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16. Abstract This report summarizes the activities conducted on a variety of topics for the Texas Department of Transportation (TxDOT), Houston District. The Texas Transportation Institute (TTI) conducted the following studies on the High Occupancy Vehicle (HOV) Lanes: field studies on five HOV facilities to measure vehicle occupancies, volumes, and travel times; vehicle counts at twenty-nine park and ride facilities to determine usage rates. TTI developed justification statements for ramp metering, road user cost analyses for U.S. 59, and traffic analyses for the Memorial City area on I-10 Katy Freeway. The project staff developed and conducted specific traffic analyses in the South Main/Texas Medical Center area to measure travel times and origin/destination patterns to address mobility and potential transportation improvements. There were two efforts in Freeway Incident Management: 1) development of Geographical Information Systems (GIS) for traffic management application; and 2) monitoring and evaluation of the Motorist Assistance Program (MAP). TTI conducted urban planning studies on over 7600 sections of roadway for inventory statistics, travel time and speed parameters, and vehicle classification data. TTI collected general traffic data collections to maintain the Houston District database and to support the road user cost analyses made for specific areas. The project staff conducted the following studies: a public information study on Houston mobility and safety at the Houston Auto Show; focus groups to select a "formal" name for Houston's new Traffic Management Center (Houston TranStar); and development of an informational brochure for the opening of the Fred Hartman Bridge in Baytown, Texas. TTI conducted significant work for the central control system design: software development of Houston TranStar and coordinated efforts with TxDOT and their Systems Integrator, Loral, in multiple aspects of preparing for the opening of the traffic management center. TTI continued the development of the Houston AVI—Phase 2 program with the recruitment of 3,000 volunteers to serve as AVI probes. TTI provided technical assistance to TxDOT in the preparation of proposals, work orders, and other documentation in conjunction with the development of several cooperative projects with the Federal Highway Administration as well as other local transportation agencies.					
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**PLANNING, DESIGN, AND OPERATION
OF TRANSPORTATION FACILITIES IN HOUSTON, TEXAS:
1995 SUMMARY OF ACTIVITIES**

by

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**Research Report 1986-1
Research Study Number 7-1986
Research Study Title: Planning, Design, and Operation of
Transportation Facilities in Houston-Phase II**

**Sponsored by the
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IMPLEMENTATION STATEMENT

The Houston District office of the Texas Department of Transportation immediately utilized much of the work activity outlined and summarized in this report in order to make decisions regarding the funding and implementation of projects. The Texas Transportation Institute conducted other historical and on-going work activities discussed herein which are continually being used in both planning and operational assessments of the transportation facilities in Houston.

DISCLAIMER

The contents of this report reflect the views of the author who is responsible for the opinions, findings, and conclusions presented herein. The contents do not necessarily reflect the official views or policies of the Texas Department of Transportation. This report does not constitute a standard, specification, or regulation and is not intended for construction, bidding, or permit purposes. The engineer in charge of this project was William R. McCasland, P.E. #21746.

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SUMMARY

This report summarizes the activities conducted on a variety of topics for the Texas Department of Transportation, Houston District. These activities range from the conduct of traffic analyses of problem areas to the monitoring of usage of High Occupancy Vehicle Lanes. Some studies are extensions of research through the evaluation of requirements to implement new technology and through the development of a new traffic management center to integrate all of the traffic management functions in a large urban area. Nine major tasks divide this project, with each task supporting the conduct of a number of activities.

Task 1 continues the monitoring of the usage of the High Occupancy Vehicle (HOV) Lane. In this project, the evaluations were conducted for only the first two quarters of this fiscal year, since TxDOT requested that the support for this effort be transferred to the Metropolitan Transit Authority (METRO). For the two quarters, TTI collected data on five HOV Lanes, measuring the vehicle occupancies, volumes, and travel times, and at the twenty-nine park and ride facilities, measuring the usage.

Task 2 concerns traffic analysis and traffic management evaluations. TTI prepared justification statements for ramp metering on several freeways, road user cost analyses for U.S. 59, and traffic analysis for access to and from the Memorial City area on I-10 Katy Freeway. TTI assisted TxDOT and their consultant for the conduct of the Major Investment Study on I-10 Katy Freeway by conducting FREQ Model analyses and providing information on the I-10 Corridor, which TTI had collected over the years. This work included the list of alternatives for Transportation Systems Management developed during the year for TxDOT and METRO. Other activities under this task include the general support given TxDOT by TTI in the conduct of Traffic Management Team meetings and other related meetings.

Under the Urban Systems Task 3, TTI conducted travel time analyses, origin destination surveys, and other studies to evaluate the effectiveness of new access ramps to support traffic flows into the South Main/Texas Medical Center area. Over 10,000 persons in the area were contacted in the study, and 2,000 elected to participate in the survey.

In the Freeway Incident Management task (Task 4), TTI continued to develop the use of the Geographical Information System (GIS) for traffic management. A GIS model was developed by TTI to investigate the effectiveness of the computer model in assisting the control center operator in responding to incidents in an appropriate time and manner. Also, under this task, TTI continued to monitor and evaluate the effectiveness of the Motorist Assistance Program (MAP). MAP continues to be one of the most effective and successful programs of the Transportation Management System, providing more than 100 assists per day to motorists who have experienced vehicle problems.

The Urban Planning task (Task 5) contains many field data collection efforts to measure roadway inventories, travel time and speed statistics, and vehicle classification information. TTI surveyed over 7,600 sections of roadway and measured travel times over 2,300 miles.

Traffic data is the basic need of transportation management systems. Until the automated systems of traffic monitoring are available, manual studies will be required to maintain the database for the Houston area under Task 6. TTI has conducted over 1,000 traffic machine volume counts, as well as other manual turning movement, classification, and travel time/delay studies as requested by TxDOT and as needed to conduct the various evaluations required of the other tasks in the project.

The Public Surveys and Information task (Task 7) provides support to the TxDOT Public Information Department. TTI conducted mobility and safety surveys at the Houston Auto Show; conducted focus groups for assisting in the research/selection of a "formal name for Houston's new Traffic Management Center (Houston TranStar); and developed an informational brochure for the opening of the Fred Hartman Bridge in Baytown, Texas.

Under Task 8, the Central Control System Design work team initiated significant work. TTI developed some of the software for Houston TranStar and coordinated efforts with TxDOT and their Systems Integrator, Loral, in multiple aspects of preparing for the opening of the traffic management center. TTI attended and participated in weekly status meetings: Operations Working Group meetings and Operations Working Group/Design Working Group

meetings. TTI also attended the Systems Design Review, presented by Loral, and submitted comments on the design to TxDOT and Loral. Another major activity supervised by this task was the inventory of existing traffic management devices in the field. This work has been very useful to Loral in their development of the operating systems for TranStar.

Finally, in the task on Intelligent Vehicle Systems Development (Task 9), TTI continued to provide support in the development of the Houston AVI—Phase 2 program with the recruitment of approximately 3,000 volunteers to serve as AVI probes. TTI also provided technical assistance to TxDOT in the preparation of proposals, work orders, and other documentation in conjunction with the development of several cooperative projects with the Federal Highway Administration as well as other local transportation agencies.

1.0 INTRODUCTION

The Houston District of the Texas Department of Transportation (TxDOT) continues to reconstruct the urban freeway system to replace roadways that have reached their effective life, to expand the roadways to accommodate the increasing demand for mobility, and to incorporate special use facilities such as High Occupancy Vehicle Lanes (HOVLS) to provide priority operations for high volumes of commuter traffic. However, TxDOT must justify the roadway expansions in terms of the effects on air quality since Houston has been designated as a non-attainment area. These air quality requirements present opportunities to expand the application of traffic management strategies and techniques to improve the efficiency and safety of existing and new freeways and arterial streets because Houston has been designated as one of four national Priority Corridor sites. The development of advanced systems of traffic management through the Intelligent Transportation System (ITS) Program has progressed with the establishment of many projects, such as: the operational test, Smart Commuter Project; several projects under the Priority Corridor Program; and other projects in the ITS Centers for Excellence Program of the Texas Transportation Institute (TTI).

TTI, through its research program, has developed a staff that is uniquely qualified to assist the Houston District of TxDOT in the planning, development, and operation of transportation facilities, in the management of traffic and traffic operations on the Houston HOVL and freeway system, and in the development of proposals for the award of contracts in the ITS and Priority Corridors Programs. The Houston-based staff of TTI has the support of the headquarters office at College Station, but is available for daily consultations with TxDOT and the Houston District staff. TTI and the Houston District staff develop these statements of work to be performed through these continuing and personal contacts.

This report summarizes the annual activities of the many projects undertaken as part of this contract, which is the eighth 2-year contract between TTI and the Houston District office. Many of these activities, such as roadway inventory, network travel time analyses, and traffic data collection, are continuing efforts that support several departments of the District Office. Many other projects involve short-term studies with specific time dependent schedules

for the analysis and determination of solutions. Recent activities have involved the formation of projects in the Federal ITS Program and the development of documentation for other demonstration programs supported by the Federal Highway Administration. The significance of these issues is the ability of the Houston District office to respond through the TTI agreement to rapidly changing requirements in the areas of air quality, traffic management, and information systems.

Therefore, the goal of the study is to provide the Houston District office of TxDOT with staff support to conduct planning, engineering, and technical services in the development and management of urban transportation facilities.

2.0 STATEMENT OF TASK ACTIVITIES

TASK I. HIGH OCCUPANCY VEHICLE LANE SYSTEM IMPLEMENTATION AND EVALUATION

TxDOT made the decision to change the funding for this project from TxDOT to the Metropolitan Transit Authority of Harris County (METRO) late in Fiscal Year 1994. In order to facilitate a successful transition from one agency to the other, TxDOT funded a small amount of the total budget in Fiscal Year 1995, which ensured TxDOT access to future summary reports from METRO and additional data requests as needed. The objective of this task is to provide planning and engineering services to TxDOT in support, as needed, for the implementation and evaluation of the Houston HOVL system. TTI supplemented this task by conducting similar tasks under an interagency contract with METRO. The work included monitoring operations on all active HOVLs on a quarterly basis, conducting studies and analyses to expedite implementation of HOVLs, and documenting and reporting evaluation results and recommendations relating to the Houston HOVL system. TTI assisted with the coordination between METRO and TxDOT in the transition of this project.

TTI conducted occupancy and vehicle volume counts during the first two quarters of the fiscal year on all Houston HOVLs at two or more locations on each facility. All associated park-and-ride lots and park-and-pool lots (twenty-nine lots in total) in the major freeway corridors were counted. TTI prepared and distributed quarterly reports of this data (1).

TASK II. TRAFFIC MANAGEMENT, OPERATIONS, AND CONTROL ANALYSIS

The objective of this task was to provide engineering and technical assistance to TxDOT as requested in the analysis of traffic management, operations, and control problems on the Houston freeway system and adjacent roadway network. These analyses included evaluations of traffic control plans in work zones and construction projects, testing new technologies in traffic detection and communications, development of accident investigation site projects, development of justification statements for air quality funding, ramp metering

projects, and priority corridor projects. This task also supported the development of detection and instrumentation to monitor speeds and classify vehicles that travel urban interchange ramps with high degree of curves. This task also provided support for TxDOT in the conduct of traffic management meetings for freeway operations, Motorist Assistance Program, and High Occupancy Vehicle Management. The project staff conducted many activities under this task, some of which are listed below.

1. Several improvements have been made to the demonstration detection system of commercial vehicles and their speeds on the I-610 North Loop Freeway connection to U.S. 290 Eastex Freeway. TxDOT has included this project in the Priority Corridor Program.
2. Prepared justification statements for ramp metering installations on three freeways: S.H. 288, I-10 Katy Freeway, and I-10 East Freeway.
3. Conducted Road User Cost Analyses for U.S. 59 Eastex Freeway.
4. Drafted Priority Corridor Program work orders for proposals developed for 1994-95 funding for submission to FHWA.
5. Conducted a study of the Sam Houston Tollway connection to I-10 Eastbound Freeway in conjunction with the Center for Transportation Research (CTR) to determine the demand from that ramp connection to the Memorial City shopping, office, and business area.
6. Conducted FREQ Model analyses for I-10 Katy Freeway and I-10 East Freeway in support of TxDOT's I-10 Major Investment Study.
7. Reviewed calibration requirements for the Computerized Transportation Management Systems (CTMS) projects on the I-45 Freeway.
8. Conducted inventory of CTMS devices installed prior to August 1995.
9. Developed list of alternatives for Transportation Systems Management (TSM) improvements for I-10 Katy Freeway.
10. TTI staff provided support to TxDOT in the conduct of monthly Traffic Management Team Meetings.

Deliverables provided to the Houston District include:

1. Technical memoranda on the Justification Statements for ramp metering (2).
2. Technical memorandum on the road user cost for U.S. 59 (3).
3. A draft report entitled "Memorial City Area Traffic Analysis" (4).
4. Layouts of flow rates and demands for the Houston HOV Lane system (5).
5. Device database and freeway diagrams (6).

TASK III. URBAN SYSTEMS CONCEPTUAL PLANNING AND DESIGN

The objective of this task is to provide conceptual planning and engineering design services to TxDOT to address long range reconfiguration of the Houston freeway system. The description of types of work accomplished under this task include: multi-modal facility analysis; future freeway simulation modeling; corridor capacity analyses; conceptual design projects; visual analyses of future design alternatives; and pre-construction/construction and traffic operations data collection. The evaluation of impacts of these projects on air quality were an objective of this task where feasible and relevant. Some of the specific analyses conducted under this task are discussed below.

1. An Evaluation of the Current State of Mobility in the South Main/Medical Center Area
 - TTI initiated this study at the request of TxDOT to evaluate mobility in and around the South Main/Texas Medical Center area. The initial data collection focused on traffic/travel related data, and a benefit/cost analysis of a proposed U.S. 59 Southwest Freeway exit ramp. A technical memorandum documented the results of this study (7). TxDOT requested additional work after their review of the technical memorandum. This work was included in a motorist survey documenting travel patterns and attitudes of commuters to Rice University and the Texas Medical Center.
 - TTI staff developed a survey instrument with the assistance of TxDOT and other transportation agency personnel. The survey was distributed to 10,000

staff and employees of the Medical Center staff/employees in March 1995. Rice University chose not to participate in the survey, but provided a listing of employee home zip codes. TTI prepared a draft report in August 1995, documenting the responses from the 2,000 survey participants.

2. Analysis of the Viability of Constructing an Exit Ramp Directly from the U.S. 59 Southwest Freeway Northbound Mainlanes to South Main Street (8)
 - Results of the two efforts undertaken to assess mobility in the South Main area of Houston were combined into one report focusing on the viability of constructing an exit ramp from the U.S. 59 Northbound mainlanes to South Main Street. This report includes benefit/cost calculations based on different diversion scenarios and revised cost estimate figures.

TASK IV. APPLICATIONS OF GEOGRAPHICAL INFORMATION SYSTEMS (GIS) IN TRAFFIC MANAGEMENT

The objective of this task was to develop a GIS for use in the Houston TranStar, on a UNIX workstation platform. The GIS, which was to be installed in the Interim Central Control Facility (ICCF), was to include applications for incident response, motorist assistance and area evacuation. The GIS was to serve as an operational manual for use by the staff of the ICCF. The broadly stated statement of work included technical support to TxDOT for documentation and analysis of all freeway incidents through monitoring of the Motorist Assistance Program (MAP) and associated incident responses through the implementation of GIS applications. Automatic Vehicle Location (AVL) technology was to be interfaced with the GIS for real-time vehicle tracking applications in fleet management, inventory management, and data collection. Some specific activities conducted under this task include the following.

1. GIS Development
 - Two separate GIS Models for incident response have been selected for development. Both use a generic set of incident response levels to compute a specific incident management plan for a particular location.

- The first model concentrates on incidents that occur on freeway interchanges. A GIS prototype for the interchange of North Freeway (I-45) and North Loop (I-610) has been developed on a PC platform. The model assigns an incident response level, based on the location, time of day, and estimated duration of the incident. The model then prompts the operator for the appropriate response that corresponds to the level and location of the incident.
- The second GIS model is for a corridor along the North Freeway. The GIS model will identify the appropriate devices for incident response and create a log of the incident response actions taken by the operator. For this purpose, a device inventory of the CCTV, Variable Message Signs (VMS), and Lane Control Signals (LCS) currently installed along the corridor has been prepared, and a database relating the devices to different sections of the corridor is being developed to convert the device inventory data to a GIS base map.

2. Automatic Vehicle Location/GPS

- Automatic Vehicle Location (AVL) is a technology that is of significance to service patrols, such as the Motorist Assistance Program (MAP). *AirTouch Teletrac*, a radio-location based AVL system, has been acquired and evaluated. The evaluation determined that this AVL system can locate a vehicle within a few hundred feet of its actual location in 95% of trials. However, there is a limit on the number of vehicles it can track simultaneously.
- A differential Global Positioning System (GPS) receiver, purchased during the fiscal year, is being used for evaluation of GIS base maps and to accurately determine the location of various traffic information and control devices for incident management. Another application of the GPS is to interface the location results with a GIS to provide for remote vehicle-tracking.

3. Monitoring of Map Operations

- Quarterly reports of the Houston Motorist Assistance Program have been prepared and submitted to the sponsor, TxDOT, over the 1994-95 Fiscal Year (9). These Quarterly Reports include Operational Summaries which update MAP operations since TTI began reporting MAP statistics in October 1989.

4. Other Activities

- TTI assisted TxDOT in the evaluation of GIS development tools for use in GIS development for Houston TranStar. TxDOT selected the GDS Corporation to provide the GIS package.
- TTI identified the following GIS-based applications for implementation in Houston TranStar:
 - Delay Estimation and Alternate Routing in incident situations;
 - Automatic Identification of Appropriate Traffic Control Devices in incident situations;
 - Service Patrol (MAP) Fleet Tracking and Management;
 - Identification of Incident Response Personnel; and
 - Identification of Barricade Points and Alternate Routes in emergency situations such as gas leaks and chemical spills.

TTI also investigated the following location referencing methods for GIS based traffic and incident management:

- Geographic Co-ordinates;
- Texas Reference Marker System and MilePost; and
- Street Intersection and Block Numbers.

Deliverables include:

1. Technical Memorandum on evaluation of GIS tools for Houston TranStar (10).
2. Technical Memorandum on GIS Traffic Management Applications (11).

3. Technical Memorandum on Incident and Response Logging (12).
4. GIS Applications Operations Manual (13).

TASK V. URBAN PLANNING STUDIES AND TECHNICAL ASSISTANCE

The objective of this study is to provide the Houston District Office of TxDOT with staff support to conduct planning, engineering, and technical services in the development and management of urban transportation facilities.

Project tasks consisted of providing collection, reduction, and analysis of transportation data in support of TxDOT studies relevant to urban planning. The project staff obtained field information regarding traffic movements, vehicle volumes and types, passenger volumes and distribution, operational speeds and travel times, roadway physical features, and other areas of special interest (environmental, etc.) required for urban planning studies. The data were processed and maintained by computer file for summary tabulation and statistical analysis. TTI also provided technical assistance as needed by TxDOT with any other computer databases or programming. Some specific activities conducted under this task are discussed in the following sections.

1. The 1993 Houston-Galveston Regional Transportation Study (H-GRTS) Roadway Inventory Project
 - This study was an update to the 1985 Roadway Inventory Project and a partial update to the inventory conducted in 1987. Field work included traveling extensively throughout Harris County and the seven (7) surrounding counties: Brazoria, Chambers, Fort Bend, Galveston, Liberty, Montgomery, and Waller. The inventory consisted of over 2,618 sections of roadway in the seven surrounding counties and 5,012 sections of roadway in Harris County. The inventory included measuring and evaluating the section of roadway for: roadway width, median type and width, type, condition and markings of pavement, number of stop control devices, etc.

2. The 1994 Houston-Galveston Regional Transportation Travel Time and Speed
 - TTI conducted Travel Time Runs (TTR) for over 120 different facilities for both directions of travel during each peak period and during non-peak travel times. TxDOT reviewed the results and TTI made corrections of any irregularities identified and conducted additional travel runs as requested by TxDOT. The data were processed and presented in summary tables for each facility. TxDOT received hard copies of the field data, computer files of the processed data, and the summary tables in May 1995.
3. The 1995 Houston Central Business District/Activity Center Travel Time Study
 - TTI conducted travel time studies in April 1995 and reduced and analyzed the data in August 1995. The Activity Center TTR supplements the larger TTR study. The studies involved collecting travel times on twelve activity center routes which totaled 2,300 miles of roadway.
4. The 1995 24-Hour Vehicle Classification Counts
 - This information provides information for planning models and capacity analysis. TTI collected classification data from June through July 1995 at fourteen locations, which included four sites on Katy Freeway, four on the 610 Loop, and one site on each of the radial freeways in the Houston area.

Deliverables include:

1. A short technical memorandum entitled 1993 Houston-Galveston Regional Transportation Study (H-GRTS) Roadway Inventory Project (14).
2. A technical memorandum entitled HOUSTON-GALVESTON REGIONAL TRANSPORTATION STUDY 1994 Travel Time and Speed Survey (15).
3. A technical memorandum entitled 24-Hour Classification Counts for the Houston Area Analysis (16).

TASK VI. TRAFFIC DATA COLLECTION AND OPERATIONAL STRATEGY SUPPORT

This task provided for the collection, reduction, and analysis of traffic data in support of TxDOT studies relative to traffic management strategy analyses and impacts on air quality. This work included the field acquisition of freeway, ramp, frontage road, arterial, and major intersection vehicular volumes and movements. TTI applied the data to the evaluation of freeway ramp metering warrants, road user cost analyses, construction lane closure strategy evaluations, right-of-way acquisition support, and other traffic operations studies as directed by TxDOT personnel. TTI prepared reports of the analyses and maintained and distributed the existing TTI database of traffic counts, completed within the District.

TxDOT deleted the additional sub-task of conducting monthly statistical analyses of traffic signal maintenance records, since the Houston District is now able to prepare their own reports.

A summary of the many studies, data collection activities, and other reports prepared at the request of the TxDOT Houston District staff are listed below.

1. For the one-year period from September 1, 1994 to August 31, 1995, TTI completed 1,150 traffic volume studies at 1,045 separate locations. TTI conducted manual turning movement, freeway mainlane volume/classification and travel time/delay/speed studies as needed. The TxDOT contact person received all data from the requested studies, upon the completion of the effort. Most of the data collected were to support other TTI studies regarding ramp metering warrant evaluation, road user cost studies, and construction/maintenance lane closure strategies. Summaries of all counts and 24-hour totals were submitted to several Houston District departments (traffic operations, right-of-way, construction, advanced project development, advanced transportation planning, design, maintenance) each month (17).

2. TTI conducted major traffic studies at six-month intervals near the Greenspoint (I-45 North at Beltway 8) and Willowbrook (S.H. 249 at FM 1960) regional shopping malls to assess the impact of the roadway construction on traffic patterns (18). TxDOT staff also used the volumes to evaluate the lane closure strategies of the traffic control plan prior to implementation.
3. TTI conducted freeway mainlane and HOV lane traffic counts to supplement yearly ramp counts completed by the Transportation Planning Division (19).
4. TxDOT identified special problems for study. For example, the project staff studies the impact of the partial closure of the I-10 East Freeway bridge over the San Jacinto River (20, 21).
5. Evaluations of freeway operations respective to ramp metering warrant analysis required the collection of freeway and frontage road volume counts and freeway travel time/speed studies. The Houston District staff requested TTI to conduct ramp metering warrant analyses, for which reports were prepared for the following freeways: S.H. 225 LaPorte Freeway (22), I-610 Loop Freeway (23), SH 288 South Freeway (24), I-10 Katy Freeway (25), and I-10 East Freeway (26).
6. TTI developed road user cost estimates to assist TxDOT in assessing liquidated damages in construction projects. TTI collected the necessary traffic data and prepared cost estimates on I-10 Katy Freeway (27), U.S. 59 Southwest Freeway at Beltway 8 (28), and U.S. 59 Eastex Freeway—Chartres Street Elevated (29).
7. A major study of traffic operations and freeway ramp/access analysis was conducted for the Memorial City Area of the I-10 Katy Freeway corridor. The study, which was originally requested of the District by the Highway Design Division, included working with staff from the Center for Transportation Research. TTI prepared a draft report (30) for presentation to TxDOT District and Division, CTR, and FHWA staff.

This task was one of the primary sources of information on traffic characteristics of freeways and frontage roads in the Houston area for several years. The Planning, Construction, Design, Maintenance, and Operation Departments of TxDOT and others use this information in many aspects of their work.

TASK VII. PUBLIC SURVEYS AND INFORMATION

The objective of this task was to assist the Houston District Office of TxDOT in increasing communication to the public and understanding by the public of TxDOT activities. This task provided technical services to TxDOT for the conduct of public opinion surveys to obtain data relevant to the presentation of public information. The performing agency also provided technical assistance as needed by TxDOT. Some specific activities conducted under this task were:

1. 1995 Houston Auto Show
 - TTI manned a booth at the 1995 Houston Auto Show from March 25-April 2, 1995. TTI staff personnel conducted a survey of visitors to the show and provided them with Texas Highway maps. TTI also arranged to provide Real Time freeway travel speeds during the show to promote and explain the AVI program, as well as gain more volunteers to the program.
2. Research for naming Houston's new Traffic Management Center
 - TTI conducted transportation consumer research to guide the four agencies involved with selecting a name for the new center. TTI conducted a mall shopper survey and a focus group discussion in Houston -- both on Wednesday, May 24, 1995. The purpose of the focus group exercise and mall survey was to test five names identified by agency representatives as potential names for the new center, determine preferences, and evaluate how effectively each name communicated the purpose of the center and program.
3. Public Information Brochure for the Fred Hartman Bridge—Baytown, Texas
 - TTI compiled construction, operational, and geometric statistics on the completion of this bridge. TTI prepared a brochure for TxDOT that will be circulated to interested parties at a later date.

Deliverables include:

1. TTI prepared thank you notes for TxDOT for those agencies helpful in the success of the Auto Show. TTI prepared a technical memorandum for TxDOT, documenting the survey results and the approximated expenses for TTI's effort for the Auto Show (31).
2. Research staff compiled a report on media relations guidelines at Traffic Management Centers around the country to give the Houston Traffic Management Team some background and guidance on establishing Houston's own policies (32).
3. TTI submitted a marketing/outreach plan to the agencies involved with naming the Traffic Management Center, which is the informal plan in current use (33).
4. The TTI staff prepared a technical report entitled, "Identity Program Development/Market Research for the Houston Traffic Management Center", which was submitted to TxDOT on May 31, 1995 (34).

TASK VIII. CENTRAL CONTROL SYSTEM DESIGN AND SOFTWARE DEVELOPMENT

TxDOT selected Loral Space Information System Corporation to be the Systems Integrator (SI) for Houston TranStar. Loral has been under contract and has been performing SI responsibilities since July 18, 1994. TTI worked closely with Loral to develop a working system within the Houston TranStar to monitor and control transportation and emergency situations in the Greater Houston Area. As Loral became the SI, TTI's role conformed to fit with the capabilities of each entity. TTI worked closely with the SI in all aspects of this project. TxDOT has the responsibility of managing project implementation. Some specific activities conducted by TTI under this task included:

1. TTI participated in weekly status meetings between Loral and the participating agencies.

2. Various TTI personnel participated in the Operations Working Group meetings. These were very successful in bringing out and documenting system requirements. Loral produced two documents, an Operations Concept and a System Requirements Document, which were both reviewed by TTI in detail, and comments, corrections, and suggestions submitted to TxDOT.
3. The Operations Working Group and Design Working Group meetings have been completed. The last meeting was a Systems Design Review presented by Loral to both groups. TTI attended this review and made comments to TxDOT and Loral on the system design. As part of the system integration, specific meetings were held with key personnel from the participating agencies to discuss and agree on design and operational issues such as ramp metering, design, and operation and HOVL system design and operation.
4. TTI located, identified, and gathered information on field devices. This information will be useful in: 1) developing a roadway model; 2) controlling devices; 3) collecting traffic data; 4) managing incidents; 5) device maintenance; and 6) estimating system load. Project staff produced a device inventory design document which lists all control and detector devices to be inventoried and exactly what information is to be collected on each device. An inventory of all devices was completed for the I-45 North and I-45 Gulf freeways, and an inventory of all operational Changeable Message Signs (CMSs) in the Houston area was completed. TTI entered the inventory into Dbase IV database and produced roadway diagrams which show the geographic location of the devices. Much of this information is currently being used in TxDOT's Freeway Traffic Management System software on I-45 North and I-45 Gulf freeways. TTI also initiated an inventory of HOVL devices on the I-45 North and I-45 Gulf Freeways. Loral used TTI's device inventory design document to begin creation of the Houston TranStar database model. TTI worked closely with Loral to create and review this model and to import the collected device data into the Oracle database server being developed for the Houston TranStar.
5. TTI participated in various design meetings dealing with the detailed design of system software for the Houston TranStar. This included areas such as network

communications, software development tool selection, hardware and computer equipment selection, existing system integration, traffic engineering, data entry form design, and database design.

6. TTI has started the initial design and planning for migrating the Automatic Vehicle Identification system into the systems of the Houston TranStar. The current AVI system is made up of two major software components. The AVIcalc software, which calculates roadway travel times, and the AVIview software which displays this information to the user. TTI will work with the SI to "port" the AVIcalc software to a workstation platform to make integration into the Houston TranStar possible. The AVIview software will remain, but will be supplemented by software developed by Loral to view the information within their mapping software.
7. TTI has begun design and implementation of an "On-line Operating Procedures" system which will allow Houston TranStar operators to have quick access to operating procedures and contact phone numbers through an MS-Windows help file. A key part of these procedures includes incident management procedures.
8. TTI provided Loral with a set of Houston Incident management GIS files in ARC/INFO interchange format as requested by TxDOT. Loral converted these to GDS GIS in order to demonstrate the data conversion capability of GDS prior to selection of the GIS tool and base map.
9. TTI assisted the development team for Houston TranStar in the evaluation of GIS tools. GDS was subsequently selected by the systems integrator.
10. TTI assisted the Houston TranStar development team regarding potential digital base maps and databases for the Houston TranStar. The team considered two maps, ETAK and NavTech, with the map and database from ETAK being extensively evaluated.
11. TTI assisted the systems integrator in the following areas:
 - AVL system for the Motorist Assistance Program;
 - Review of database sub-model, especially in the area of incident logging and road closure logging; and

- Software development features in GDS, the GIS tool selected for Houston TranStar.
12. Developed graphical user-interface screen designs for Incident/Response Logging and Roadway Closure. These designs are currently under implementation by the systems integrator.
 13. TTI made arrangements to obtain the following for further work by TTI regarding the Houston TranStar:
 - a copy of GDS software for TTI at no cost; and
 - a copy of digital base map from ETAK, also at no cost.

Deliverables include:

1. Technical memorandum on review of Operations Concept (35).
2. Technical memorandum on review of System Requirement Document (36).
3. Technical memorandum on System Design Review (37).
4. Summary of Field Device Inventory (38).
5. Design documents for user-interface for the incident and response logging and for roadway closure logging (39).
6. A report on the evaluation of ETAK base map (40).

TASK IX. INTELLIGENT VEHICLE/HIGHWAY SYSTEM (IVHS) DEVELOPMENT (DEVELOPING AND IMPLEMENTING PHASE 2 OF THE AVI PROGRAM)

There were two main objectives under this work task: 1) to solicit 3,200 citizen volunteers to serve as traffic probes in the AVI-Phase 2 Real Time Information Program by contacting the public through the news media and other available sources; and 2) to work with METRO, TxDOT, and the MPO of Houston to develop a strategic plan for the development of Intelligent Transportation Systems (ITS) projects. This objective was initiated in the second half of the year, with additional funding support made available from METRO and the MPO. Specific activities conducted under this task are:

1. The project continued to publicize the AVI system through the media and to use roadside message signs to obtain the volunteers to serve as traffic probes. Over 2,900 persons signed up for AVI-Phase 2, joining the 1,000 persons who had previously signed up for AVI-Phase 1.
2. The processed real travel time information provided by the AVI system has been available to the general public since December 1994 on the Internet System, with an address of *HTTP://Herman.TAMU.EDU/Houston-Real.HTML*. TTI is continuing the study of other approaches for disseminating the information to various user groups.

The development of an ITS Strategic Plan has progressed through the collection of information from various agencies responsible for the implementation of transportation management and information systems. A draft report of these activities have been prepared and submitted to the Houston agencies for review.

Deliverables include:

1. A summary report on the distribution of probe tags (41).
2. A draft report on the strategic plan development of ITS (42).

3.0 CLOSURE

The activities listed in this report represent only a part of the accomplishments of the partnership of the Houston District office and TTI. TTI staff attend and participate in numerous meetings with TxDOT and other transportation agencies. TTI staff often meet with visitors to TxDOT from other states and countries. Prebid conferences, planning and management meetings, plan reviews, and traffic control conferences are some of the activities in which TTI staff participate.

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36. Technical Memorandum on Review of System Requirement Document.
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