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16. Abstract The Houston ITS Priority Corridor is one of four corridors selected by the U.S. Department of Transportation to showcase Intelligent Transportation Systems applications. The Texas Transportation Institute assisted the coalition of four local governments, comprised of the Texas Department of Transportation, Metropolitan Transit Authority (METRO), Harris County, and City of Houston, along with the Houston-Galveston Area Council (local MPO) in developing the Houston ITS Priority Corridor Program Plan. This report documents development of the 20-year Houston ITS Priority Corridor Plan. The Plan provides a 20-year vision for the Houston ITS Priority Corridor, with specific deployment projects identified for the initial 10-year period, totaling an estimated cost of \$43,143,750. Implementation of the individual projects will be lead by the four local transportation agencies (i.e., TxDOT, METRO, Harris County, City of Houston) and the Houston-Galveston Area Council.					
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**HOUSTON ITS PRIORITY CORRIDOR
PROGRAM PLAN**

by

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**Research Report 2931-2
Research Study Number 7-2931
Research Study Title: Development of ITS Priority Corridor Program Plan**

**Sponsored by the
Texas Department of Transportation
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**TEXAS TRANSPORTATION INSTITUTE
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IMPLEMENTATION STATEMENT

This report documents the Houston Intelligent Transportation Systems (ITS) Priority Corridor Plan. The Plan is inherently "implementation oriented" and is structured in three implementation time frames: Short Range (1996-2000), Intermediate Range (2001-2005), and Long Range (2006-2015). There are 37 individual deployment projects identified in the Plan. These projects will be implemented by one or more of the local transportation agencies (Texas Department of Transportation, Metropolitan Transit Authority of Harris County, Harris County, City of Houston) or Houston-Galveston Area Council (local MPO). The report outlines a general process for project implementation, with leadership on individual projects assumed by the lead agency for the project.

DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Texas Department of Transportation (TxDOT). This report does not constitute a standard, specification, or regulation. It is not intended for construction, bidding, or permit purposes. The engineer in charge of this project was Merrell E. Goolsby, P.E. #29551.

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Development of the Plan represents a collaborative effort by the Houston ITS Priority Corridor Technical Committee listed in Table 1 of this report, with assistance from TTI. Appreciation is extended to Dr. Douglas Wiersig, Executive Director of the multi-agency Houston TranStar Center and Chair of the Technical Committee, and to Mr. John Gaynor, who serves as TxDOT's Program Manager for the Priority Corridor Program.

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SUMMARY

The U.S. Department of Transportation (USDOT) in 1993 designated Houston as one of four Intelligent Transportation Systems (ITS) Priority Corridors in the United States. The intent of the Priority Corridor Program is to showcase ITS and provide testbeds for demonstrating and evaluating ITS concepts and technologies. The ITS program, including the Priority Corridors Program, was an important element of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA).

Each of the four designated U.S. corridors is to develop an ITS Priority Corridor Program Plan which identifies projects, schedules, priorities, and estimated funding requirements. This report documents the development of the Houston ITS Priority Corridor Program Plan, with emphasis on a 10-year Program of Projects. Development of the Plan was a collaborative effort by the Houston ITS Priority Corridor Technical Committee, with assistance from the Texas Transportation Institute (TTI).

The Plan builds upon the existing and evolving ITS core infrastructure of the Corridor, which includes the freeway and HOV lane Computerized Transportation Management System (CTMS), Electronic Toll Collection System on the Harris County Toll Road System, Automatic Vehicle Identification (AVI) system, Regional Computerized Traffic Signal System (RCTSS), Motorist Assistance Program (MAP), METRO's Smart Bus, and the Houston TranStar Center. This approach provides quicker implementation of programs, since specific, focused projects can be developed which extend and enhance the functionality of the ITS core infrastructure.

The Plan is a twenty-year vision of ITS deployment, structured in three implementation time frames: Short Range (1996-2000), Intermediate Range (2001-2005), and Long Range (2006-2015). The Short Range Plan contains 28 projects with an estimated cost of \$27,543,750. An Immediate Action Program was developed early in the project and incorporated as part of the Short Range Plan to enable programming and implementation

activities to proceed while the Priority Corridor Program Plan was being developed. Deployment is currently underway for the 14 projects of the Immediate Action Program.

The Intermediate Range Plan includes nine additional projects with an estimated cost of \$15,600,000. Thus, the combined ten-year program of projects contained in the Short and Intermediate Range Plans will require an estimated \$43,143,750 to deploy. Deployment flexibility is envisioned for the 10-year period of the Short and Intermediate Range Plans. Individual projects may need to be shifted between the Short Range and Intermediate Range Plans, based upon funding availability, changes in priorities, agency work loads, and deployment status of other projects. The Houston ITS Priority Corridor Plan will be reviewed and updated annually to consider necessary changes in the Plan, including the addition of new projects.

1.0 INTRODUCTION

The U.S. Department of Transportation (USDOT) selected Houston to be one of four Intelligent Transportation Systems (ITS) Priority Corridors. These four corridors will showcase ITS concepts and technologies through implementation of ITS projects directed at improving transportation systems operation. This report documents the Plan for development and implementation of ITS projects in the Houston ITS Priority Corridor. This report describes the corridor characteristics and context, institutional framework, approach to developing the Plan, and delineates a program of ITS projects for implementation over the next ten years.

BACKGROUND OF ITS

Passage of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) introduced a new direction for surface transportation development and operation in the United States. With completion of the Interstate Highway System, ISTEA focuses on multimodal approaches to efficiently utilize existing and upgraded transportation resources to improve safety and reduce congestion. An important element of ISTEA is the creation of an ITS program which will contribute significantly to meeting the goals of ISTEA. ITS uses advanced communications, computer, and surveillance systems to address surface transportation needs.

The USDOT has initiated an aggressive ITS research program aimed at investigating issues related to long-term deployment goals, such as real-time adaptive control strategies. In addition, 71 ITS operational tests were initiated to explore promising ITS concepts. Early deployment planning studies are being conducted in over 70 metropolitan areas to formulate ITS applications. A National ITS System architecture project is being conducted to develop a consensus architecture for ITS deployments.

The overriding concept of ITS is to increase transportation system performance, efficiency, and safety through application of advanced operational and technological

applications. ITS applies advanced and emerging technologies to address the goals adopted for the ITS program, as follows (1):

- Improve the safety of the Nation's surface transportation system;
- Increase the operational efficiency and capacity of the surface transportation system;
- Reduce energy and environmental costs associated with traffic congestion;
- Enhance present and future productivity;
- Enhance the personal mobility and the convenience and comfort of the surface transportation system; and
- Create an environment in which the development and deployment of ITS can flourish.

National ITS Planning

The U.S. Department of Transportation and ITS America developed strategic plans for ITS development in 1992 (2, 3). These plans outline a strategic program to improve surface transportation operations in the United States. These plans focus on the premise that increased safety and efficiency are achieved by improving conventional transportation infrastructure with new control, information, and communications capabilities.

In order to establish a framework for ITS deployment, USDOT and ITS America initiated development of the National ITS Program Plan, published in 1995. The purposes of the National Plan are listed below:

- Promote shared ITS goals;
- Guide ITS investment decisions;
- Encourage coordination;
- Maintain a focus on deployment; and
- Ensure ITS is intermodal.

The National ITS Program Plan will serve as a living document, with annual updates conducted. Similarly, the Houston ITS Priority Corridor Plan will be a living document; updated annually to review progress, direction, and the evolving ITS technology.

ITS User Services

In formulating the ITS program, USDOT developed the concept of "user services" to describe individual ITS tools used by travelers and transportation providers. Table 1 lists the resulting twenty-nine user services, grouped into seven related "bundles." These tools can assist transportation agencies in increasing the efficiency of existing facilities, while fostering attainment of environmental goals.

Table 1. ITS User Services and Bundles

Bundle	User Services
1. Travel and Transportation Management	<ol style="list-style-type: none"> 1. En-Route Driver Information 2. Route Guidance 3. Traveler Services Information 4. Traffic Control 5. Incident Management 6. Emissions Testing and Mitigation
2. Travel Demand Management	<ol style="list-style-type: none"> 1. Pre-Trip Travel Information 2. Ride Matching and Reservation 3. Demand Management and Operations
3. Public Transportation Operations	<ol style="list-style-type: none"> 1. Public Transportation Management 2. En-Route Transit Information 3. Personalized Public Transit 4. Public Travel Security
4. Electronic Payment	<ol style="list-style-type: none"> 1. Electronic Payment Services
5. Commercial Vehicle Operations	<ol style="list-style-type: none"> 1. Commercial Vehicle Electronic Clearance 2. Automated Roadside Safety Inspection 3. On-Board Safety Monitoring 4. Commercial Vehicle Administrative Processes 5. Hazardous Material Incident Response 6. Commercial Fleet Management
6. Emergency Management	<ol style="list-style-type: none"> 1. Emergency Notification and Personal Security 2. Emergency Vehicle Management
7. Advanced Vehicle Control and Safety Systems	<ol style="list-style-type: none"> 1. Longitudinal Collision Avoidance 2. Lateral Collision Avoidance 3. Intersection Collision Avoidance 4. Vision Enhancement for Crash Avoidance 5. Safety Readiness 6. Pre-Crash Restraint Deployment 7. Automated Highway Systems

Source: National Program for Intelligent Transportation Systems, U.S. Department of Transportation, 1995.

Core Infrastructure

FHWA considers implementation of a "core infrastructure" to be a necessary ingredient in deploying traffic management and traveler information services. The core infrastructure establishes a foundation upon which ITS deployment by both the public and private sectors can proceed. Development of the core infrastructure is a near-term (and evolutionary) deployment activity lead by the public sector. FHWA has defined core infrastructure as having seven features (4):

- Regional Multimodal Traveler Information Center;
- Traffic Signal Control System(s);
- Freeway Management System(s);
- Transit Management System(s);
- Incident Management Program;
- Electronic Fare Payment System(s); and
- Electronic Toll Collection System(s).

It can be seen that development of the core infrastructure directly addresses the six ITS goals established in the National Program Plan for ITS. In addition, deployment of the core infrastructure in a "building block" approach provides a rational basis for continued, progressive future ITS deployment.

The Houston area has made significant progress in putting an ITS infrastructure in place. By 1996, a significant portion of the Computerized Transportation Management Systems will be in place, including completion of the Houston TranStar Center. In addition, other ITS infrastructure is being implemented, including a regional computerized traffic signal system, automatic vehicle identification systems on area freeways, and "smart" buses for the Metropolitan Transit Authority's (METRO) transit system.

THE PRIORITY CORRIDOR PROGRAM

ISTEA established the ITS Corridors Program as part of the ITS Act. In April 1993, USDOT designated four priority corridors to become test beds for ITS deployment. The basis for selection of these priority corridors was seven specific criteria.

1. Traffic density (as a measurement of vehicle miles traveled per highway mile) at least 1.5 times the national average for such class of highway.
2. Severe or extreme nonattainment for ozone under the Clean Air Act, as determined by the Administrator of the Environmental Protection Agency.
3. A variety of types of transportation facilities, such as highways, bridges, tunnels, and toll and nontoll facilities.
4. Inability to significantly expand capacity of existing surface transportation facilities.
5. A significant mix of passenger, transit, and commercial motor carrier traffic.
6. Complexity of traffic patterns.
7. Potential contribution to the implementation of the Secretary's plan (National Program Plan for ITS).

The four priority corridors follow:

- Northeast (IH-95) Corridor—Includes a corridor from Maryland to Connecticut, with numerous transportation agencies involved.
- Midwest Corridor—Includes the corridor from Gary, Indiana through Chicago to Milwaukee, Wisconsin.
- Southern California Corridor—Includes IH-10/IH-5 from Los Angeles to San Diego.
- Houston, Texas Corridor—Includes the area surrounding IH-45 and IH-10, essentially including urbanized Greater Houston.

In its designation of the Houston ITS Priority Corridor, FHWA defined the corridor as the area surrounding IH-45 and IH-10. These major urban freeways pass through the Houston area in a north-south and east-west orientation, intersecting near the Central Business District. Local agencies and FHWA consider the corridor to include the Greater Houston area.

THE HOUSTON ITS PRIORITY CORRIDOR

The Federal Highway Administration and the Texas Department of Transportation officially created the Houston Priority Corridor in an ITS Partnership Agreement dated September 8, 1993. The Agreement established initial funding (\$3,105,000 from FHWA and \$776,250 from TxDOT) defining a "work order" process for project implementation and establishing other contractual requirements. The ITS Partnership has been amended twice to supplement initial funding. Amendment 1 increased FHWA funding by \$2.00 million, and Amendment 2 added \$2.25 million. The ITS Partnership Agreement and Amendments are provided in Appendix A.

The Houston Corridor is unique among the other national corridors. Similarly, the Houston ITS Priority Corridor Program Plan is unique, building on previous and in-process ITS infrastructure development. Houston has a longstanding commitment to development of advanced traffic management, incident management, traveler information, electronic toll collection, and public transportation systems. TxDOT developed an operational freeway surveillance and control system in Houston in the mid-1960s. Later research, development, and design by TxDOT and METRO have culminated in the Computerized Transportation Management System (CTMS) which is now under construction on Houston's freeway and HOV lane system. In addition, the Houston TranStar Center (TranStar Center) is under construction and transportation operations and public safety staff of TxDOT, METRO, Harris County, and the City of Houston will occupy the TranStar Center in early 1996.

CORRIDOR ORGANIZATION

The FHWA and TxDOT entered into an ITS Partnership Agreement which established and funded the Houston ITS Priority Corridor Program. The agreement establishes the framework for program development and administration. The agreement also recognizes the importance of involvement of other local implementing agencies in management of the Corridor. TxDOT, Harris County, City of Houston, and METRO entered into a Memorandum of Understanding to manage and implement the Houston ITS Priority Corridor Program. The extensive prior development of ITS infrastructure in the area, the development of Houston TranStar, and the joint Priority Corridor approach demonstrate the commitment of area agencies to ITS deployment in the Houston area.

These four jurisdictions, through their broad geographic boundaries, encompass the majority of the transportation system in the eight-county Houston-Galveston Metropolitan Area. However, other area agencies can become participants or included in project implementation through coordination with participating agencies. This structure provides a workable and flexible organizational setting that allows quick implementation and avoids the cumbersome process of combining a large number of agencies.

The organizational structure for the Houston ITS Priority Corridor Coalition is shown in Figure 1. Top management members of the four coalition agencies comprise the Executive Committee. This committee, which also directs the TranStar Center, has overall management responsibility for the corridor program and its implementation.

The Technical Committee is responsible for the technical direction of the corridor program development, administration, and implementation. This committee developed the Priority Corridor Program Plan and the individual deployment projects. In addition, this committee will guide deployment of these projects. Houston-Galveston Area Council (H-GAC) is a member of the Priority Corridor Technical Committee, and as the Metropolitan Planning Organization for the eight county area that includes Houston and Harris County, H-GAC is committed to ITS and its long-range deployment in order to achieve its goals for areawide

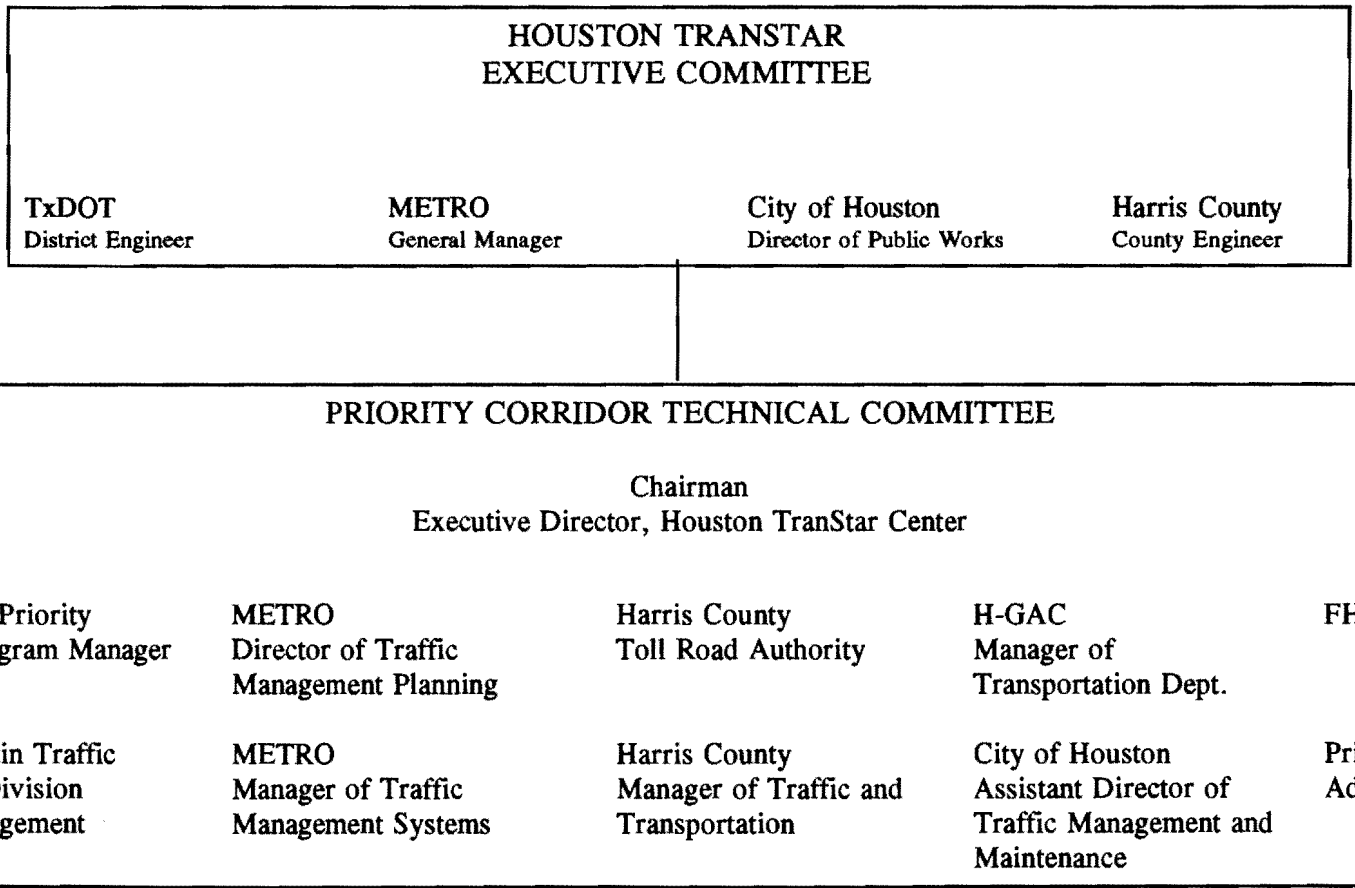
improvements in mobility safety and air quality. H-GAC involvement in the planning and deployment of ITS projects is essential to the success of long-term areawide deployment of ITS. Members of the Executive Committee are also members of the Transportation Policy Committee of H-GAC. This provides another loop back to the areawide approach to project deployment and the intent of Priority Corridor projects to be a forerunner to larger-scale ITS projects that are part of the Area's long-range transportation plan.

ITS CORRIDOR PLAN

Each of the four designated corridors is to develop a vision of ITS applications to be undertaken in the corridor. The ITS Corridor Program Plan for each corridor will identify projects, schedules, priorities, and estimated funding requirements. ITS Corridor Program Plans are to be consistent with national needs and the National Program Plan. The Plan brings together ITS goals (e.g., improved mobility, increased safety, air quality concerns), a coordinated organizational approach, the concept of core infrastructure development, and the unique needs of the Houston area to define a series of specific ITS deployment projects. With the primary focus of the ITS Corridor Plan on definition and implementation of ITS projects, the primary audience for this Plan is decision-makers of local, state, and federal transportation agencies.

This Houston ITS Priority Corridor Plan outlines the process of plan development, the 20-year vision for ITS deployment, and identification of specific deployment projects for a Short Range Plan (1996-2000) and an Intermediate Range Plan (2001-2005). An earlier interim report delineates an Immediate Action Program for the Corridor (5), which is a part of the Short Range Plan. The Immediate Action Program enabled programming and implementation activities to proceed on the fourteen priority projects defined in the Immediate Action Program while corridor planning was in progress.

Figure 1. Organization of Houston ITS Priority Corridor Coalition



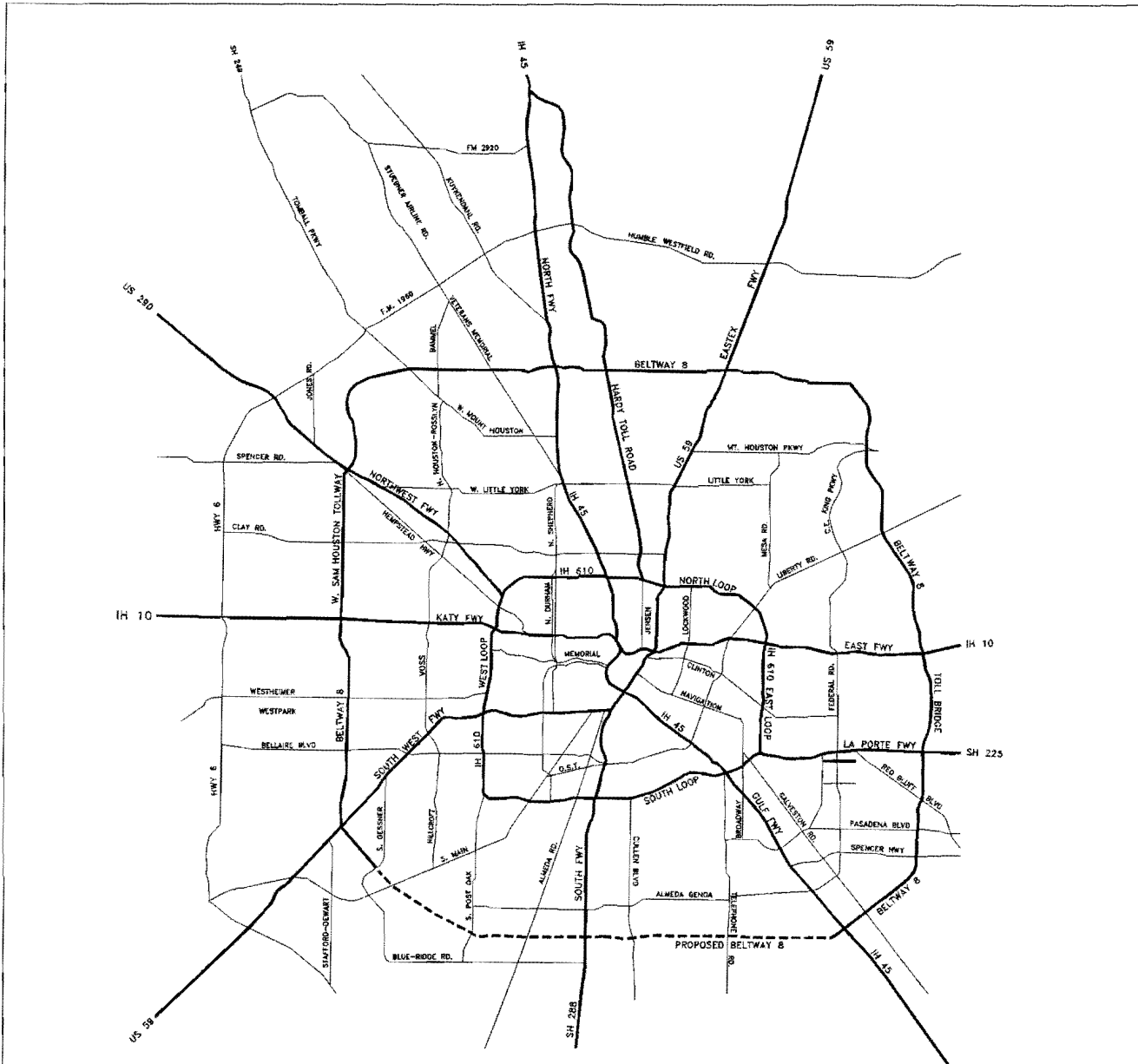
2.0 CONTEXT FOR ITS DEPLOYMENT

The eight county Houston-Galveston Area is the tenth most populous urban area in the United States. The Area's population was 3.7 million persons in 1990 and is predicted to be 5.1 million persons by the year 2010. This population growth will result in disproportionate increases in future transportation demand.

The Houston area has historically addressed growing transportation demands by increasing the capacity of the street and freeway system and expanding transit service into unserved areas. In recent years, it has become increasingly difficult to extend or increase the capacity of streets and freeways, and efforts have been made to reduce tripmaking, increase carpooling and transit ridership, and apply other "transportation management" measures to reduce the impact of increasing travel demands. ITS provides an opportunity to utilize new technologies and concepts to better manage Houston's traffic and transit systems. This chapter reviews existing transportation resources, future growth, and the ITS resources which are currently being developed by area transportation agencies.



EXISTING SYSTEMS

Existing corridor characteristics were discussed in the Immediate Action Program report, and roadway and the public transportation system will be briefly reviewed here. An extensive freeway and arterial street system serves the Houston Area, as illustrated in Figure 2. Seven radial freeways (from the CBD), two circumferential loops, and an evolving 135 kilometer (84 mile) toll road system comprise the freeway system. The 480 kilometer (300 mile) freeway system provides regional coverage and service to major trip generators.



HOUSTON AREA FREEWAYS AND PRINCIPAL ARTERIALS

LEGEND

-  FREEWAYS
-  PRINCIPAL ARTERIALS

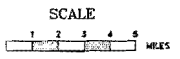


FIGURE 2

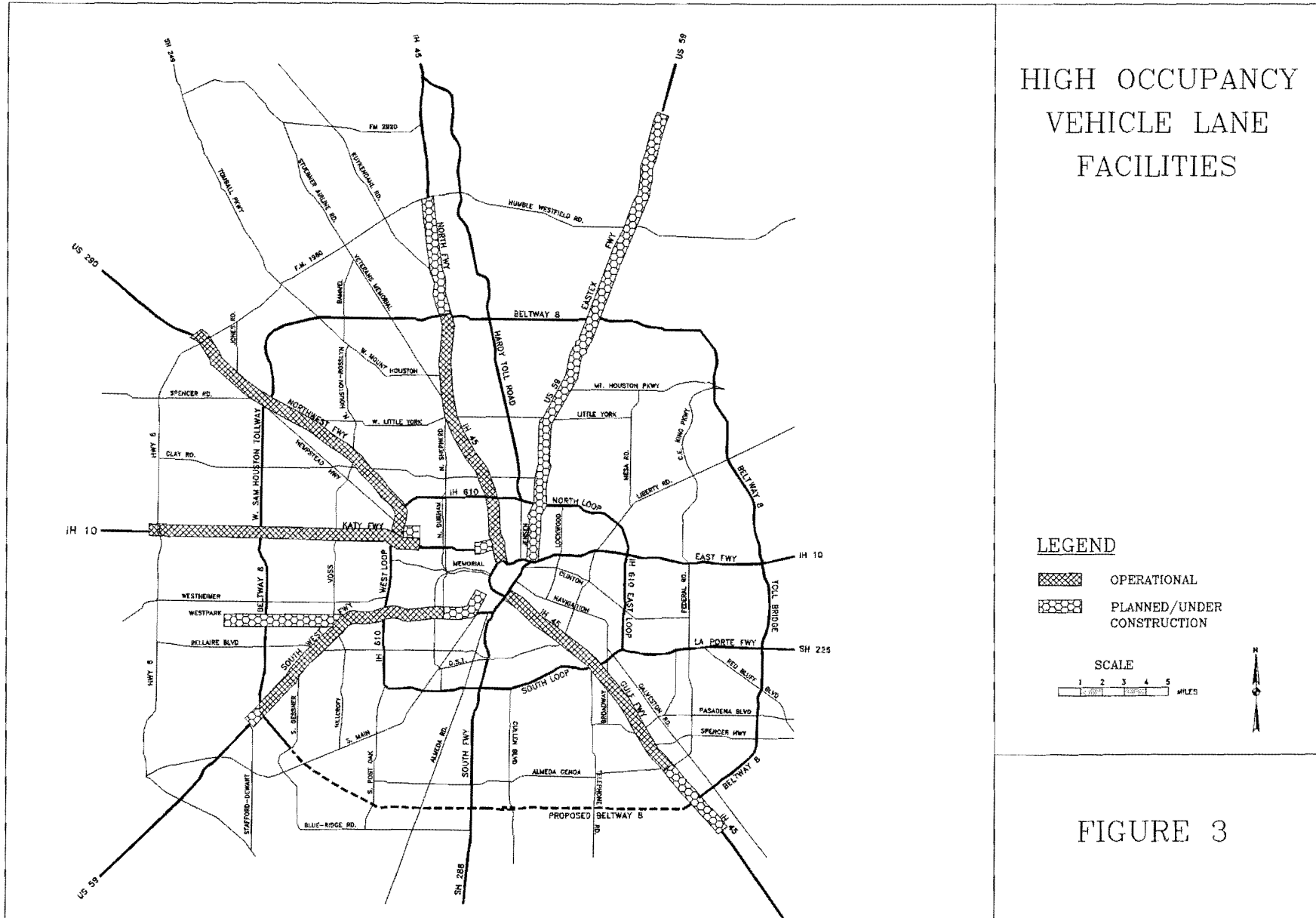
METRO and TxDOT have developed an extensive system of HOV lanes, located primarily in freeway medians. The HOV system currently has 103 kilometers (64 miles) of one-lane, reversible HOV lanes in operation, 34 kilometers (21 miles) under construction, and 31 additional kilometers (19 miles) planned, as shown in Figure 3. METRO operates 840 peak period bus trips daily on the HOV lane system, carrying over 24,000 persons. Total daily person trips made on the HOV lane system exceeds 77,000.

METRO operates a fleet of over 1,200 transit coaches on 3,220 kilometers (2,000 miles) of routes in its 3,315 square kilometer (1,280 square mile) service area. Annual ridership for the METRO system exceeds 60 million passenger trips. Much of METRO's fixed route service is oriented to the Central Business District, although METRO also operates crosstown, circulator, and shuttle routes. METRO's paratransit service, METROLIFT, serves the mobility needs of the disabled. The 98-van METROLIFT System makes more than 700,000 passenger trips annually. Thirteen transit centers (four regional, nine neighborhood) provide opportunities for transferring between routes, as well as serving major activity centers.

METRO operates commuter service from a number of park and ride lots to serve buses, carpools, and vanpools. Many of the park and ride lots have direct access to HOV lanes located in freeway medians. There are currently 22 park and ride lots in operation with 9 planned for future development. Existing park and ride facilities have over 24,000 parking spaces, with an average daily usage of over 10,000 vehicles. In addition, TxDOT provides three park and pool lots on the IH-10 Katy Freeway, which have over 1,100 spaces.

FUTURE AREA GROWTH

The Houston Area is expected to experience steady growth in population and employment through the year 2010, the horizon year for the Metropolitan Transportation Plan (MTP) (6). This section provides a review of forecast growth developed in the MTP.



Population and Employment

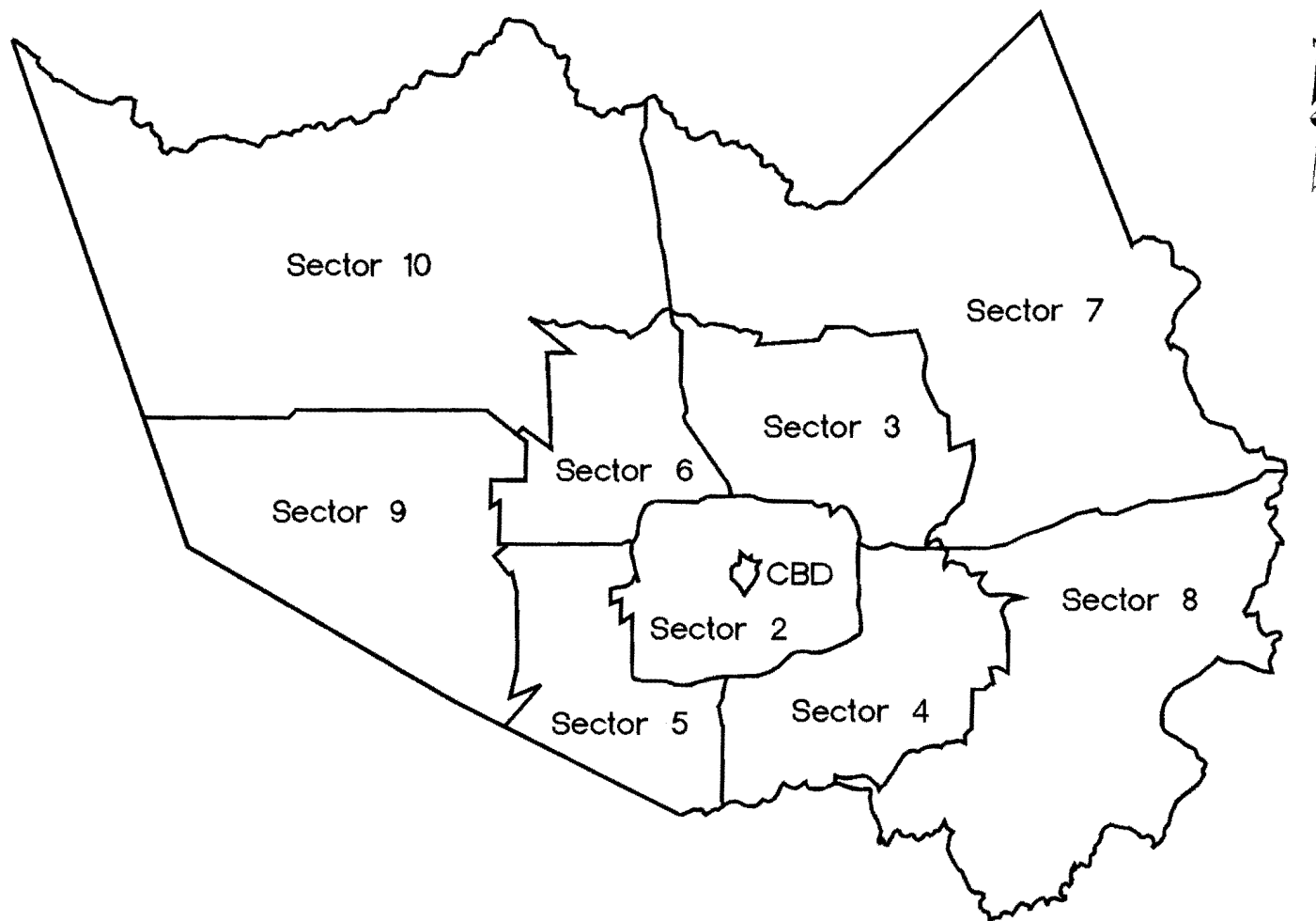
From 1980 to 1990, the eight-county region's population grew at a rate slightly higher (19.6 percent) than that of the State of Texas as a whole (19.4 percent). Growth in the region was bolstered somewhat during this time period by expansion in the oil and gas industry which faltered in the mid-1980s. The forecast rate of growth in the population is less during the 1990s, attaining a level of growth of 16.0 percent between 1990 and the year 2000. Between 2000 and 2010, population is expected to increase 17.2 percent.

For planning purposes, H-GAC has divided Harris County into 10 sectors based on 1980 census tract geography (see Figure 4). While population in Harris County is projected to increase 31.6 percent between 1990 and 2010, there are some sectors which will be contributing more than others to this overall increase, as shown in Table 2. Projected population growth in Harris County follows trends established for the region as a whole with Sectors 9 and 10 (outer southwest and outer northwest, respectively) projected to grow more than 60 percent during the 20 year period from 1990 to 2010. Sectors 7 (outer northeast) and 8 (outer southeast) are also projected to experience significant increases in population (around 40 percent), reflecting the preference of area residents for single-family housing—most of which is being built in suburban areas.

Employment in the eight county region is forecast to increase from 1.9 million persons in 1990 to 2.8 million in 2010 (an increase of over 47 percent). The increase in Harris County employment is forecast to be 43 percent, with forecast employment by sector also listed in Table 2. Highest percent employment increases are in the outlying sectors (similar to population increases) with percent changes of over 80 percent in the outer southwest and outer northwest sectors.

Forecast growth and development follows trends of the last three decades. This trend is toward outward expansion (suburbanization) accompanied by infill development and redevelopment in established areas. The trend toward dispersion of employment into growth areas and development of outlying activity/employment centers is expected to continue.

FIGURE 4
PLANNING SECTORS FOR HARRIS COUNTY



Source: Access 2010: 1994 Update, Metropolitan Transportation Plan, Houston Galveston Area Council. October, 1994.

Table 2. Population and Employment Forecasts for Harris County

Sector Number/Name	Actual 1990	Forecast 2010	Percent Change
<u>Population</u>			
1 CBD	7,005	8,881	26.78
2 Inside 610	428,439	462,148	7.87
3 Inner Northeast	262,958	305,677	16.25
4 Inner Southeast	314,584	350,428	11.39
5 Inner Southwest	372,476	455,541	22.30
6 Inner Northwest	291,223	387,719	33.13
7 Outer Northeast	236,523	342,940	44.99
8 Outer Southeast	273,350	379,844	38.96
9 Outer Southwest	330,260	529,530	60.34
10 Outer Northwest	301,474	485,161	60.93
County Total	2,818,292	3,707,869	31.56
<u>Employment</u>			
1 CBD	137,530	193,765	40.89
2 Inside 610	451,965	598,212	32.36
3 Inner Northeast	94,004	125,346	33.34
4 Inner Southeast	108,730	143,409	31.89
5 Inner Southwest	206,482	276,216	33.77
6 Inner Northwest	148,740	203,509	36.82
7 Outer Northeast	80,852	130,004	60.79
8 Outer Southeast	121,761	185,856	52.64
9 Outer Southwest	131,043	238,767	82.21
10 Outer Northwest	92,360	159,380	72.56
County Total	1,573,467	2,254,464	43.28

Source: Access 2010: 1994 Update, Metropolitan Transportation Plan, Houston-Galveston Area Council, October 1994.

Both population and employment projections indicate that the northwest and southwest areas will experience higher growth rates than other areas.

H-GAC conducted an analysis of the existing and future freeway and arterial system as reported in the MTP. H-GAC conducted a detailed analysis of individual freeway and arterial street segments, relating per-lane average daily traffic volumes to generalized daily lane capacity.

Table 3 (existing conditions) and Table 4 (year 2010 conditions) summarize the results of these analyses by sectors in Harris County. The 2010 projections reflect implementation of the recommended transportation plan (Action Plan).

For existing conditions, the inner southeast, inner southwest, and inner northwest sectors (Sectors 4, 5, and 6) have the highest percent deficient freeway lanes. The highest existing deficient thoroughfare lanes are in the inner southwest, inner northwest, southwest, and northwest (Sectors 5, 6, 9, and 10). For future freeway conditions, the inner southwest, inner northwest, and the CBD sector (Sectors 5, 6, CBD) have the highest deficiencies, while future thoroughfare deficiencies are highest in the southwest, inner southwest, and inner northwest sectors (Sectors 9, 5, 6). On a geographic basis, the percent of deficient roadway sections tend to be higher in the western half of the county and outside IH-610 for both existing and forecast conditions.

CURRENT ITS DEVELOPMENT

ITS infrastructure development in Houston began in the early 1980s as TxDOT, and later the other local agencies, initiated planning and design of the freeway and HOV lane management system. This element, referred to as the Computerized Transportation Management System (CTMS), is currently under construction. In recent years, other ITS deployment has been undertaken, including electronic toll collection on 80 kilometers (50 miles) of toll roads, Motorist Assistance Program (MAP), Automatic Vehicle Identification (AVI), Regional Computerized Traffic Signal Systems (RCTSS), and the METRO "smart bus."

Computerized Transportation Management System

The CTMS is being implemented on all area freeways with construction currently underway on IH-45 (North), IH-45 (South), U.S. 290 (Northwest), IH-10 (West), U.S. 59 (Southwest), and IH-610. Estimated total cost of the CTMS is approximately \$180 million, with over \$93 million completed or under construction. Construction for the remaining \$87 million is scheduled for contracting by 1998.

Table 3. Existing Roadway Deficiencies in Harris County

Sector Number	Lane Kilometers (Miles)		Percent Deficient Lane Kilometers (Miles) by Sector					
	Freeways	Thoroughfares	FREEWAYS ⁽¹⁾			THOROUGHFARES ⁽²⁾		
			Heavy Congestion	Severe Congestion	Total	Heavy Congestion	Severe Congestion	Total
1. Central Business District	74.2 (46.1)	279.8 (173.8)	5	46	51	1	0	1
2. Inside IH-610	801.0 (497.5)	2,110.2 (1,310.7)	7	33	40	5	1	6
3. Inner Northeast	198.4 (123.2)	1,004.0 (623.6)	0	34	34	4	1	5
4. Inner Southeast	313.3 (194.6)	1,092.7 (678.7)	25	47	72	4	0	4
5. Inner Southwest	393.0 (244.1)	1,290.7 (801.7)	11	57	68	21	11	32
6. Inner Northwest	330.1 (205.0)	1,074.0 (667.1)	14	55	69	9	4	13
7. Northeast	159.6 (99.1)	1,327.6 (824.6)	9	33	42	6	3	9
8. Southeast	374.8 (232.8)	1,495.4 (928.8)	6	12	18	3	2	5
9. Southwest	275.8 (171.3)	1,368.3 (849.9)	20	23	43	10	6	16
10. Northwest	212.4 (131.9)	1,604.4 (996.5)	5	23	28	6	11	17
County Total	3,132.7 (1,945.8)	12,808.4 (7,955.5)	11	36	47	7	4	11

⁽¹⁾ Heavy Freeway Congestion = 17,500 - 20,000 vehicles/lane/day.

Severe Congestion = More than 20,000 vehicles/lane/day.

⁽²⁾ Heavy Thoroughfare Congestion = 7,000 - 8,500 vehicles/lane/day.

Severe Thoroughfare Congestion = More than 8,500 vehicles/lane/day.

Source: Based on 1990 data from *Access 2010: 1994 Update, Metropolitan Transportation Plan*, Houston-Galveston Area Council, October 1994.

Table 4. Roadway Deficiencies in Harris County for the 2010 Action Plan

Sector Number	Lane Kilometers (Miles)		Percent Deficient Lane Kilometers (Miles) by Sector					
	Freeways	Thoroughfares	FREEWAYS ⁽¹⁾			THOROUGHFARES ⁽²⁾		
			Heavy Congestion	Severe Congestion	Total	Heavy Congestion	Severe Congestion	Total
1. Central Business District	72.8 (45.2)	278.5 (173.0)	9	54	63	1	1	2
2. Inside IH-610	965.8 (599.9)	2,186.5 (1,358.1)	21	37	58	7	3	10
3. Inner Northeast	502.0 (311.8)	1,338.9 (831.6)	11	12	23	2	1	3
4. Inner Southeast	467.4 (290.3)	1,460.3 (907.0)	14	44	58	2	1	3
5. Inner Southwest	559.8 (347.7)	1,689.4 (1,049.3)	15	55	70	19	17	36
6. Inner Northwest	374.0 (232.3)	1,403.8 (871.9)	22	51	73	12	6	18
7. Northeast	413.1 (256.6)	1,671.0 (1,037.9)	3	4	7	2	3	5
8. Southeast	599.6 (372.4)	1,752.0 (1,088.2)	11	16	27	7	4	11
9. Southwest	361.0 (224.2)	1,677.8 (1,042.1)	22	43	65	14	21	35
10. Northwest	674.6 (419.0)	2,162.1 (1,342.9)	7	5	12	6	10	16
County Total	4,990.0 (3,099.4)	15,620.2 (9,702.0)	14	29	43	8	7	15

⁽¹⁾ Heavy Freeway Congestion = 17,500 - 20,000 vehicles/lane/day.

Severe Congestion = More than 20,000 vehicles/lane/day.

⁽²⁾ Heavy Thoroughfare Congestion = 7,000 - 8,500 vehicles/lane/day.

Severe Thoroughfare Congestion = More than 8,500 vehicles/lane/day.

Source: *Access 2010: 1994 Update, Metropolitan Transportation Plan, Houston-Galveston Area Council, October 1994.*

CTMS provides extensive surveillance and control capabilities through the following elements:

- Loop and video imaging vehicle detectors (speed, occupancy, flow);
- Closed circuit television;
- Ramp metering;
- Changeable message signs;
- Highway advisory radio;
- Intersection signal control;
- Fiber optic communications backbone; and
- Traffic management center.

Motorist Assistance Program

The MAP program was initiated in 1989 to provide patrol and motorist assistance for freeway incidents. The MAP program is a joint undertaking of TxDOT, METRO, and the Harris County Sheriff's Department. Private sector support is provided by the Houston Automobile Dealers Association and Houston Cellular Telephone Company.

The MAP program currently operates a 13-van fleet, sixteen hours per weekday. During an average month the MAP patrols 50,000 vehicle miles and provides assistance for 2,200 incidents. Over 80 percent of the freeway incidents are detected by these moving patrols. As the various computerized traffic monitoring projects become operational, more incidents will be detected by the TranStar Center and the patrols will be dispatched to the incident scenes. The MAP has been a successful incident management strategy, resulting in an estimated benefit/cost ratio of approximately twenty to one.

Automatic Vehicle Identification

AVI systems are operational on 238 kilometers (147.7 miles) of the freeway system and 57 kilometers (35.6 miles) of HOV lanes, at a cost of \$5.3 million. The system provides

current travel time/travel speed data for freeway segments to the Interim Transportation Management Center (ITMC). ITMC staff are provided graphic AVI data in map and tabular form for their use in freeway management. Freeway and HOV lane travel speeds are also provided to individual commuters through the Internet World Wide Web as traveler information, as well as to the local traffic reporting services who provide information to the broadcast media. This AVI data will be an integral part of the real-time database for the Houston TranStar Center and will also be used in the Smart Commuter ITS operational test. The system will be expanded in the future to include 363 kilometers (227 miles) of freeway and 112 kilometers (70 miles) of HOV lanes.

METRO Smart Bus

METRO is implementing a "smart bus" system which will include an advanced radio communications system (ARCS) for voice and data transmission between all METRO vehicles and METRO facilities. An on-board computer will serve the data and information processing needs for on-board systems and digital communications. A contract for the ARCS, which will provide the "platform" for all Smart Bus applications on approximately 1,700 METRO vehicles, was awarded in late 1995 for \$22 million.

Another key component of the system is the automatic vehicle location (AVL) system. Other on-bus components will be modular and can be implemented in stages, including silent alarm, automated fare collection, annunciator, traffic signal preemption, engine and fuel monitoring, and other components. The entire Smart Bus system will be completed in 1998.

Regional Computerized Traffic Signal System

The goal of RCTSS, which is being undertaken by METRO, the City of Houston, Harris County, TxDOT, Federal Transit Administration (FTA), and FHWA, is to modernize and coordinate control of 2,800 traffic signals in the Houston Area. The RCTSS will be able to handle day-to-day variations in traffic as well as adjust arterial and frontage road signal timings in response to traffic diverted by freeway incidents. It will also permit emergency

vehicle preemption and transit priority handling at individual intersections. Central control computers and operations staff who will be responsible for system management and control will be located in the TranStar Center.

Initial implementation includes 1,300 signalized intersections serving transit routes. Funding will be provided by METRO (\$60 million) and FTA (\$60 million). Planning for RCTSS was initiated in 1990 and the multi-phase program is to be completed in stages by the year 2000.

Houston TranStar Center

The Houston TranStar Center will be completed and occupied in early 1996. It will be the focal point for ITS operations (e.g., CTMS, RCTSS, AVI, MAP, transit operations) and will house staff of the local transportation agencies. The TranStar Center will have 52,000 square feet of space with an estimated cost of \$11.4 million. The TranStar Center includes a large central control room, communications and equipment rooms, briefing room, and three floors of offices for staff.

It is apparent that the Houston ITS Priority Corridor begins with a substantial ITS foundation in place or under development. The institutional framework and relationships are in place, including Houston TranStar.

3.0 PLAN DEVELOPMENT

The previous chapter reviewed characteristics of the corridor area and the status of key ITS core infrastructure development. One of the strengths of the Houston corridor is the extensive previous and ongoing development of ITS infrastructure. This infrastructure development and the interagency teamwork that is in place were important factors in shaping the Priority Corridor Program Plan.

APPROACH TO PLAN DEVELOPMENT

The approach to development of the Plan was to build on existing strengths and extend the current ITS development program. The Plan consists of a program of specific, focused projects which deploy elements of ITS core infrastructure. Given the ever-changing state of new technologies, the Plan's development approach was to assess consumer needs relative to the availability of technology and ease of implementation. The Plan should be flexible and evolutionary, as the ITS program continuously evolves and emphasis shifts occur on a national level.

Goals for the Plan

A previous chapter listed goals for the national ITS program, and these goals are an integral part of the Houston Priority Corridor Plan. In addition to the national goals, the following goals guided development of the Houston Priority Corridor Program Plan.

- Develop a Corridor Plan which is consistent with the National mission and goals, while addressing specific needs and opportunities of the Houston area.
- Develop an Immediate Action Program of individual projects oriented to capitalize on existing resources, thus enabling quick deployment.
- Create a long-term technical and institutional environment that encourages innovation and deployment of evolving ITS technologies and applications.

- Foster institutional relationships among TxDOT, METRO, Harris County, City of Houston, H-GAC, Harris County Toll Road Authority, other local governments, and the private sector that facilitate and speed implementation of the Plan and individual projects.
- Deploy individual projects in a timely, efficient, and effective manner.

Framework of the Plan

The Houston Priority Corridor Program Plan is a twenty-year plan divided into three time frames: Short Range (1996-2000), Intermediate Range (2001-2005), and Long Range (2006-2015). Thus, the plan provides a vision of ITS development through approximately the Year 2015 with specific projects identified for the initial ten years (1996-2005). Several guiding principles are considered to be important in developing the Plan, as well as during its period of deployment:

- Projects based on consumer market needs;
- Employment of the "building block" approach;
- Cooperative public and private sector efforts; and
- Technical and institutional flexibility in project deployment.

The framework of the Plan and the vision and general direction selected for the three time periods are as follows.

Short Range Plan (1996-2000)

Program emphasis during the initial years is on addressing the areas of indicated need and highest potential for success. The Short Range Plan also includes those projects previously identified in an interim report as the Immediate Action Program. The Short Range Plan will focus on the following:

- Develop core infrastructure/systems—build on and extend infrastructure development currently underway;
- Test concepts, technologies, and user acceptance in deployed projects;
- Focus on short time frame projects; and
- Flexibility in deployment projects, permitting modification of projects (or even termination) based on deployment and evaluation results.

Intermediate Range Plan (2001-2005)

The second time period will provide the opportunity to build on the experience of the initial Houston projects and successful ITS deployment projects in other areas. Features of this five-year period include the following:

- Identify additional core infrastructure needed for areawide deployment of proven concepts and technologies;
- Pivot from successful Houston ITS projects and experience to expand the deployment areawide or to modify and enhance capabilities;
- Deploy in the Houston Priority Corridor those ITS projects from other locations (U.S. and abroad) which have been successful or show promise to demonstrate their success in a different environment; and
- Develop an adaptive approach to take advantage of new or evolving technologies.

It is apparent that portions of the second five year program are adaptive, and specific projects are to be defined in detail as ITS experience and technology develop over time.

Long Range Plan (2006-2015)

The Plan identifies specific projects for the first ten years of the Corridor Program Plan (although a flexible approach to their deployment is encouraged). We do not consider identification of specific projects for the second ten years to be useful, since it is difficult to

envision the specific scope and nature of potential ITS tools to be available after the year 2005. Instead, the Plan describes a broad vision for ITS deployment for the second ten years.

PROJECT PLANNING PROCESS

The Priority Corridor Technical Committee and TTI staff used a project development process which systematically developed and evaluated potential concepts and projects for inclusion in the Plan. The Committee met bi-weekly for several months to consider issues, assess candidate projects, and finalize the Plan. The following outline highlights this process.

Project Selection

- Development of needs and project concepts by agencies and Technical Committee.
- Project descriptions developed by members of Technical Committee and local agencies.
- Assessment of Candidate Projects by Technical Committee—Highest rated-readily implementable projects have higher priority.
- Technical Committee develops recommended program.
- Steering Committee approves program.

Evaluation Considerations

Evaluation, selection, and prioritization of Priority Corridor Projects were generally qualitative, comparative assessments of candidate projects based on the following considerations:

- Core infrastructure/system development;
- Relationship to other planned projects (building blocks) and on-going projects;
- Impact on traffic congestion/air quality;

- Ease of implementation/project complexity;
- Cost of project;
- Compatibility with National ITS Program Plan;
- Number of persons/vehicles affected;
- Relative potential impact (greater need/higher pay-off);
- High potential for success;
- Distribution of projects among User Services/among agencies;
- FHWA input; and
- Needs of high demand/major activity centers.

RECOMMENDED PROGRAM PLAN

The recommended plan includes identification of 37 projects for deployment during the initial ten years of the program with 28 projects in the first five years. Table 5 lists the proposed projects by core infrastructure feature. It can be seen that projects are recommended in each core infrastructure category with participation by each of the four operational agencies and H-GAC. The Appendix provides descriptions of the recommended projects. Estimated total deployment cost for the 37 projects is \$43,143,750 in 1995 dollars.

Elements of each project and related estimated costs include the following:

- Project development and design;
- Construction;
- System integration (as applicable);
- System operation (as applicable); and
- Project evaluation.

The Plan is discussed for the three time frames in the following sections.

**Table 5. Program of Projects Grouped by
Core Infrastructure Features**

Category/Project	Lead Agency	Estimated Cost
0. <u>Administrative/Planning</u>		
0-1 Development of ITS Priority Corridor Program Plan	TxDOT	\$ 400,000
0-2 Public Information/Program Administration (Years 1-2)	TxDOT	200,000
0-3 Public Information/Project Management (Years 3-5)	TxDOT	800,000
0-4 ITS Technology for Data Collection and Transportation Planning	H-GAC	500,000
1. <u>Regional Multimodal Traveler Information Center</u>		
1-1 Real-Time Information Kiosks	TxDOT	750,000
1-2 On-Vehicle Navigation/Information Applications	TxDOT	400,000
1-3 Monitoring and Information Systems for Environmental Conditions	TxDOT	500,000
1-4 Expansion of Traveler Information Kiosks	TxDOT/METRO	1,100,000
1-5 Using AVI Technology for Best Route Selection in Clear Lake City	City of Houston	1,400,000
1-6 Using Advanced AVI Technology for In-Vehicle Traveler Information	TxDOT	700,000
1-7 Using ITS Technology for Airport Area Traffic Management and Traveler Information	TxDOT/City	1,700,000
2. <u>Traffic Signal Control Systems</u>		
2-1 Changeable Lane Assignment System (CLAS) on Frontage Roads	TxDOT	750,000
2-2 Changeable Lane Assignment System (CLAS) at Arterial Intersections	Harris County	250,000
2-3 Providing Core Infrastructure Through the Use of Fiber Optic Cable in North and Northwest Corridors	Harris County	2,100,000
2-4 Use of AVI for Traffic Signal System Control	TxDOT/METRO	900,000
2-5 Expansion of CLAS Applications	TxDOT	1,400,000

**Table 5. Program of Projects Grouped by
Core Infrastructure Features**

Category/Project	Lead Agency	Estimated Cost
3. <u>Freeway Management Systems</u>		
3-1 Monitoring Traffic and Transit Conditions and Incident Detection with AVI (Phase 4)	TxDOT	1,831,250
3-2 Truck Monitoring and Warning Systems for Freeway to Freeway Connections	TxDOT	220,000 ⁽¹⁾
3-3 Integrated Corridor Transportation Management and Traveler Information System	TxDOT/METRO	1,862,500
3-4 Air Quality Monitoring to Evaluate Traffic/Air Characteristics	TxDOT/H-GAC	600,000
3-5 Coordinated Ramp Metering and Intersection Traffic Signal Control	TxDOT	400,000
3-6 AVI System Expansion	TxDOT	1,600,000
4. <u>Transit Management Systems</u>		
4-1 Integrating Transit into Houston TranStar Center	METRO	400,000
4-2 En-Route Transit Information System	METRO	1,950,000
4-3 ITS-Based Scheduling, Reservation, Dispatching of Personalized Public Transit	METRO	4,600,000
4-4 Public Travel Security	METRO	3,300,000
5. <u>Incident Management Program</u>		
5-1 CCTV Surveillance System Lease for Astrodome Area	TxDOT	480,000
5-2 Railroad Grade Crossing Monitoring System	TxDOT	500,000
5-3 Automatic Vehicle Locator System for Incident Management	TxDOT	100,000
5-4 Washburn Tunnel Traffic Management and Information System	Harris County	950,000
5-5 Incident Management and Traveler Information for Critical Roadway Links	TxDOT	2,950,000
5-6 Automatic Traffic Management in High Water Areas Through Use of ITS Technologies	Harris County	3,750,000

Table 5. Program of Projects Grouped by Core Infrastructure Features		
Category/Project	Lead Agency	Estimated Cost
5-7 Automated Incident Management Strategies and Support Systems	TxDOT	1,600,000
5-8 Accident Information Reporting and Retrieving with ITS Police Vehicles	TxDOT	500,000
5-9 North Freeway/Hardy Toll Road Incident Management Through Toll Adjustment	TxDOT/HCTRA	900,000
6/7. <u>Electronic Fare Payment/Toll Collection</u>		
6/7-1 Use of AVI in Priority Lane Pricing	METRO/TxDOT	500,000
6/7-2 ITS in Parking System Management	City of Houston	300,000
Estimated Program Cost		\$43,143,750

⁽¹⁾ Estimated cost does not include private sector participation of \$80,000.

Short Range Plan (1996-2000)

The initial five years of the program plan are the most critical since they are nearest in time to being implemented, but also because they encompass the period (at least initial period) of the federal ISTEA and ITS programs. Implementation has already begun on projects contained in the Immediate Action Program, which comprises the first fourteen projects of the Short Range Plan.

Table 6 summarizes the recommended projects of the Short Range Plan and estimated schedule for project initiation. Estimated project costs and funding requirements by funding fiscal year are summarized in Table 7. Estimated total cost to implement the 28 projects is \$27,543,750. Appendix B contains detailed project descriptions for the Short Range Plan.

The first 14 projects of the Short Range Plan comprise the Immediate Action Program, which was developed early in this planning program to enable implementation activities to proceed concurrent with the development of the full Priority Corridor Plan. The Immediate Action Program is estimated to cost \$9,193,750 and would utilize designated FHWA funding for the Houston Priority Corridor for Fiscal Years 1993, 1994, and 1995. Implementation has begun on many of these projects.

Intermediate Range Plan (2001-2005)

Table 8 summarizes the Intermediate Range Plan and includes nine projects with an estimated implementation cost of \$15,600,000. It is envisioned that projects in this time frame would be more flexible in terms of scope, cost, and schedule. With annual updates scheduled for the Plan, projects in this five-year period will become more firmly defined as the time for scheduled implementation approaches. It is also expected that additional projects will be added to this part of the Plan during periodic updates as ITS deployment experience and technology mature.

Table 6. Short Range Program (1996-2000) and Deployment Schedule

Project	Year of Project Initiation ⁽¹⁾				
	1996	1997	1998	1999	2000
5-1 CCTV Surveillance System Lease for Astrodome Area ⁽²⁾	X ⁽³⁾				
0-1 Development of ITS Priority Corridor Program Plan ⁽²⁾	X ⁽³⁾				
3-1 Monitoring Traffic and Transit Conditions and Incident Detection with AVI (Phase 4) ⁽²⁾	X				
2-1 Changeable Lane Assignment System (CLAS) on Frontage Roads ⁽²⁾	X				
0-2 Public Information/Program Administration (Years 1 and 2) ⁽²⁾	X				
3-2 Truck Monitoring and Warning Systems for Freeway to Freeway Connections ⁽²⁾	X				
1-1 Real-Time Information Kiosks ⁽²⁾	X				
5-2 Railroad Grade Crossing Monitoring System ⁽²⁾	X				
5-3 Automatic Vehicle Locator System for Incident Management ⁽²⁾	X				
1-2 On-Vehicle Navigation/Information Applications ⁽²⁾	X				
1-3 Monitoring and Information System for Environmental Conditions ⁽²⁾	X				
2-2 Changeable Lane Assignment System (CLAS) at Arterial Intersections ⁽²⁾		X			
3-3 Integrated Corridor Transportation Management and Traveler Information System ⁽²⁾		X			
5-4 Washburn Tunnel Traffic Management and Information System ⁽²⁾		X			
5-5 Incident Management and Traveler Information for Critical Roadway Links		X			
0-4 ITS Technology for Data Collection and Transportation Planning		X			
4-1 Integrating Transit into Houston TranStar Center			X		
5-6 Automatic Traffic Management in High Water Areas Through Use of ITS Technologies			X		
0-3 Public Information/Project Management (Years 3-5)			X		
4-2 En-Route Transit Information System				X	
6/7-2 ITS in Parking System Management				X	
2-3 Providing Core Infrastructure Through the Use of Fiber Optic Cable in North and Northwest Corridors				X	
5-7 Automated Incident Management Strategies and Support Systems				X	
3-4 Air Quality Monitoring to Evaluate Traffic/Air Characteristics					X
3-5 Coordinated Ramp Metering and Intersection Traffic Signal Control					X
2-4 Use of AVI for Traffic Signal System Control					X
3-6 AVI System Expansion					X
5-8 Accident Information Reporting and Retrieving with ITS Police Vehicles					X

⁽¹⁾ Year listed is the estimated fiscal year of initial deployment. Most project durations are multi-year.

⁽²⁾ These projects are included in the Immediate Action Program and are currently funded and are being implemented.

⁽³⁾ Project begun prior to FY 1996.

Table 7. Short Range Program (1996-2000) Funding Requirements					
Project	Estimated Cost by Funding Fiscal Year ⁽¹⁾				
	FY 93	FY 94	FY 95	FY 96	FY 97
5-1 CCTV Surveillance System Lease for Astrodome Area ⁽²⁾ —Work Order #1	\$ 480,000				
0-1 Development of ITS Priority Corridor Program Plan ⁽²⁾ —Work Order #2	400,000				
3-1 Monitoring Traffic and Transit Conditions and Incident Detection with AVI (Phase 4) ⁽²⁾ —Work Order #3	1,831,250				
2-1 Changeable Lane Assignment System (CLAS) on Frontage Roads ⁽²⁾ —Work Order #4	750,000				
0-2 Public Information/Program Administration (Years 1 and 2) ⁽²⁾ —Work Order #5	200,000				
3-2 Truck Monitoring and Warning Systems for Freeway to Freeway Connections ⁽²⁾ —Work Order #6	220,000				
1-1 Real-Time Information Kiosks ⁽²⁾ —Work Order #7		\$ 750,000			
5-2 Railroad Grade Crossing Monitoring System ⁽²⁾ —Work Order #8		500,000			
5-3 Automatic Vehicle Locator System for Incident Management ⁽²⁾ —Work Order #9		100,000			
1-2 On-Vehicle Navigation/Information Applications ⁽²⁾ —Work Order #10		400,000			
1-3 Monitoring and Information System for Environmental Conditions ⁽²⁾ —Work Order #11		500,000			
2-2 Changeable Lane Assignment System (CLAS) at Arterial Intersections ⁽²⁾ —Work Order #12		250,000			
3-3 Integrated Corridor Transportation Management and Traveler Information System ⁽²⁾ —Work Order #13			\$1,862,500		
5-4 Washburn Tunnel Traffic Management and Information System ⁽²⁾ —Work Order #14			950,000		

Table 7. Short Range Program (1996-2000) Funding Requirements					
Project	Estimated Cost by Funding Fiscal Year ⁽¹⁾				
	FY 93	FY 94	FY 95	FY 96	FY 97
5-5 Incident Management and Traveler Information for Critical Roadway Links				\$2,950,000	
0-4 ITS Technology for Data Collection and Transportation Planning				500,000	
4-1 Integrating Transit into Houston TranStar Center				400,000	
5-6 Automatic Traffic Management in High Water Areas Through Use of ITS Technologies				3,750,000	
0-3 Public Information/Project Management (Years 3-5)				800,000	
4-2 En-Route Transit Information System				1,950,000	
6/7-2 ITS in Parking System Management				300,000	
2-3 Providing Core Infrastructure Through the Use of Fiber Optic Cable in North and Northwest Corridors					\$ 2,100,000
5-7 Automated Incident Management Strategies and Support Systems					1,600,000
3-4 Air Quality Monitoring to Evaluate Traffic/Air Characteristics					600,000
3-5 Coordinated Ramp Metering and Intersection Traffic Signal Control					400,000
2-4 Use of AVI for Traffic Signal System Control					900,000
3-6 AVI System Expansion					1,600,000
5-8 Accident Information Reporting and Retrieving with ITS Police Vehicles					500,000
Annual Total Cost	\$3,881,250	\$2,500,000	\$2,812,500	\$10,650,000	\$7,700,000
Estimated USDOT Share	\$3,105,000	\$2,000,000	\$2,250,000	\$ 8,520,000	\$6,160,000
Estimated State/Local Share	\$ 776,250	\$ 500,000	\$ 562,500	\$ 2,130,000	\$1,540,000
Short Range Program Total Cost	\$27,543,750				

⁽¹⁾ Project cost is listed for the funding fiscal year.

⁽²⁾ These projects are included in the Immediate Action Program and are currently funded and are being implemented.

Table 8. Intermediate Range Program (2001-2005)		
Category/Project	Lead Agency	Estimated Cost⁽¹⁾
5-9 North Freeway/Hardy Toll Road Incident Management Through Toll Adjustment	TxDOT/HCTRA	\$ 900,000
4-4 Public Travel Security	METRO	3,300,000
1-4 Expansion of Traveler Information Kiosks	TxDOT/METRO	1,100,000
2-5 Expansion of CLAS Applications	TxDOT	1,400,000
4-3 ITS-Based Scheduling, Reservation, Dispatching of Personalized Public Transit	METRO	4,600,000
6/7-1 Use of AVI in Priority Lane Pricing	METRO/TxDOT	500,000
1-5 Using AVI Technology for Best Route Selection in Clear Lake City	City of Houston	1,400,000
1-6 Using Advanced AVI Technology for In-Vehicle Traveler Information	TxDOT	700,000
1-7 Using ITS Technology for Airport Area Traffic Management and Traveler Information	TxDOT/City	1,700,000
Estimated Five-Year Program Cost		\$15,600,000

NOTE: Projects are listed in general order of deployment priority.

⁽¹⁾ Funding for the Intermediate Range Program is anticipated to be beyond FY 97.

Program Funding Needs

The ten-year program of projects contained in the Short and Intermediate Range Plans will require a total estimated investment of more than \$43 million. Estimated costs, funding authorizations, and additional funding needs are summarized in Table 9.

Current funding authorizations total \$9,193,750 (\$7,355,000 from USDOT and \$1,838,750 from local agencies), which is sufficient to fund the Immediate Action Program portion of the Short Range Plan. These projects utilize the earmarked ITS funding for the Houston Priority Corridor for Fiscal Years 1993, 1994, and 1995. An additional \$33,950,000 will be needed to complete the projects of the Short Range and Intermediate Range Plans.

Table 9. Summary of Funding Needs			
	USDOT	State/Local	Total
<u>Estimated Ten Year Program Costs</u>			
Short Range Plan			
Immediate Action Program (14 Projects)			\$ 9,193,750 ⁽¹⁾
Other Short Range Projects			18,350,000
Intermediate Range Plan			<u>15,600,000</u>
Total Program Cost			\$43,143,750
<u>Current Funding Authorizations</u>			
FY 1993	\$ 3,105,000	\$ 776,250	\$ 3,881,250
FY 1994	2,000,000	500,000	2,500,000
FY 1995	<u>2,250,000</u>	<u>562,500</u>	<u>2,812,500</u>
Total Authorized	\$ 7,355,000	\$1,838,750	\$ 9,193,750 ⁽¹⁾
<u>Estimated Additional Funding Needs</u>			
FY 1996	\$ 8,520,000	\$2,130,000	\$10,650,000
FY 1997	6,160,000	1,540,000	7,700,000
FY 1998 and Beyond	<u>12,480,000</u>	<u>3,120,000</u>	<u>15,600,000</u>
Total Additional Funding Needed	\$27,160,000	\$6,790,000	\$33,950,000

⁽¹⁾ Currently authorized funding is sufficient for deployment of the Immediate Action Program only.

Long Range Vision (2006-2015)

The broad vision for ITS for the Long Range Plan is a technology which has matured to support wider and more effective deployment of transportation management and traveler information systems. ITS technology (e.g., communications, electronics, computers, control) will advance to the point that applications and tools will be available in ten years that now are not even conceived. Communication devices thought to reside at home, in the office, or in the vehicle may be replaced with one portable communications device. In addition, experience and direction will be available from nationwide/industrywide efforts to develop commercial vehicle systems, advanced vehicle control, and automated highway systems.

The vision for the Houston ITS Priority Corridor also includes the following:

- Control center based traffic management/traveler information systems with expanded capabilities and a broader, multi-county area of control;
- Traveler information which is timely, accurate, and widely available;

- Pervasive communications which are increasingly available to travelers in-vehicle, at roadside, and in home or workplace;
- Availability of a single, portable, personal communication device which may be used instead of fixed devices at home, office, or vehicle;
- Closely integrated systems for data, communications, transportation management, toll/fare collection, traveler information transit system, and other ITS systems;
- Rapid incident detection and effective response through finely-tuned institutional cooperation; and
- Areawide traffic signal systems and freeway control systems which are traffic responsive and effective in optimizing traffic operations.

4.0 IMPLEMENTATION OF THE PLAN

This section discusses deployment of the Plan and the continuing planning activities needed over the period of the Priority Corridor Program. The Plan represents the current consensus and desired direction for ITS project deployment in the Corridor. Implementation of these projects, particularly those in the Immediate Action Program, should proceed quickly in order to respond to the National ITS program schedule.

Involved local agencies and FHWA consider the Plan to be a "living document" which is subject to periodic update and revision. Some projects will be modified or even eliminated as further study and detailed project development proceeds. It is also expected that ITS technologies will expand over time, providing additional project deployment opportunities. Therefore, the Plan is considered flexible in terms of project makeup, scope, cost, and schedule. The Plan will serve as a roadmap for ITS deployment, but recognize that there are alternate routes and opportunities along the "road."

PROJECT DEPLOYMENT

The action elements of the Plan are a series of projects which extend ITS core infrastructure. Many of the projects are related, creating a building block approach to the incremental development of transportation management and traveler information systems. However, from the standpoint of deployment, each project is developed and implemented separately. The process of project deployment is similar for all projects as discussed in the following sections.

Project Organization

The Houston Priority Corridor Program is staffed by a Program Manager and a Program Administrator, who are responsible for overall management of the program. They will coordinate program development with the Priority Corridor Technical and Executive Committees. At the individual project level, a "lead agency" (currently one of the four

operating agencies or H-GAC) will be responsible for project management and (typically) providing the local funding match. Projects will be deployed primarily through the designated lead agency and its project manager. Although there will be a lead agency, other local agencies, as well as private sector partners, will often be involved on a specific project. One of the goals of the National ITS Program is to utilize public/private partnerships to the extent possible in developing individual projects.

Implementation Process

Although each project will have its own unique characteristics, most will track the following steps.

Project Approval and Funding

Each project will need to have the necessary administrative processing, approvals, and funding commitment before proceeding with planning, design, and implementation. Approvals will typically include the lead agency, TxDOT, and FHWA, with typical local funding by the lead agency.

Project Development and Design

Additional planning and concept development of the project will be necessary to define the project sufficiently for design and construction. This Plan has developed projects only to the concept level, and further study and refinement will be needed. This refinement leads directly to project design and development of construction plans and specifications.

Construction

Typically, the construction or installation of necessary hardware or facilities will follow the lead agency's bidding/contracting procedures with the lead agency responsible for contract

administration and project acceptance. However, all federal regulations for procurement must be followed, including record-keeping and audit requirements.

System Integration

Many of the projects have components which will need to be integrated with the TranStar Center and/or other systems. If system integration is not a part of the construction/installation scope for a specific project, it may be necessary to contract with an independent systems integration firm to integrate the project into the Houston TranStar Center.

Operation/Maintenance

Operation and maintenance of developed ITS infrastructure have been reorganized as potential weak links in the ITS program and should not be overlooked. These activities will be the responsibility of the local agencies and sufficient staffing and funding should be provided to assure the continuing functionality of the complex ITS systems deployed. Actual operation and maintenance activities could be performed in-house or through contracts with qualified private firms. Several of the projects are structured as lease systems with a private supplier responsible for all operations and maintenance.

Project Evaluation

The FHWA requires that each project undergo an evaluation study. These evaluation studies will provide the documentation and independent assessment needed for technology sharing with the worldwide ITS community. These evaluation studies should be contracted with research organizations or qualified consultants. Evaluation studies should generally include assessing the achievement of project objectives, quantitative evaluation of measures of effectiveness, and the potential for widespread future deployment.

FUNDING OF PRIORITY CORRIDOR PROJECTS

Federal funding of ITS programs is provided through Title VI (Research) of the ISTEA. A portion of the ITS funds is specified for Priority Corridors (approximately \$43 million per year). Although Houston must compete nationwide for general ITS funding, the competition for Priority Corridor funding is among only the four designated corridors. ITS funding provided for each corridor will not be automatic, but based on the site's ITS Corridor Program Plan and USDOT funding decisions. The maximum federal funding for priority corridor projects is 80 percent of project costs, with minimum local funding of 20 percent required.

The FHWA has approved a total of \$7,355,000 in combined FY 1993-FY 1995 Priority Corridor funding for the Houston Priority Corridor. This funding is sufficient to support the Immediate Action Program, estimated to cost \$9,193,750 (including local matching funds).

The recommended Short Range Plan for the Houston Priority Corridor has an estimated cost of \$27,543,750, which indicates a need for federal Priority Corridor funding at a significantly higher rate than that which has previously been authorized. If this funding is not sufficient, it will be necessary to find other funding (local, state, or other federal program funding) or delay deployment of a portion of the Plan.

It is significant that a number of local ITS projects have been funded using other ISTEA program funds and/or local funding. The CTMS program, with over \$93 million in completed work or projects under construction, was funded primarily from the Congestion Mitigation and Air Quality (CMAQ) program of ISTEA. Similarly, significant funding (\$60 million) for the RCTSS is being provided by the Federal Transit Administration through Section 3 funding grants. The AVI system was initiated using 100 percent state funds. It can be seen that the limited ITS Priority Corridor funding has been leveraged for greater overall program effectiveness by using other federal funding categories and local funds.

CONTINUING PLANNING AND COORDINATION

The Plan was developed as a living document which should be monitored on a continuing basis and updated annually. In addition, the Plan should be coordinated with other agencies and areawide transportation planning efforts.

Coordination with Regional Planning Process

The ITS Priority Corridors Program is a part of the Research Program (Title VI) of ISTEA, which is not normally subject to inclusion in the regional or statewide transportation plans and TIPs. However, some Priority Corridor projects which involve construction could fall under requirements to be included in the planning process. Depending upon project funding decisions by the local agencies and USDOT, other federal funding programs may be utilized for deployment of ITS projects included in the Plan, and these projects should be included in the MTP/TIP process.

The Technical Committee contains a representative of H-GAC, who can serve to foster coordination of ITS projects with other area plans and implementation activities. This cooperation is also important to the process of transitioning ITS concepts and applications into the overall transportation planning process of the area and incorporating individual projects and programs into the long range Metropolitan Transportation Plan (MTP) and Transportation Improvement Program (TIP).

Coordination with Regional ITS Strategic Plan

H-GAC and other local agencies are currently developing, with the assistance of TTI, a regional ITS Strategic Plan. The scope and coverage of the regional plan and the Priority Corridor Plan are different, but there is a need to coordinate the two plans to assure compatibility and consistency. The regional plan will stress the development of region-wide core infrastructure and the deployment of proven technologies in Advanced Traveler Information and Advanced Traffic Management Systems. The regional plan includes an

approach to encourage participation of the private sector in ITS deployment, which utilizes a "model process" for identifying needs, opportunities, and mechanisms for private sector involvement. It is an objective of the ITS program to maximize opportunities for the creation of public/private partnerships. Involvement of the private sector should be sought in the deployment of Priority Corridor projects, particularly in traveler information, route guidance/navigation, and commercial vehicle operations.

Continuing Planning Activities

The planning for the Houston Priority Corridor is a continuing process with the development of this Plan the beginning point. The Plan should be monitored as projects are undertaken and updated annually. Feedback from early project deployments will provide input for development of later projects. Texas Transportation Institute will assist in these activities as part of its contract for development of the Program Plan. Following are recommended planning activities:

- Project deployment planning and coordination, including regular Technical Committee meetings to review and assess status of project development.
- Monitoring of national ITS activities and other Priority Corridors.
- Annual assessment and update of Plan.
 - meetings with agencies and Technical Committee;
 - assess status of project deployments;
 - review needs and resources;
 - develop new/revised projects; and
 - develop scope, schedule, and cost for projects.
- Documentation.
 - current status of Plan deployment;
 - recommended Plan revisions; and
 - annual corridor Plan update.

5.0 CONCLUSION

This report documents the development of a project-oriented ten-year plan and vision for ITS development in the Houston Priority Corridor. This Plan is unique and builds on previous and in-process ITS core infrastructure development by TxDOT, USDOT, and local transportation agencies. This Plan was developed by the Technical Committee of the multi-agency consortium comprised of TxDOT, METRO, City of Houston, Harris County, and the Houston-Galveston Area Council. These agencies are currently implementing this Plan, as the 14 projects of the Immediate Action Plan have been approved and are in the planning, design, or construction stage.

6.0 REFERENCES

1. *National Program Plan for Intelligent Transportation Systems*, Final Draft, U.S. Department of Transportation, 1995.
2. *Department of Transportation's IVHS Strategic Plan: Report to Congress*, December 1991.
3. *Strategic Plan for Intelligent Vehicle-Highway Systems in the United States*, IVHS America, 1992.
4. *Core ITS Infrastructure Elements for Metropolitan Area ATMS/ATIS Deployment*, Working Paper by Federal Highway Administration, USDOT, Version 1.7, March 22, 1995.
5. *Immediate Action Program Houston ITS Priority Corridor Program Plan*, Research Report 2931-1, Texas Transportation Institute, October 1995.
6. *Access 2010: 1994 Update, Metropolitan Transportation Plan*, Houston-Galveston Area Council, October 1994.

APPENDIX A. ITS PARTNERSHIP AGREEMENT

HOUSTON, TEXAS PRIORITY IVHS CORRIDOR

IVHS Partnership Agreement

between

The Federal Highway Administration

and

The Texas Department of Transportation

Project No. IVH-9348(305)

The purpose of this Agreement is to award a grant of Federal assistance to the State of Texas (State) for certain specific Intelligent Vehicle Highway Systems (IVHS) activities relating to the Houston IVHS Priority Corridor, and to maximize the involvement of the State and other project participants in the IVHS program, as authorized by P. L. 102-240, Sections 6053(a), 6055(d), and 6056(a) (23 USC 307 note). The parties to this Agreement are independent contracting parties, and nothing in this Agreement shall be deemed to create a business partnership for purposes of sharing profits and losses.

1. Estimated Cost

The State shall be reimbursed for allowable costs incurred in the performance of work under this IVHS Partnership Agreement in an amount not to exceed \$3,105,000 in Federal IVHS funds. This amount shall be matched at an 80/20 (Federal/non-Federal) ratio, resulting in a matching share valued at not less than \$776,250. Reimbursement for costs incurred will follow regular Federal-aid billing and payment procedures.

2. Responsibilities of the State

In conformance with approved Work Orders (see paragraph 3 below), the State shall perform, or cause to be performed, the following:

a. Development and Maintenance of the Houston IVHS Priority Corridor Program Plan

Management of the Houston IVHS Priority Corridor is envisioned as the responsibility of key State and local officials (principally TxDOT, the City of Houston, Houston METRO, Harris County, and the Houston-Galveston Area Council) in cooperation with US DOT participants. These parties have been working together over a number of years to develop a full-featured

transportation management concept which will serve needs such as provision of traveller information, public transportation and ridesharing, and commercial vehicle-oriented elements. The IVHS Priority Corridor Program Plan will document the comprehensive vision for IVHS applications within the Corridor, specifically addressing what IVHS elements will be showcased. Projects, schedules, priorities, and estimated funding needs should be identified. The Priority Corridor Program Plan should break the IVHS vision for the area into realizable segments or incremental capability levels for implementation, each building on the previous segment or capability level. An extended series of projects/tests should be described in the Priority Corridor Program Plan, which would make the Corridor an IVHS test bed and showcase, with sustained deployment of IVHS services and technologies as they become available. The Priority Corridor Program Plan should be closely coordinated with the needs of the national IVHS program as defined in the US DOT Strategic Plan and the National IVHS Program Plan.

Eligible activities included under this item are expected to include overall project management, coordination, and public information / public relations efforts associated with the IVHS Priority Corridor in Houston. In addition, establishment of a systems integration function is envisioned. This would provide for oversight and technical assistance for coordination, communications, and integration of the various IVHS-related projects in the Corridor.

b. Development and Implementation of Selected High-Priority IVHS Operational Tests

The Houston IVHS Priority Corridor officials have identified several IVHS operational test projects having early implementation opportunities. The IVHS Priority Corridor Program Plan discussed above will identify additional opportunities. Specific work tasks, schedules, budget, evaluation goals, and responsibilities will be defined in Work Orders proposed by the State and approved by the FHWA. Beyond currently anticipated opportunities, additional high-priority operational test proposals may be proposed and approved under this IVHS Partnership Agreement, as funding limitations allow.

3. Work Orders

Individual activities agreed to be performed by the State or caused to be performed by the State shall be incorporated in Work Orders. Each Work Order will specify the work and goals to be accomplished and the type and amount of assistance to be provided by the FHWA. Each Work Order must include a description of the work (addressing clearly the technical, institutional, and evaluation goals and objectives to

be included), completion dates for the work, and the signatures of the FHWA Division Administrator and an authorized representative of the State indicating acceptance of the Work Order prior to initiation of any work described therein. Issuance of a Work Order does not constitute a promise, either expressed or implied, that the FHWA will issue further Work Orders or provide additional assistance pursuant to this IVHS Partnership Agreement.

4. Period of Performance, Modifications, and Project Completion

The period of performance and completion date for each task or activity is as stated in the Work Orders. It is expected that this IVHS Partnership Agreement will remain in effect at least through fiscal year 1997, which is the last year of IVHS funding authority currently provided to FHWA under P. L. 102-240 (the Intermodal Surface Transportation Assistance Act [ISTEA] of 1991). Modifications of this Agreement may be made, but no promise, either expressed or implied, is made at this time that FHWA will provide additional funding beyond that specified in paragraph 1. The US DOT will make decisions regarding additional funds under this Agreement (per Section 6056 of the ISTEA; "IVHS Corridors Program") based upon the overall quality of the Corridor's technical and institutional program and the degree to which the proposed activities contribute to achieving the National IVHS Program Plan.

A final project evaluation report shall be delivered within six months from the date of completion of the final Work Order and shall constitute completion of the project. The evaluation report is to include a review of the work completed and a discussion of the technical and institutional issues encountered in completing the project.

5. US DOT Participation

The FHWA and the Federal Transit Administration (FTA) shall be considered full participants in the project. As such, these agencies shall be a voting member of appropriate project management committees as they develop. The FHWA and the FTA shall be provided the opportunity for membership on all sub-committees, working groups, task forces, and other such groups related to the project. The FHWA and the FTA will provide names, addresses, and phone numbers of committee representatives to the State Program Manager as required.

6. Project Documentation and Reporting Requirements

Copies of all project reports, correspondence, meeting announcements, and other documents shall be supplied directly to the FHWA. In addition, brief monthly progress statements and quarterly reports summarizing work performed, significant events, expenditures, and progress of work shall be supplied to the FHWA. The FHWA will provide names and addresses of specific contacts to receive these documents.

7. Evaluation Work Plans

The funding provided by this IVHS Partnership Agreement for individual operational test efforts shall include an appropriate amount for a comprehensive evaluation. An evaluation work plan for each operational test shall be developed and submitted for FHWA approval, normally within eight (8) weeks after the approval of the Work Order which initiates the test. Each evaluation plan shall discuss the scope and method of evaluation for each funded activity. The plan(s) should also assess the opportunity to collect data that can answer questions of both local and national significance. The FHWA will participate in the evaluation of the work performed. As appropriate, the final report for each evaluation shall include a section prepared by legal counsel reporting and analyzing the disposition of significant legal issues, including contract, liability, privacy, regulatory and intellectual property issues. In addition, analysis of all significant institutional issues which are addressed during the project, along with discussion of how they were resolved, shall be part of the evaluation report.

8. Programmatic Changes

The State must obtain the prior approval of the FHWA whenever any significant change is anticipated. These include, but are not limited to:

- a. Any revision of the scope, goals or objectives of the consultant contract or related activities (regardless of whether there is an associated budget revision requiring prior approval); and
- b. Changes in key personnel, program manager, or prime contractor.

9. Intellectual Property

Intellectual property consists of copyrights, patents, and any other form of intellectual property rights covering any data bases, software, inventions, training manuals, systems design or other proprietary information in any form or medium.

Copyrights. The FHWA reserves a royalty-free, nonexclusive and irrevocable license to reproduce, publish or otherwise use, and to authorize others to use, for Federal Government purposes:

- (a) The copyright in any works developed under this Agreement, or under a subgrant or contract under this Agreement; and
- (b) Any rights of copyright to which the State, its subgrantee or contractor purchases ownership with Federal financial assistance provided by this Agreement.

Patents. Rights to inventions made under this Agreement shall be determined in accordance with 37 C.F.R. Part 401. The standard patent rights clause at 37 C.F.R. §401.14, as modified below, is hereby incorporated by reference.

- (a) The terms "to be performed by a small business firm or domestic non-profit organization" shall be deleted from paragraph (g)(1) of the clause;
- (b) Paragraphs (g)(2) and (g)(3) of the clause shall be deleted; and
- (c) paragraph (1) of the clause, entitled "Communications" shall read as follows:
"(1) Communications. All notifications required by this clause shall be submitted to the FHWA Division office.

10. Costs

The State shall limit its progress claims and final claims to those costs incurred in accordance with this IVHS Partnership Agreement, and shall submit its final claim within 90 days after the project is completed.

11. Additional Requirements

The State shall comply with all applicable laws, regulations and FHWA requirements, including but not limited to 49 C.F.R. Parts 18, 20, 21, 27, and 29, and the assurances in OMB SF 424B attached hereto as Appendix A.

12. Certification Regarding Lobbying

The State makes the certification regarding lobbying which is attached hereto as Appendix B.

13. Termination

The State shall notify FHWA immediately of any intent to terminate this IVHS Partnership Agreement.

14. Effective Date

This IVHS Partnership Agreement is effective upon execution by both parties.

Texas Department of Transportation

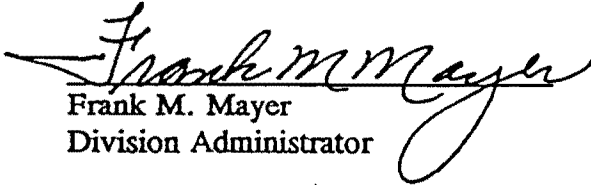
Executed for the Executive Director and approved by the Texas Transportation Commission under the authority of Minute Order No. 82513 and Administration Order 15-88, for the purpose and effect of activating and/or carrying out the orders, established policies or work programs heretofore approved by the Texas Transportation Commission under the authority of Minute Order No. 100002.



Roger G. Welsch
Associate Executive Director, Field Operations

Date 9-7-93

Federal Highway Administration



Frank M. Mayer
Division Administrator

Date 9/8/93

ATTACHMENT 1

Houston, Texas, IVHS Priority Corridor
 Amendment 1 to the
 IVHS Partnership Agreement
 between
 The Federal Highway Administration
 and
 The Texas Department of Transportation
 Project No. IVH-9348(305)

The Federal Highway Administration (FHWA) hereby provides the State of Texas Department of Transportation (State) with additional Federal assistance funding to support the activities being undertaken as part of the Houston, Texas, Priority IVHS Corridor Program pursuant to 23 USC 307. This document hereby amends sections 1 and 2 of the Intelligent Vehicle Highway Systems (IVHS) Partnership Agreement signed between FHWA and the State on May 11, 1993. All other sections of the original IVHS Partnership Agreement remain in full force.

1. Estimated Cost. The State shall be reimbursed for allowable costs incurred in the performance of work under this IVHS Partnership Agreement in an amount not to exceed \$2,000,000 in Federal IVHS funds. Funding under this Partnership Agreement is available as follows:

	\$ 3,105,000 - FY 1993
	\$ 2,000,000 - FY 1994 (This Amendment)
Total	<u>\$ 5,105,000</u>

This total amount shall be matched at a minimum 80/20 (Federal/non-Federal) ratio, resulting in a minimum matching share valued at \$ 1,276,250. Reimbursement for costs incurred will follow regular Federal-aid billing and payment procedures.


2. Responsibilities of the State. In conformance with approved Work Orders (see paragraph 3), the State shall perform, or cause to be performed the activities described in the February 23, 1994 letter from Mr. Gary K. Trietsch to FHWA Technology Assistance Engineer C. L. Chambers. In addition to on-going IVHS activities initiated utilizing funds provided in FY 1993, efforts planned by the State and tentatively supported by this Agreement for FY 1994 include projects concerning:
- a. Advanced Traveler Information for Commercial Vehicles
 - b. Dynamic Lane Assignment Controls on Frontage Roads (A System for Traffic Diversion Within the Priority Corridor)

- c. Automatic Vehicle Locator (AVL) System for Incident Management
- d. On-Vehicle Navigation/Information Applications
- e. Monitoring and Information Systems for Environmental Conditions

This amendment is effective upon execution by both parties.

Texas Department
of Transportation

Federal Highway Administration


 Title: Assistant Executive Director
 Field Operations

Division Administrator

Date July 1, 1994

Date _____

Houston, Texas, ITS Priority Corridor

Amendment 2 to the

ITS Partnership Agreement
between

The Federal Highway Administration
and

The Texas Department of Transportation

Project No. IVH-9348(305)

The Federal Highway Administration (FHWA) hereby provides the State of Texas Department of Transportation (State) with additional Federal assistance funding to support the activities being undertaken as part of the Houston, Texas, Priority Intelligent Transportation Systems (ITS) Corridor Program pursuant to 23 U.S.C. 307. This document hereby replaces section 1 and amends section 2 of the ITS Partnership Agreement executed between FHWA and the State on May 11, 1993, and amended on July 6, 1994. All other sections of the original ITS Partnership Agreement and Amendment 1 remain in full force.

Section 1 is replaced in its entirety by the following:

1. Estimated Cost. The State shall be reimbursed for allowable costs incurred in the performance of work under this IVHS Partnership Agreement in an amount not to exceed \$7,355,000 in Federal IVHS funds. Funding under this Partnership Agreement is available as follows:

	\$3,105,000	- FY 1993
	\$2,000,000	- FY 1994 (Amendment 1)
	<u>\$2,250,000</u>	- FY 1995 (This Amendment)
Total	\$7,355,000	

This total amount shall be matched at a minimum 80/20 (Federal/non-Federal) ratio, resulting in a minimum matching share valued at \$1,838,750. Reimbursement for costs incurred will follow regular Federal-aid billing and payment procedures.

Section 2 is amended by the following:

2. Responsibilities of the State. In conformance with approved Work Orders (see paragraph 3), the State shall perform, or cause to be performed, the activities described in the February 13 letter from Mr. Edward G. Schroeder to FHWA Division Traffic Operations Engineer, Mark D. Olson. In addition to on-going ITS activities that were initiated with funds provided in fiscal

years 1993 and 1994, efforts planned by the State and tentatively supported by this Agreement for FY 1995 include projects concerning:

- a. Integrated Corridor Transportation Management and Traveler Information System; and
- b. Washburn Tunnel Traffic Management and Information System.

This amendment is effective upon execution by both parties.

Texas Department of Transportation

Federal Highway Administration

Robert Curran

Frank M. Mayer

Assistant Executive Director for Field Operations

Division Administrator

for

Date 6-16-95

Date 6/27/95

APPENDIX B. PROJECT DESCRIPTIONS

APPENDIX B. PROJECT DESCRIPTIONS LISTED BY CORE INFRASTRUCTURE FEATURES

0. ADMINISTRATIVE/PLANNING

- 0-1 Development of ITS Priority Corridor Program Plan
- 0-2 Public Information/Program Administration
- 0-3 Public Information/Program Administration
- 0-4 ITS Technology for Data Collection and Transportation Planning

1. REGIONAL MULTIMODAL TRAVELER INFORMATION CENTER

- 1-1 Real-Time Information Kiosks
- 1-2 On-Vehicle Navigation/Information Applications
- 1-3 Monitoring and Information Systems for Environmental Conditions
- 1-4 Expansion of Traveler Information Kiosks
- 1-5 Using Advanced AVI Technology for Best Available Route Selection in Clear Lake City
- 1-6 Using Advanced AVI Technology for In-Vehicle Traveler Information
- 1-7 Using ITS Technology for Airport Area Traffic Management Traveler Information

2. TRAFFIC SIGNAL CONTROL SYSTEMS

- 2-1 Changeable Lane Assignment System (CLAS) on Frontage Roads
- 2-2 Changeable Lane Assignment System (CLAS) at Selected Intersections
- 2-3 Providing Core Infrastructure Through the Use of Fiber Optic Cable in North and Northwest Corridors
- 2-4 Use of AVI for Traffic Signal System Control
- 2-5 Expansion of CLAS Applications

3. FREEWAY MANAGEMENT SYSTEMS

- 3-1 Monitoring Traffic and Transit Conditions and Incident Detection with AVI Technology (Phase 4)
- 3-2 Truck Monitoring and Warning Systems for Freeway to Freeway Connections
- 3-3 Integrated Corridor Transportation Management and Traveler Information System
- 3-4 Air Quality Monitoring to Evaluate Traffic/Air Characteristics
- 3-5 Coordinated Ramp Metering and Intersection Traffic Signal Control
- 3-6 AVI System Expansion

4. TRANSIT MANAGEMENT SYSTEMS

- 4-1 Integrating Transit into Houston TranStar Center
- 4-2 En-Route Transit Information System
- 4-3 ITS-Based Scheduling, Reservation, and Dispatching of Personalized Public Transit
- 4-4 Public Travel Security

5. INCIDENT MANAGEMENT PROGRAM

- 5-1 Closed Circuit Television Surveillance System Lease for Astrodome Area
- 5-2 Railroad Grade Crossing Monitoring System
- 5-3 Automatic Vehicle Locator System for Incident Management
- 5-4 Washburn Tunnel Traffic Management and Information System
- 5-5 Incident Management and Traveler Information for Critical Roadway Links
- 5-6 Automatic Traffic Management in High Water Areas Through the Use of ITS Technologies
- 5-7 Automated Incident Management Strategies and Support Systems
- 5-8 Accident Information Reporting and Retrieving with ITS Police Vehicles
- 5-9 North Freeway/Hardy Toll Road Incident Management Through Toll Adjustment

6/7. ELECTRONIC FARE PAYMENT/TOLL COLLECTION

- 6/7-1 Use of AVI in Priority Lane Pricing
- 6/7-2 ITS in Parking System Management

0. ADMINISTRATIVE/PLANNING

0-1 Development of ITS Priority Corridor Program Plan

Problem: The USDOT requires each Priority Corridor to develop a plan which provides a 20-year ITS vision and identification of deployment projects, schedules, and estimated costs. A Plan is needed to guide funding and project implementation decisions.

Description: The objective of this study is to develop the Corridor Program Plan for the Houston ITS Priority Corridor. The study is a multi-year planning effort through 1998. The initial activity and the major effort will be the initial development of the Plan, which will be completed in the first year. Annual updates of the plan will occur as deployment activities progress, new applications occur, and schedule revisions are made. This annual review and update is important in maintaining a viable Priority Corridor Program Plan.

Development of the Priority Corridor Program Plan will result from a cooperative effort of local governmental organizations, the private sector, and the Texas Transportation Institute. The Priority Corridor Program Plan is envisioned as a "living document", which will be periodically reassessed and updated based on experience with deployed projects and the evolving state-of-the-art of ITS.

Lead Agency: TxDOT

Estimated Cost: \$400,000

0-2 Public Information/Program Administration

Problem: Administrative support is needed to manage the multi-year Priority Corridor Program, with its many individual projects. Similarly, a public information program will be needed to foster understanding and acceptance of the program and individual projects.

Description: In conjunction with the planning and deployment of ITS Priority Corridor projects, there is a need for an ongoing program administration and continuing public information effort by TxDOT. A Priority Corridor Program Office will be established with a Project Coordinator.

The Coordinator will be responsible for providing support for the various ITS deployments, informing the participating agencies and sponsors of the progress of the Priority Corridors Program, and working with the news media to provide information to the general public. The Coordinator will also be responsible for coordinating proposals for the continued efforts in the Priority Corridors Program.

Lead Agency: TxDOT

Estimated Cost: \$200,000 (2 years)

0-3 Public Information/Program Administration

Problem: Administrative support for the program, as well as related public information activities, will be a continuing need through the five-year Priority Corridor Program. Continuing support and funding of these activities is needed for years 3-5 of the program.

Description: Project 0-2 provides for Program Administration during the initial two years of the Program. This activity will be continued for the duration of the Priority Corridor Program, with a strengthened Public Information component added.

Lead Agency: TxDOT

Estimated Cost: \$800,000 (3 years)

0-4 ITS Technology for Data Collection and Transportation Planning

Problem: The urban transportation planning process coordinated by H-GAC has typically needed extensive traffic data to define travel characteristics and system performance. Data developed by the Houston TranStar Center will be useful to H-GAC's continuing planning/monitoring process. An effective method is needed to capture the needed data and provide it in a useful form for use by H-GAC and other local agencies.

Description: This project will develop a computer system to facilitate use of the extensive operational and relational databases assembled at the Houston TranStar Center for use in transportation planning efforts. Data assembly and analysis could include historical trends in traffic characteristics, traffic sampling for special studies, and routine summarization of operational measures. This project would also equip vehicle(s) with GPS and on-board computers to collect real-time traffic data directly in a GIS database.

Lead Agency: H-GAC

Estimated Cost: \$500,000

1. REGIONAL MULTIMODAL TRAVELER INFORMATION CENTER

1-1 Real-Time Information Kiosks

Problem: ITS surveillance and communications systems will assemble active databases of information that would be valuable to travelers. Various traveler information delivery systems, including information kiosks should be used to make real-time information available to travelers. Kiosks provide an excellent means to provide traveler information at the non-home end of a trip.

Description: Real-time traffic information (average speed, travel time) is available through the AVI system in the Houston TranStar Center. In addition, incident status information and transit schedule status will also be available from the TranStar Center. A primary purpose of

this system is to provide real-time information on traffic conditions to commuters, travelers, and commercial operators. METRO will be implementing an automatic vehicle location (AVL) system with their regular route bus system in the near future. This will provide the opportunity for bus passengers and potential riders to obtain real-time information on the status of buses. The potential exists to greatly expand and enhance the availability of real-time traffic and transit information to a wide range of users, allowing them to make more informed travel choices. Further, the real-time transit information could be provided in both visual and passenger activated audio formats to enhance the ability of visually impaired or disabled individuals to use public transit.

This project will focus on expanding the availability of real-time traffic and transit information to commuters, travelers, and commercial operators in the Priority Corridor area. Specifically, the project will deploy and test the use of real-time information kiosks at activity centers, provided to allow travelers and commuters to make more informed travel decisions. Thus, the demonstration will provide improved information to transit and roadway system users to help them select the best travel mode, travel route, and time of travel based on current traffic conditions and transit options. These kiosks will be located at ten major activity centers, such as transit centers, shopping centers, truck terminals, major office buildings, and other employment centers. Three different kiosk applications will be deployed, tailored to each location and traveler need.

Lead Agency: TxDOT

Estimated Cost: \$750,000

1-2 On-Vehicle Navigation/Information Applications

Problem: One of the most promising benefits of ITS is the ability to provide route guidance and real-time traveler information in vehicles. The Houston TranStar Center will be the focal point for databases on travel conditions and incidents in the Priority Corridor, and their information (particularly AVI-based freeway travel speeds) can be valuable for contemporaneous route decisions.

Description: One of the objectives of the ITS program is to provide current information on travel conditions to travelers at all stages of their trip. Operational tests relating to in-vehicle information systems are being conducted in other major cities, and the intent of this proposed program is to extend these concepts to the Houston Priority Corridor. TxDOT proposes to examine the results of national and international studies on in-vehicle information systems and the resultant products that are available and develop an operational test that will address a particular group of travelers within the Priority Corridor, the travelers that use the Houston Intercontinental Airport (IAH).

The project will propose systems for use by all travelers, regardless of the mode of transportation selected to travel to or from the IAH facility. TxDOT will seek the support and participation of public and private industry in the development and operation of this project. An automobile manufacturer and a rental car agency have indicated an interest in developing a project in Houston that would extend the in-vehicle concepts developed for the TravTek

Project in Orlando. It is the intent of this project to provide support for the planning and coordination of a major demonstration project that may develop in the Houston area.

Lead Agency: TxDOT

Estimated Cost: \$400,000

1-3 Monitoring and Information Systems for Environmental Conditions

Problem: The Houston area is subject to unpredictable and severe weather conditions that can result in extensive roadway flooding during periods of intense rainfall. Several freeways, frontage roads, and major arterials have a history of being closed due to the flooding conditions during severe storms. The technology is currently available to provide real-time monitoring of these conditions to the TranStar Center and this information could be used by TranStar Center personnel to make control decisions and distribute traveler information.

Description: A system will be implemented which monitors water levels at roadway locations which historically experience roadway flooding and the status of pumps which are automatically activated to pump low roadway areas (typically underpasses), which cannot be drained through gravity flow systems. Harris County Flood Control District has 80 stream-level and rainfall gages which are continuously monitored and could be integrated into the TranStar Center's database, as well as correlated with flooding at critical roadway locations. In addition to monitoring roadway and waterway conditions, the availability of real-time weather radar and National Weather Service alerts would provide for advanced warning of severe conditions that may impact roadways. Because unpredictable and variable weather conditions occur at all times of the year, the implementation of such a system could be a useful component of an Advanced Traveler Information System.

This project will integrate the electronic data stream from an existing Harris County Flood Control District network of stream-level and rainfall gages with a proposed system of devices which monitor roadway environmental conditions and the operational status of TxDOT's stormwater pumping facilities.

Using these sources of real-time information on the status of general weather conditions and location-specific data, ATIS services will assist motorists in both pre-trip planning, as well as en-route response to advisory information on flooding.

Lead Agency: TxDOT

Estimated Cost: \$500,000

1-4 Expansion of Traveler Information Kiosks

Problem: The placement of traveler information kiosks in areas of high activity offers a promising means of delivering traveler information. Providing kiosks at locations where the information is most needed (i.e., office buildings, shopping malls, hospitals, truck terminals) can enable travelers to make mode, route, or departure time decisions. This project will build on the experience of Project 1-1, deploying additional kiosks at locations of greatest effectiveness.

Description: The Immediate Action Program (Project 1-1) will deploy ten kiosks. These kiosks will be deployed in various location types with varied information provided (e.g., traffic, transit). Experience gained with Project 1-1 will provide a basis for refinement and expansion of the kiosk approach to providing traveler information. It is anticipated that up to 50 additional kiosks will be deployed for displaying transit and/or traffic information. Private sector involvement is also expected and joint public/private development may increase the number of kiosks deployed.

Lead Agency: TxDOT/METRO

Estimated Cost: \$1,100,000

1-5 Using Advanced AVI Technology for Best Available Route Selection in Clear Lake City

Problem: Suburban centers, such as the Clear Lake City area of Houston, are a microcosm of the City's existing transportation system control and traveler information systems and needs. Clear Lake City is both a major residential community and a major employment center (NASA and related aerospace contractors). The arterial street system of Clear Lake City is not sufficient to accommodate the peak period traffic demands and could benefit from deployment of AVI and traveler information technology to better utilize the roadway system and serve traveler information needs.

Description: This project would utilize existing AVI technology to sample vehicle speeds on major arterials in the Clear Lake City area. In addition, train movements along the MKT railroad track parallel to State Highway 3 would be monitored, using AVI technology. This information would be processed and displayed in an easily understood format on Changeable Message Signs (e.g., direction of train travel and current location, speed on arterials, speed on major arteries into and out of Houston CBD). The placement of the signs would be in strategic locations to allow the motorist to make informed route decisions, particularly during congested periods.

Lead Agency: City of Houston

Estimated Cost: \$1,400,000

1-6 Using Advanced AVI Technology for In-Vehicle Traveler Information

Problem: The most effective driver information system would deliver information specific to the vehicle's location and deliver it into the vehicle, at or near a location where a route decision would need to be made.

Description: New developments in AVI technology (read/write) now provide for two-way communication with the added ability to provide communication from the roadside to within the vehicle. This project would investigate the effectiveness of providing information to selected persons using the AVI equipment. This would be comparable to similar information that could be displayed to all motorists on roadside changeable message signs and broadcast to all persons tuned in on either commercial radio or low-powered roadside highway advisory

radio, except that this information will be location specific (to the site of the reader/transmitter).

Lead Agency: TxDOT

Estimated Cost: \$700,000

1-7 Using ITS Technology for Airport Area Traffic Management/Traveler Information

Problem: Houston Intercontinental Airport is a significant generator of automobile and truck traffic. Direct access to the airport is provided only by two arterial facilities (JFK Boulevard and Will Clayton Parkway). However, a number of area access facilities, including three freeways and the Hardy Toll Road, provide opportunities for route selection if traffic management and traveler information systems are employed.

Description: This project would apply the concepts of traffic management/traveler information systems specifically to Houston Intercontinental Airport (IAH) as a major traffic generator and intermodal transportation hub. It would be a logical extension of core infrastructure deployment now underway in the Greater Houston area. Supplemental core infrastructure would include JFK Boulevard, Will Clayton Parkway, adjacent freeway connections, and other area arterial roadways. The key element of the system is the traffic management/information system. This function is viewed as an extension of the areawide ITS system, with the TranStar Center serving as a focal point.

Lead Agency: TxDOT/City of Houston

Estimated Cost: \$1,700,000

2. TRAFFIC SIGNAL CONTROL SYSTEMS

2-1 Changeable Lane Assignment System (CLAS) on Frontage Roads

Problem: Frontage roads are an essential element of design and operation on urban freeways in Texas. Because of high interchanging traffic demands, double turns from the frontage road are often permitted. However, turning traffic demands are often highly variable throughout the day. In addition, freeway incidents often create high frontage road demands, as traffic diversion occurs from the mainlanes to the frontage roads.

Description: The objective of this project is to design, install, and evaluate 11 changeable lane assignment control systems that can alter the permissive double turns at frontage road intersections based on traffic demands. TTI developed a Changeable Lane Assignment System (CLAS) concept which used fiber optic lane use signing. These changeable (dynamic) lane use signs permit double turns when needed and then changed to indicate normal lane use (turns permitted only from outer lanes) when appropriate. TxDOT installed a prototype CLAS system in Houston on the inbound frontage road of I-10 at Bingle/Voss. This CLAS installation provided reliable, effective control, and it is this lane use control system with certain improvements proposed for implementation on U.S. 290, as well as for replacement

of the prototype installed on I-10. The proposed locations for the installations are 10 outbound intersections on U.S. 290 Northwest Freeway and one intersection on I-10 Katy Freeway. The system will operate in both pre-timed and responsive control modes with monitoring and control from the TranStar Center.

Lead Agency: TxDOT

Estimated Cost: \$750,000

2-2 Changeable Lane Assignment System (CLAS) at Selected Intersections

Problem: In the system of urban highway transportation facilities, the arterial street network is the backbone of the regional transportation infrastructure. Operation of an arterial's signalized intersections directly affects the capacity of an arterial street and the level of traffic service offered to its users. Development of an advanced traffic control technology will allow the signalized arterial street intersections to dynamically respond to the changing demand of turning traffic existing at these locations.

Description: A priority corridor project has been proposed to deploy CLAS at arterial/arterial street intersections in Harris County. It is also the objective of this project to expand the deployment strategy to include traffic responsive operation of the traffic signal control system as well as the CLAS. Harris County will select two or three intersections to test CLAS deployment in operational treatments not included in the earlier CLAS deployment along freeway frontage roads. There are four potential CLAS applications which may be tested in this project: arterial/arterial intersections; interior approaches of arterial streets with wide median separations; arterial network to provide capability of dynamic traffic diversion as an incident traffic management alternative; and to explore the possibility of developing traffic responsive algorithm and guidelines for real-time integrated CLAS and signal control system.

Lead Agency: Harris County

Estimated Cost: \$250,000

2-3 Providing Core Infrastructure Through the Use of Fiber Optic Cable in North and Northwest Corridors

Problem: The data communications system is one of the key elements of ITS core infrastructure. Fiber optic cable is being deployed extensively in the Corridor to support CTMS, RCTSS, and other ITS systems. There is a need to extend the fiber optic cable system into the north/northwest area to provide expanded coverage and to close the redundant ring communication infrastructure.

Description: This project will extend the communications infrastructure, now under development by local agencies to support the CTMS, RCTSS, and other ITS applications. The project will connect the I-45 North and U.S. 290 single mode fiber optic cable systems to both extend communications into the County and provide the redundant loop needed for contingent systems operations. Extension of this cable system will enable extension of the RCTSS and

other ITS technologies to serve the congested areas of north and northwest Houston and connect to the TranStar Center.

Lead Agency: Harris County
Estimated Cost: \$2,100,000

2-4 Use of AVI for Traffic Signal System Control

Problem: Traffic signal systems currently provide traffic responsive control based on measurements of traffic flow and occupancy characteristics at specific points (where vehicle detectors are placed). AVI technology permits measurement of actual travel times along roadways in a signal system which is limited only by the placement of AVI readers and the number of transponder-equipped vehicles. The number of transponder-equipped vehicles in the Houston area is approximately 45,000 (including TxDOT and HCTRA issued transponders). This number will increase as HCTRA expands its tollroad mileage and enhances the attractiveness of transponder use. These could be supplemented by distributing additional transponders in a targeted area for this project.

Description: This project proposes using AVI-developed travel time data to supplement vehicle detector data in establishing system control parameters for a limited signal network, which employs advanced traffic control systems (e.g., an area under RCTSS control). This operational test would develop modifications to signal system control strategy and parameters to incorporate AVI-based travel time data in measuring traffic operational conditions and establishing signal splits and offsets.

Lead Agency: TxDOT/METRO
Estimated Cost: \$900,000

2-5 Expansion of CLAS Applications

Problem: Two projects of the Immediate Action Program will utilize Changeable Lane Assignment Systems (CLAS) for control of freeway frontage road intersections and arterial street intersections, respectively. If findings from these two projects are promising, then further deployment and extension to other applications should be undertaken.

Description: This proposed project would provide for wider deployment of CLAS, as well as expansion of the capabilities of CLAS. It is envisioned that the U.S. 290 CLAS would be enhanced to include automatic traffic responsive operation (e.g., phasing and timing) to complement freeway incident detection and incident management. This project would also deploy CLAS at freeway interchanges and arterials with unique geometric and operational characteristics.

Lead Agency: TxDOT
Estimated Cost: \$1,400,000

3. FREEWAY MANAGEMENT SYSTEMS

3-1 Monitoring Traffic and Transit Conditions and Incident Detection with AVI Technology (Phase 4)

Problem: The Houston Priority Corridor has been instrumented with Automated Vehicle Identification (AVI) Systems designed to measure travel times and average speeds on the freeway (mainlanes) and HOV lanes. The monitoring stations have an average spacing of 4.8 kilometers (3 miles) and do not provide sufficiently detailed travel time information for use in automatic incident detection/management. In addition, there is a need for the AVI system to monitor transit activity at major transit facilities.

Description: This project proposes to provide a traffic monitoring system using AVI technology to monitor the following applications: transit vehicle schedules from High Occupancy Vehicle (HOV) lanes' access points to Park and Ride Facilities and from transit terminal facilities for shuttle bus operations; traffic conditions on arterial streets that serve as alternate routes to the freeway system; and freeway incident detection for traffic incidents that block one or more lanes.

The traffic data collected from the ramps and roadways with the expanded AVI coverage will enhance the travel time information used to advise motorists of alternate routes, assist emergency response agencies in incident management procedures, and inform transit agencies and HOV lane users of travel conditions.

Lead Agency: TxDOT

Estimated Cost: \$1,831,250

3-2 Truck Monitoring and Warning Systems for Freeway to Freeway Connections

Problem: Direct connections in freeway to freeway interchanges are a major source of traffic congestion and safety concerns. Because the design speeds on these connections are usually lower than the design speeds on the mainlane roadways and approaches, traffic tends to enter the connection curves at higher than desired speeds. High speed vehicles, particularly trucks, can lose control or turn over in these connections. An active detection/warning system could serve to reduce the occurrence of truck accidents on freeway to freeway connections.

Description: The project proposes to apply speed measurement and vehicle classification technologies on the approaches to and within freeway to freeway connectors that have sections with low design speeds. These monitoring systems will detect large trucks and determine their spot speeds. A data processor will identify trucks and determine if the conditions are critical for maintaining control of the vehicle through the connection. If the spot speed is too high for conditions, warning systems are activated to advise the driver to reduce his speed. The warning systems proposed would be dynamic to increase the target value and the compliance

to what will be an advisory speed limit. New techniques for displaying messages on roadsides may be enhanced by also exploring methods of communicating to the driver within the vehicle.

Lead Agency: TxDOT

Estimated Cost: \$220,000

3-3 Integrated Corridor Transportation Management and Traveler Information System

Problem: The Houston Priority Corridor program has proposed a number of deployment projects in the Integrated Corridor project area (Northwest Corridor). There is an opportunity and a need to integrate these projects and build upon them with additional system deployment to provide an "integrated" approach to multimodal transportation operations, incident management, and traveler information in a single geographic corridor (U.S. 290/Hempstead Road). The operational concept of the Integrated Corridor Project is to focus within one geographic corridor, a number of ITS concepts and technologies, most of which are complementary and synergistic. The core infrastructure developed in the Integrated Corridor will provide the ability to monitor traffic conditions, operate traffic control systems, and communicate current operational conditions to travelers.

Description: The project proposes to deploy, operate, and evaluate various traffic and transit monitoring, transportation management, and traveler information systems on: U.S. 290 Northwest Freeway mainlanes, HOV lanes, and frontage roads; the parallel Hempstead Road; and other arterial streets in the Northwest Corridor from FM 1960 to I-610 West Loop.

The proposed integrated corridor approach will apply ITS technologies and applications individually and on a system basis. These technologies include: CCTV, AVL, vehicle and railroad monitoring with AVI, variable message signs, highway advisory radio, and in-vehicle communications.

Lead Agency: TxDOT/METRO

Estimated Cost: \$1,862,500

3-4 Air Quality Monitoring to Evaluate Traffic/Air Characteristics

Problem: One of the criteria for selection of priority corridors was that the area have unacceptable air quality conditions. There is a need to be able to relate transportation operational conditions to air quality and to integrate this information into transportation management and traveler information systems.

Description: This project will investigate and apply state-of-the-art air quality sensing technologies to determine the characteristics and interrelationships of air quality and traffic operations. These characteristics and relationships would be utilized in a real-time air quality monitoring program which could be used in making transportation management decisions.

Lead Agency: TxDOT/H-GAC

Estimated Cost: \$600,000

3-5 Coordinated Ramp Metering and Intersection Traffic Signal Control

Problem: Ramp metering is to be implemented on Houston freeways as part of the Computerized Traffic Management System (CTMS), becoming an integral part of the freeway surveillance and control system. Signalized intersections, including freeway frontage road signals, will be under system control of the RCTSS. These two traffic control systems need to be coordinated, particularly for use during incident management conditions.

Description: This project would deploy and evaluate control concepts and strategies for interrelating traffic signal and ramp metering signal operations. Operational concepts could involve only incident management situations or could include routine operating conditions. The "smart diamond" controller is being developed by TTI in a research project for TxDOT, and this controller could be considered for deployment on this project. This proposed project will develop, deploy, and evaluate coordinated control of a Houston area freeway on a selected section.

Lead Agency: TxDOT

Estimated Cost: \$400,000

3-6 AVI System Expansion

Problem: The current multi-stage development of AVI will provide basic coverage of the freeway system in the Priority Corridor. However, it is anticipated that additional AVI reader stations will be needed as experience is gained with use of the AVI system and with analyses conducted on AVI reader data.

Description: It is proposed to install additional AVI readers and transponders in areas with high proportions of interchanging traffic (e.g., freeways near CBD, freeway/freeway interchanges), and at other locations. In addition, readers would be added at locations where more detailed AVI data needs exist (e.g., areas of recurrent congestion, high accident locations).

Lead Agency: TxDOT

Estimated Cost: \$1,600,000

4. TRANSIT MANAGEMENT SYSTEMS

4-1 Integrating Transit into Houston TranStar Center

Problem: The Houston TranStar Center is currently being developed to provide state-of-the-art transportation management for the Houston area. Transit operations should be integrated into the TranStar Center's communications and control systems in order for the benefits of the TranStar Center to be fully realized.

Description: The project will develop specifications to integrate transit operations into the Houston TranStar Center which will be based on the general guidelines resulting from the Texas A&M ITS Research Center of Excellence research project, focusing on the functional, operational, and informational needs of public transit operators in a control center environment. It will also develop a standard interface for linking into the Houston TranStar Center, enhancing the ability to integrate additional transit components or other elements in the future. METRO transit components include the regular route transit system, the METROLift paratransit system, and the rideshare system. The project will outline the steps and activities necessary to accomplish this integration.

Lead Agency: METRO

Estimated Cost: \$400,000

4-2 En-Route Transit Information System

Problem: The National Program Plan for ITS has established a need for providing travel-related information on traffic, transit, and roadway conditions through the use of wayside communications infrastructure. While the technology exists in component pieces, no experience from a full implementation on a transit fleet exists.

Description: This project will provide an infrastructure capable of identifying a moving transit vehicle by a roadside transponder and using the vehicle's identity to trigger an appropriate bi-directional exchange of transit rider information and vehicle data with the roadside device. The service would include real-time information on traffic, transit, and roadway conditions through the use of this device. The system could include traveler information for riders, next bus arrival kiosks at selected bus stops and transit centers, and transit fleet management information.

Lead Agency: METRO

Estimated Cost: \$1,950,000

4-3 ITS-Based Scheduling, Reservation, and Dispatching of Personalized Public Transit

Problem: Evolving ITS technologies yielded promising capabilities to manage and operate real-time systems for personalized transit service. Today's demand responsive systems (e.g., elderly and disabled persons) could be more effectively scheduled and dispatched by utilizing these advanced communications, computer, and operational hardware and software.

Description: This project will develop and test real-time scheduling, reservation, and dispatching systems utilizing state-of-the-art communications, computer, and automatic vehicle locator (AVL) systems. Systems will be assessed, developed, and integrated to provide an AVL-based demand responsive transit delivery system. Automated reservation systems and real-time scheduling and dispatching, together with AVL systems, offer the potential to better allocate vehicle resources and serve transit riders by continuously optimizing vehicle routing and maximizing the use of available capacity. This project will incorporate all the elements

into a personalized public transit demonstration project which will be implemented and evaluated in a selected area.

Lead Agency: METRO
Estimated Cost: \$4,600,000

4-4 Public Travel Security

Problem: Personal safety and the feeling of security are important factors which affect transit ridership. A high level of security should be provided at boarding points and other passenger facilities in order to reduce crime and increase riders sense of personal safety.

Description: The goal of the Public Travel Security Program is to develop, implement, and evaluate the effectiveness of providing automated security at transit boarding points such as bus stops, transit centers, and park and ride lots. The objectives are to use advanced technologies currently available to respond to security needs at transit boarding points. The project will consist of CCTV cameras and call boxes at six park and ride lots, four transit centers, CBD transit streets, and in the Texas Medical Center. The fiber optic cable system now being implemented by TxDOT and METRO will provide the communications link with the CCTV and call boxes.

Lead Agency: METRO
Estimated Cost: \$3,300,000

5. INCIDENT MANAGEMENT PROGRAM

5-1 Closed Circuit Television Surveillance System Lease for Astrodome Area

Problem: Transportation agencies traditionally install their own communications medium for transmission of video signals from Closed Circuit Television (CCTV) cameras located in the field. The installation of such systems require lengthy design periods, tedious approval processes, extensive field testing, and software development. As a result, the minimum construction period for such projects is two years. There is a need to find expedient approaches to development, operation, maintenance, and use of CCTV.

Description: The objective of this project is to expeditiously lease a turnkey CCTV system from a private organization utilizing existing communications media installed by the organization for other purposes. A survey of three potential bidders determined that a minimum lease of five years is required for such an arrangement to be feasible relative to public sector costs and private industry needs. The project will include the lease of a ten-camera CCTV in the Astrodome area to be used for transportation management of special events. An evaluation will be made of procedures used to secure the leased fiber optic system and services.

Lead Agency: TxDOT
Estimated Cost: \$480,000

5-2 Railroad Grade Crossing Monitoring System

Problem: Railroad grade crossings represent a major source of delay in Houston. There are numerous at-grade crossings that can affect traffic flow and safety on the arterial street system. The objective of this project is to examine how information systems and traffic control systems can be used to monitor the movements of trains and to adjust traffic patterns and advise emergency vehicles in the corridor to reduce delays at railroad at-grade crossings. On major bus routes and on routes frequently used by emergency vehicles, the additional travel times can be critical to their operations.

Description: This project proposes to monitor railroad train movements along one or more of these corridors: the Union Pacific rail line that parallels I-10 Katy Freeway and the Southern Pacific rail lines that parallel the I-610 West Loop Freeway and the U.S. 290 Freeway/Hempstead Road. The monitoring systems will use AVI readers at eight to ten locations to determine the position and identification of the train and to measure the travel times of trains moving along the lines. Advanced warning/information systems would be developed and implemented on approaches to selected intersections.

Lead Agency: TxDOT
Estimated Cost: \$500,000

5-3 Automatic Vehicle Locator System for Incident Management

Problem: TxDOT and Harris County, through the Motorist Assistance Program (MAP), currently operate a fleet of vans to patrol freeways and respond to incidents and disabled vehicles. The application of a fleet management system is essential for coordinated and effective operation. Quick response and effective dispatching of these units can reduce the time for emergency response and the time needed to restore normal traffic operations. The objective of this project is to increase the effectiveness of incident management by implementation of an Automatic Vehicle Locator (AVL) system which identifies vehicles and locations on a real-time basis.

Description: The project proposes to implement one of a number of available automatic vehicle locator systems that would provide the management information needed for vehicle dispatch, patrol assignments, and automatic information collection and storage. The project will increase the effectiveness of the program by providing dispatchers in the Transportation Management Center with continuous and accurate vehicle location information. With this information, dispatchers can quickly access availability and location of the nearest MAP vehicle, as well as being able to provide guidance on the best route to use when responding

to an incident. The use of the AVL information as a traffic monitoring source will also be tested.

Lead Agency: TxDOT

Estimated Cost: \$100,000

5-4 Washburn Tunnel Traffic Management and Information System

Problem: The Washburn Tunnel was constructed under the Houston Ship Channel in 1950 to connect the cities of Pasadena and Galena Park and provides access to area industries as well as important linkage between major employers and the residential areas on both sides of the Ship Channel. Weekday traffic volumes through the tunnel are approximately 30,000 vehicles per day with directional (one lane) peak hour volumes of 1,400 vehicles per hour. These peak period traffic volumes approach capacity for the 6.7 meters (22-foot) wide roadway. The tunnel is approximately 1,220 meters (4,000 feet) long and has a maximum grade of six percent. An estimated 20 percent of the tunnel traffic consists of trucks, even though those carrying hazardous materials are prohibited. When incidents occur in the tunnel or its approaches, severe congestion results, and diversion to alternate routes is severely limited. The objective of this project is to implement automatic incident detection and closure systems for the tunnel and develop traveler information services to advise travelers of conditions at the tunnel.

Description: The proposed integrated, areawide traffic management and traveler information systems would extend over a large area in order to minimize the user impacts of tunnel closures. The project will include four implementation components: an incident detection system, automatic tunnel closure, areawide traveler information, and an AVI-based CVO permitting process. It is anticipated that visual imaging technology, such as the Mobilizer Advanced Tracking System, will be used for incident detection at three detection locations in the tunnel. Automatic gates would replace manually operated gates at the tunnel entrances.

Lead Agency: Harris County

Estimated Cost: \$950,000

5-5 Incident Management and Traveler Information for Critical Roadway Links

Problem: There are a number of roadway system links in the Greater Houston area which, when closures or capacity reductions occur, can result in significant motorist delay and inconvenience. Typically, these critical links have no reasonable alternative routes, and diverted trips could require 16 kilometers (10 miles) or more in additional travel. In addition, a blockage on these links can trap motorists in long queues with no alternative but to wait for the incident to be cleared.

Description: This project will focus ITS technologies on critical roadway system links (e.g., Baytown Bridge, I-610 Bridge, Galveston Causeway, I-10 at San Jacinto River, I-10 and U.S. 59 elevated sections) where incidents can have severe impacts. Evacuation routes in the Galveston area would also be treated as critical links, and ITS technologies would be developed to assist in hurricane evacuations. Critical links would be equipped with CCTV,

vehicle detection, changeable message signs, and possibly AVI, and HAR. In addition, environmental monitoring equipment (wind, ice, rain measurements) may be used on bridges and elevated structures.

Lead Agency: TxDOT
Estimated Cost: \$2,950,000

5-6 Automatic Traffic Management in High Water Areas Through the Use of ITS Technologies

Problem: The coastal areas of Texas (including the Houston area) are flat lands at low elevations and receive 55 to 60 inches of rain each year. During heavy rains, roadways become impassible due to high water. This is particularly a problem in the developed areas near Addicks Reservoir in West Houston. Several major arterial roadways may be submerged and impassible for a period of a week or more following heavy rains. ITS technologies could mitigate the diversion and travel delay problems created by these surface flooding events.

Description: The objective of this project is to demonstrate how to significantly reduce major congestion problems in the Houston and Harris County area when major arterials are blocked by high water for extended periods, such as occurs in the Addicks Reservoir area. The project would attempt to identify and/or use ITS technologies such as video detection cameras, rainfall and stream-level gauges, Automatic Vehicle Identification (AVI), Changeable Message Signs (CMS), Highway Advisory Radio (HAR), and Advanced Traffic Control (ATC) systems. An areawide traffic management and traveler information system would be developed and implemented to address the unique needs of the loss of three critical arterial links due to reservoir flooding.

Lead Agency: Harris County
Estimated Cost: \$3,750,000

5-7 Automated Incident Management Strategies and Support Systems

Problem: Accidents, stalled vehicles, and other incidents create a significant amount of vehicle and passenger delays on freeways. Effective management of the non-recurring incidents could significantly reduce delays and restore the freeway to normal operation sooner. Management systems could include rapid notification and deployment of special personnel and equipment needed for incident removal.

Description: This project will develop incident response, clearance, and traffic diversion strategies and the automated systems to support them. TTI developed preliminary design and architecture concepts for an Automated Incident Management System for traffic management centers. The system would use GIS to provide incident management, alternative routing, on-line roadway information, and other capabilities.

A communication system would be developed to transmit real-time data collected system wide at the Traffic Management Center to TxDOT traffic operations and maintenance personnel, law enforcement agencies, fire departments, and emergency medical services (EMS) that may be

responsible for managing or responding to an incident that impacts a regional arterial or freeway. These response agencies/persons would receive needed information (e.g., CCTV, AVI, traffic data) in their office or home (if on a quick response team) to permit fast decisions and response to major incidents. Innovative driver communications, such as truck/trailer mounted CMS, CCTV camera, HAR and traffic signals, would be used for on-site incident management.

Lead Agency: TxDOT

Estimated Cost: \$1,600,000

5-8 Accident Information Reporting and Retrieving with ITS Police Vehicles

Problem: Accident investigation and reporting are a routine part of incident management, yet the process has changed little in the last 50 years. The accuracy of information and minimizing the time to complete accident investigations can be improved by using ITS technologies.

Description: The primary objective of the proposed project is to develop a core infrastructure, including ITS equipped police vehicles, for the accurate and timely collection and dissemination of traffic accident information. Using GPS locators, investigating officers can transmit accurate accident location information directly to the TranStar Center. Pen-based notebook computers with wireless communication capability would be used to record and transmit the accident report. This real-time accident reporting (particularly accurate location information) could be valuable in traffic management decisions by TranStar Center staff.

Lead Agency: Harris County

Estimated Cost: \$500,000

5-9 North Freeway/Hardy Toll Road Incident Management Through Toll Adjustment

Problem: The Hardy Toll Road and I-45 North (North Freeway) are generally parallel facilities in North Houston, and converge near the Harris/Montgomery county lines. They are parallel for approximately 32 kilometers (20 miles) between their convergence and the I-610 North Loop. Changeable message signs presently are in place at the interchanges at both ends of this section. The physical proximity of the two facilities in an essentially common travel corridor provides an opportunity to coordinate their operation when major incidents occur, particularly on the North Freeway.

Description: The proposed project would develop operational and administrative approaches to encouraging diversion to the Hardy Toll Road when major incidents with significant capacity reductions occur on the North Freeway. It is conceivable that tolls on the Hardy Toll Road would be reduced during these incidents, with reimbursements (if revenues are reduced) made to the HCTRA from project funding. Guidelines would be developed for implementing "encouraged diversion," and the impacts and benefits would be evaluated.

Lead Agency: TxDOT/Harris County Toll Road Authority
Estimated Cost: \$900,000

6/7. ELECTRONIC FARE PAYMENT/TOLL COLLECTION

6/7-1 Use of AVI in Priority Lane Pricing

Problem: One of the criticism of HOV lane operation and an inherent inefficiency is that unused capacity often exists, particularly under the 3+ persons per vehicle regime. One of the means of gaining higher usage of HOV lanes is the tolling or congestion pricing of the unused capacity that is available. Through congestion pricing, the tolls could be set to optimize usage of the HOV (priority) lanes.

Description: Priority Pricing is the selling of available capacity on a priority lane during the restricted hours of operation. The technology proposed is the AVI transponder system similar to that used to measure travel times on the freeways and HOVs. Special traffic monitoring software would be provided that would identify the authorized vehicles in the field so METRO Police could be notified of a non-conforming vehicle using the HOV lane. The project would investigate the operational effectiveness of providing selective use of the HOV lane by pre-approved, non-conforming carpools or single occupant vehicles.

Lead Agency: METRO/TxDOT
Estimated Cost: \$500,000

6/7-2 ITS in Parking System Management

Problem: Metered parking technology has changed little in the last 50 years. ITS technology offers the opportunity for cities to operate a more efficient parking program, as well as provide more effective enforcement and revenue control.

Description: This project will test evolving ITS technologies for use in parking management. These technologies could include use of coinless payment systems (e.g., stored value cards, parking vouchers, in-car electronics, smart cards) and space occupancy detection for more efficient and cost effective parking system management.

Lead Agency: City of Houston
Estimated Cost: \$300,000