH PUBLIC ENTITY (TAX-EXEMPT)

COST DESCRIPTION	1999	2000	2001	2002	2003	2004	2005	TOTAL DISBURSEMENTS
EARTHWORK				10,855	$16,608	$16,940	$11,519	$55,922
RAILROAD CONSTRUCTION				912	1,396	1,424	968	4,700
TRACKWORK				36,087	55,213	56,318	38,296	185,914
STRUCTURES				37,079	56,731	57,865	39,348	191,023
RIGHT-OF-WAY		3,183	8,117	4,967				16,267
ELECTRIFICATION				23,099	35,341	36,048	24,513	119,001
MAINTENANCE FACILITIES				1,035	1,583	1,615	1,098	5,332
TRAIN CONTROL				17,866	27,335	27,881	18,959	92,041
ENGINEERING:								
PRELIMINARY ENGINEERING AND R.O.W. DETERMINATION	4,189	7,660						11,850
FINAL DESIGN, SPECIFICATIONS & ESTIMATES		9,484	$22,790	13,947				46,222
CONSTRUCTION MANAGEMENT				3,985	6,097	6,219	4,229	20,529
RIGHT-OF-WAY ACQUISITION		844	2,029	1,242				4,116
CONTINGENCIES				9,951	15,225	15,529	10,560	51,264
YEARLY TOTAL	$4,189	$21,172	$32,936	$161,025	$215,529	$219,839	$149,491	$804,181

APPENDIX H

LEGAL PROVISIONS
(Other States)

STATE AGENCY CREATED	FLORIDA	OHIO	PENNSYLVANIA (Proposed)
Name	Florida High-Speed Rail Transportation Commission (within Department of Transportation)	Ohio High Speed Rail Authority (within Department of Transportation)	Pennsylvania High Speed Intercity Rail Authority
Members	• 7 appointed by Governor, subject to Senate confirmation • All members state residents	• a. 5 appointed by Governor with Senate consent (no more than 3 of same political party) b. 2 members of Ohio Senate c. 2 members of Ohio House of Representatives (no more than 1 from b and 1 from c of same political party) • All members state residents • b and c members are nonvoting members	• 9 members of Board of Directors appointed by Governor subject to Senate consent (no more than 5 from 1 political party) • All members state residents
Chairman	First Chairman designated by Governor for 2 year term. Subsequent Chairmen selected by members for 2 year terms	Governor names chairman and vice-chairman who serve at the pleasure of Governor	Governor selects chairman
Member Terms	4 years; eligible for re-appointment	6 years; eligible for re-appointment	4 years; eligible for reappointment
Compensation	No salary - per diem and traveling expenses	Members reimbursed for actual expenses	Members reimbursed for actual expenses
Meetings	Annually or more frequently at call of Chair	Annually or more frequently at call of Chair	Annually or more frequently at call of Chair
Quorum	4 members; majority of members present necessary to take action	3 members; affirmative vote of 3 necessary to take action	4 members; affirmative vote of 3 necessary to take action
Staff	May employ executive director and other staff	May employ executive director and other staff and fix employee compensation	May appoint executive director and other staff
Conflicts	No member may have direct or indirect interest during term and 2 years after term	[no provision]	No member may have direct or indirect interest during term and 2 years after term
Other	Governor may remove member for cause	Department of Transportation may use all appropriate sources of revenue to assist Authority in developing and implementing service	

GENERAL POWERS AND DUTIES OF THE AGENCY	FLORIDA	OHIO	PENNSYLVANIA
1. To sue and be sued in agency's name	X	X	X
2. To adopt an official seal	X	X	X
3. To maintain a principal office, regional offices if necessary		X	X
4. To adopt and amend bylaws necessary for regulation of its affairs and conduct of business and to make rules to implement its powers and duties	X	X	X
5. To make and enter into contracts and to execute instruments necessary and incidental to performance of its duties and execution of its powers	X	X	X
6. To contract for services of investment banking, financial advisory, legal or other consultants to plan, review, structure or advise agency as to requirements associated with the rail system	X		X
7. To contract for services of architects, engineers, urban planners, attorneys and consultants in relation to the feasibility, safety, or other considerations of the rail passenger service	X		X
8. To purchase property coverage and liability insurance for projects and offices of agency; to purchase insurance protecting the agency and its employees from liability; to purchase other insurance the agency believes prudent or that it agrees to provide under a resolution authorizing the issuance of bonds or trust agreement securing the bonds		X	X
9. To enter into contracts of group insurance for benefit of its employees or to set up or continue an insurance, pension or retirement system or other employee benefit arrangement covering employees of an acquired transportation system			X
10. To apply for coverage of its employees under the state retirement system	X		
11. To acquire by purchase, gift, grant, devise, contribution, exchange or interagency transfer and hold property or any interest therein	X	X[1]	X
a. Title to property acquired shall be held in the name of	State of Florida[2]		Commonwealth of Pa
b. and administered by	the Commission		the Authority
c. Any conveyance or lease of property or interest in property acquired from the agency to any private entity shall be made for fair market value	X		
d. Any conveyance of a property interest between the agency and another agency shall be for a negotiated consideration of less than fair market value	X		

GENERAL POWERS AND DUTIES OF THE AGENCY	FLORIDA	OHIO	PENNSYLVANIA
12. To receive and accept from any federal agency or other person, subject to the approval of the Governor, grants for or in aid of the construction, repair, renovation or acquisition of intercity rail service projects and receive and accept aid or contributions from any source of money, property, labor or other things of value to be held, used and applied for the purpose for which such grants and contributions were made		X	X
13. To invest funds not required for immediate use, including proceeds from the sale of any bonds, note or other obligations, in such obligations, securities and other investments as the agency deems prudent			X
14. To lease to or from any person, firm, corporation, association, or public or private body, any interest, property or ancillary facilities associated with a high speed intercity rail line	X[3]	X	X
15. To undertake the acquisition, renovation, repair, refunding or construction of any intercity rail service project		X	
16. To contract for services, including managerial and operating services, whenever it can more efficiently and effectively serve the public by so doing than by conducting its own operations			X
17. To do all acts necessary and proper to carry out the powers expressly granted to the agency in the act		X	X
18. To do any act necessary and convenient to the exercise of the foregoing powers or reasonably implied therefrom			X

[1] Conditions for purchase of property facilities, or equipment:
a Authority determines property is suitable after inspection.
b Controlling board approves the purchase by an affirmative vote of no fewer than 5 members.

[2] Title to all high-speed rail line facilities financed by the issuance of Authority bonds shall be held in the name of the state, and the title to other high-speed rail line facilities may be held in the name of the state or encumbered as may be determined by the division in its discretion as necessary to provide for the security of the issuance of the bonds. In the event that the title to any high-speed rail line facility financed by the issuance of bonds is not held by the state, then the title shall be pledged as security for the bonds by the owner of such title.

[3] Any lease agreement between the Commission and a franchise may provide for the transfer of title to such facilities only when such bonds have been retired and the holders of all outstanding bonds issued to finance such facilities have received all principal, interest payments, and redemption premiums to which the holders are legally entitled.

SPECIAL POWERS AND DUTIES OF THE AGENCY	OHIO	PENNSYLVANIA
I. *Ohio and Pennsylvania*		
1. To borrow money from private lenders, from the state or federal government, or from any municipality		X
2. To issue bonds and notes and refunding bonds of the state	X	X
3. To establish and operate a revolving loan fund for the purpose of making loans to qualifying subdivisions, local or regional transportation authorities, on other persons for the acquisition, renovation, repair, refunding or construction of intercity rail service projects	X	
4. To establish or increase reserves from moneys received or to be received by the Authority to secure or pay principal and interest on bonds, notes and other obligations issued by the authority	X	X
5. To receive and disburse proceeds of general obligation or other bonds of the state or agencies thereof as allowed by law	X	X
6. To extent permitted by contract, to consent to modification of terms of a bond contract or other agreement to which the Authority is a party	X	X
7. To make grants to counties or municipal corporations, qualifying subdivisions, local or regional transportation authorities or other persons for 1 or more projects or part thereof	X	X
8. To provide consultation services to any qualifying subdivision, local or regional transportation authority or other person in connection with a rail service project	X	X
9. To establish and amend the criteria and qualifications for the making of any loan to, or the purchasing of any bond from, any qualifying subdivision, local or regional transportation authority, or other person	X	X
10. To acquire by eminent domain any real or personal property including improvements, fixtures and franchises for the purposes set forth in the Act		X
11. To exercise power as a redevelopment authority after consultation with other such authorities in order to provide ancillary facilities and services for high speed intercity rail passengers	only real property	X
12. To enter into contracts with the State, its agencies and instrumentalities, municipalities or corporations		X
13. To request any state agency to provide it with data, plans, research, and other information	X	X
14. To request any railroad to provide it with data and information necessary to carry out the Act's purposes. (The Authority shall not disclose confidential information supplied.)	X	X
15. The Authority may give priority to projects undertaken within geographic boundaries of qualifying subdivisions	X	

SPECIAL POWERS AND DUTIES OF THE AGENCY	OHIO	PENNSYLVANIA
16. To make available to the government of a municipality or any appropriate agency, the Authority's recommendations of any area in its field of operation which it may deem likely to promote the public health, safety and welfare		X
17. To act as agent of the state or of the Federal government or any of their instrumentalities or agencies for the public purposes set out in the Act.		X
18. To review the fixing of rates, fares, changes or marketing practice for passenger and related services		X
19. To prescribe appropriate rules, regulations, orders and standards to ensure safety of passengers and employees		X
20 To regulate the operation of the system as necessary and convenient	X	X
21. To require such books and records as necessary and convenient		X
22 To conduct examinations and investigations and to hear testimony and take proof under oath or affirmation at public or private hearings on any matter material to the Act's public purposes		X
23 To prepare an annual report		X

II. *Florida*
1. To prepare and issue requests for proposals for the provision of a high-speed rail line, specifically addressing qualifications of applicants and information essential to aid the Commission in assessing applications
2. To review the proposals from the applicants, receive and review the reports of all applicable agencies and issue a franchise to an applicant
3. To assess a reasonable application fee for each application for a franchise
a. initial application fee of $5,000 to pay for costs associated with conduct of franchise and Environmental Review Committee
b. franchise component fee in amount determined by the Commission, not to exceed $30,000 per applicant
c. certification component fee of $2,000 per mile of proposed rail line corridor (minimum fee of $60,000 per applicant)
d. application amendment fee if corridor alignment change is proposed by applicant (minimum: $3,000 plus $2,000 for each mile of realignment)
e. certification modification fee: $3,000 if no corridor alignment change is proposed

4. To receive notice of the abandonment of a high speed rail line

5. To execute intergovernmental agreements consistent with prevailing statutory provisoins, including, but not limited to, special benefits or tax-increment financing initiatives

6. To collect an annual franchise fee in an amount sufficient to cover the costs associated with the regulation of the rail line

7. To establish reserve funds for future Commission operations

8. To enter into agreements for the joint development of properties contiguous to and necessary or convenient for the operation of the high speed rail line

9. To review and approve a proposed conveyance lease, or other transfer of property or interest from the franchisee to any other party

FINANCING	FLORIDA	OHIO	PENNSYLVANIA
1. Who may issue bonds to finance the project	the Commission	the Authority	the Authority
2. What may be pledged to secure payment of the bonds (Principal, interest, and redemption premiums, if any)			
a. Commission or Authority revenues	Yes	Yes, if expressly pledged	Yes, including grants and contributions from the federal or state government or any agency or instrumentality thereof
b. Commission or Authority assets	Yes, to the extent allowed by the state constitution		Yes, by a mortgage of any property of the Authority
c. Commission or Authority reserves		Yes, if created for such purposes and expressly pledged, without preference or priority of the first bonds issued, subject only to agreements with bond or noteholders pledging particular revenue	
d. Revenues or property of the state or any municipality thereof			No
e. The full faith and credit of the Commission or Authority	No		
f. The full faith and credit of the State or any of its political subdivisions	No	Yes[1]	No
g. The taxing power of the State	No	No	No

---

[1] It is expressly determined that any bonds of the Authority shall not be deemed to constitute "bonded indebtedness" of the state within the limitations of the Ohio Constitution. It is further expressly provided that excises, fees, fines and forfeitures, and all other revenues of the state after making provision for the payment of all obligations authorized by Article VIII, Section 2 of the Ohio Constitution and obligations issued pursuant to Am. Sub H.B 492 of the 116th General assembly, except revenues derived from motor vehicle registrations and excises upon motor vehicle full, may be pledged and used by the Authority from time to time to pay debt service charges on its bonds with the annual consent of the controlling Board provided that five votes have been cast in favor of the pledge or use of such revenues.

FINANCING	FLORIDA	OHIO	PENNSYLVANIA
3. Tax status of the bonds			
a. The bonds, the transfer thereof, and the income therefrom, including any profit made on the sale thereof, are free from state taxation.		Yes	Yes
b. The Commission is authorized to take action to provide that interest on the bonds be exempt from federal income tax	Yes		
4. Are bonds negotiable instruments	Yes	Yes	Yes
5. Terms of the bonds	determined by the Commission	determined by the Authority[2/]	determined by the Authority
6. The Bonds may be sold at			
a. Public sale	Yes	Yes	Yes
b. Negotiated sale	Yes[3]		Yes[3]
c. Private sale		Yes[4]	Yes[4]

[2] The date of maturity, in case of any note or any renewal thereof, shall not be more than five years from the date of issue of the original note, and in case of any bond, not more than fifty years from the date of issue.

[3] If the Commission or Authority determines by official action at a public meeting that a negotiated sale of the bonds is in the best interest of the agency, or in the event an offer of an issue of bonds at public sale produces no bid, or in the event all bids received are rejected, the agency may negotiate for the sale of bonds with the underwriter(s) designated by the agency. In the official action authorizing the negotiated sale, the agency shall state the reasons for the negotiated sale, including, but not limited to, characteristics of the bond issue and prevailing market conditions. In the event the agency decides to negotiate for a sale of the bonds, the managing underwriter, financial consultant or advisor shall provide the agency with a disclosure statement prior to the award of the bonds.

[4] If bonds are sold at private sale, the Authority may publish notice of the execution of the contract of sale of the bonds in a newspaper of general circulation in Columbus (if Ohio) or Harrisburg (if Pennsylvania). Once notice is published, no action to contest the validity of such bonds or notes at private sale may be brought after the fifteenth day following the pbulication of notice.

PLANS FOR THE PROPOSED SYSTEM	FLORIDA	OHIO	PENNSYLVANIA
<u>Ohio and Pennsylvania</u>: The state agency is required to prepare a plan for the construction and operation of the high speed intensity rail passenger system			
<u>Florida</u>: Applicants for the rail service franchise submit plans for the system			
<u>The plan shall include the following</u>:			
a. the route alignment of the proposed system	X	X	X
b. the proposed technology	X	X	X
c. the size, nature and scope of the proposed system	X	X	X
d. the sources of public and private revenue needed to finance the system	X	X	X
e. the projected ability of all revenue sources to meet both the capital and operating fund requirements of the proposed system		X	X
f. the construction, operation and management plan for the system including a timetable for construction and the proposed location and number of necessary transit stations		X	X
g. the likelihood that state-based corporations will be used to manufacture or supply components of the proposed system		X	
h. the likelihood that additional or subsidiary development will be generated	X	X	
i. the extent to which the proposed system will create an additional or reduced demand for sources of energy	X	X	
j. the extent to which the high speed rail line will create or alleviate environmental problems	X		
k. the amount of pedestrian or vehicular traffic likely to be generated	X		
l. the number of persons likely to be residents, employees, or riders	X		
m. the unique qualities of particular areas of the state	X		
n. the impact of the rail line on the demands for infrastructure provided by local government	X		
o. the effects of the rail line on the fiscal base of local government	X		
p. the extent to which the proposed rail line will be consistent with local government comprehensive plans, zoning ordinances, and nonprocedural requirements of agencies	X		
q. any changes in the law necessary to implement the proposed system		X	
r. the proposed system's impact on the economy of the state and on the economic and other public policies of the state		X