PLANNING, DESIGN, AND OPERATIONS OF TRANSPORTATION FACILITIES IN HOUSTON

A Summary of Activities
Final Report
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TABLE OF CONTENTS

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Introduction

This report is a summary of activities conducted by the Texas Transportation Institute (TTI) over a two-year period for the Houston District Office of the Texas Department of Transportation (TxDOT) as part of a study entitled, "Planning, Design, and Operations of Transportation Facilities in Houston." The objective 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. This study is organized into ten major tasks. A work statement and brief report on the activities conducted under each of the tasks is presented in this report. This study represents the sixth 2-year contract between TTI and the Houston District Office of TxDOT.

Task 1. Transitway System Implementation and Evaluation

This task provides planning and engineering services to TxDOT in support as needed for the implementation and evaluation of the Houston transitway system, now known as the High Occupancy Vehicle Lane (HOVL) System. This task provides for the monitoring of operations on all active HOVL's, the conduct of necessary studies and analyses to expedite implementation of HOVL's in planning and design, and the documentation and reporting of evaluative results and decisive recommendations relating to the Houston HOVL System. TTI also assists TxDOT with coordination between cooperative agencies and serves with representation at all requested technical meetings.

During this year vehicle occupancy and vehicle volume counts were conducted monthly on all four of the Houston Transitways at two or more locations on each facility. Vehicle counts were also made at all park-and-ride lots and park-and-pool lots (twenty-six lots in total) in the major freeway corridors. Travel time surveys were conducted on each

High Occupancy Vehicle (HOV) Lane during each quarter. Quarterly reports of this data were prepared and distributed (1). A 90-day evaluation of 2+ person carpools on the North Transitway was conducted (2).

Task 2. Traffic Management, Operations, and Control Analyses

This task provides engineering and technical assistance to TxDOT for the analyses of traffic management, operations, and control problems on the Houston freeway system and the adjacent arterial network. Studies were conducted to improve capacity, level of service, and motorist information within physical and fiscal constraints. The areas of study included construction and maintenance work zones, major interchanges, intersections, ramp metering, freeway reconfiguration, and freeway/frontage road interface. The development of automated signs and signals on frontage roads to adjust approach capacities to traffic demands to reduce congestion and energy consumption was partially sponsored by this task. TTI also coordinated and provided participative support to traffic management meetings and conducted workshop training in specific areas of technical need as defined by the TxDOT.

Some specific activities conducted under this task are:

1. Conducted a frontage road analysis at I-45 North Freeway at Needham Road and submitted a technical memorandum to District.
2. Prepared road user cost analyses for several projects:
   - Pavement overlay project at SH 105 with FM 149.
   - Bridge replacement project on U.S. 90A near Wayside (3).
   - Bridge replacement project in North Harris County (4).
   - Freeway reconstruction project on U.S. 59 Eastex Freeway (5).
3. Analyzed the benefits of expending the proposed reversible lane along Westpark a distance of 0.5 miles.
4. Analyzed traffic alternatives within the Galleria Area. Private sector and TxDOT alternatives were compared using the TRANSYT-7F Model and two technical memoranda were prepared (6).

5. Calibrated six FREQ10PC simulation models of U.S. 59 Southwest Freeway and prepared a report of the simulation results.
6. Prepared an analysis of the I-10 Katy Freeway at Sam Houston Tollway split diamond interchange.
7. Evaluated the use of the HOVL on Katy Freeway as a bypass to the I-10 Katy Freeway overlay project.
8. Development of Operation Plans and Operating Manuals for the METRO crews that are responsible for deployment and response to incidents (7).
9. Implementation of a demonstration project to detect and measure truck speeds on critical freeway sections was completed. Studies of effective warning systems are being conducted.
10. Video imaging processing systems have been investigated for applications to the surveillance and measurement of traffic operational characteristics (8).
11. Analyzed the freeway system in Harris County for the implementation of Accident Investigation Sites (9, 10).
12. Analyzed the design and operation of the U.S. 59 Southwest Freeway northbound to the I-45 Gulf Freeway southbound connection (11).

Task 3. Urban System Conceptual Planning and Design

This task provides conceptual planning and engineering design services for TxDOT to establish long-range reconfiguration of Houston urban system. Capacity and level-of-service model projections were made to identify operational and safety constraints, and alternative interim and future improvements were evaluated in terms of mobility benefits accrued versus construction and delay costs incurred. Recommended designs were prepared in both schematic and report form.

Some of the specific analyses that were conducted under this task are:

1. Conducted an analysis of the ramp configurations on I-610 North Loop from I-45 to U.S. 290 and evaluating current design and the design being proposed

by Houston District Office. A simulation study using the FREFLOW Model determined that the current design should be maintained.

2. Prepared the demand modeling, schematic design, and the cost estimates for I-10 Katy Freeway bypass lanes between I-610 West Loop and I-45 North Freeway, and for I-10 Katy HOV facility alternatives in the same area. The FREFLOW Model was used in the analysis.
3. Completed the route definition and cost estimate for a new major facility along the S.H. 225/Harrisburg route from I-610 South Loop to U.S. 59. Three routes were evaluated with the navigation alignment being selected because of the available rights-of-way (12).
4. Prepared the modelling and the alternative analysis for the proposed I-610 West Loop improvements. Two alternatives were considered and the link node diagrams with level-of service for each link were prepared.
5. A conceptual design for a strategic arterial street along the S.H. 225/Harrisburg route to downtown was developed and evaluated. Cross sections, intersections, and signalization plans were considered. A technical memorandum with schematic drawings, estimated construction costs, and benefit/cost analyses on the proposed facility was prepared (13).
6. Prepared a complete model of the I-610 Loop and radial freeways to downtown using the FREFLOW Simulation Model for the entire system. The Houston District is awaiting the program release by FHWA to fully utilize the model for evaluation purposes (14).
7. Evaluated low-speed weaving section characteristics of collector-distributor systems. A literature search and several initial study site evaluations were completed to develop a methodology and procedures to evaluate frontage road weaving areas.

Task 4. Freeway Incident and Special Event Planning and Implementation

This task provides technical support to TxDOT for documentation and analysis of all major freeway incidents and special event planning and implementation. A few of the

activities that have been studied under this task are: evaluation of the Motorist Assistance Program (MAP); planning and evaluation of bus shuttle services from park-and-ride facilities to special events, such as Houston Livestock Show and Rodeo and Houston Air Show; development of operations handbook for the Interim Communications Center (ICC); development of a Geographic Information Systems (GIS) for use in an automated incident management plan; and development of area wide designs for Accident Investigation Sites and informational signs for hotline numbers.

The two major activities during this contract were the evaluation of the Motorist Assistance Program (MAP) and the development of a Geographical Information System (GIS) for applications to traffic management.

1. For MAP the following was accomplished:
   a. Prepared operations handbook and dispatchers resource manual for developing the database for field inventory and report generations.
   b. Conducted MAP meetings to review status and operation of the program.
   c. Prepared monthly, quarterly, and annual activity reports for evaluating the effectiveness of MAP (15).
2. For the GIS the following activities have been accomplished:
   a. Contacted various agencies in the area that are interested in developing GIS, to include: TxDOT, METRO, Houston Police Department, Houston Fire Department, and Houston-Galveston Area Council to attempt to coordinate efforts in GIS development.
   b. Collected and coordinated the various resources for developing GIS to include: maps, roadway inventory, traffic demand volumes, and travel time information from various agencies.
   c. Designed database structure with geographical identifiers to link various databases provided from various agencies.

d. Developed applications for use in incident management plans to include alternate routing, origin-destination information, hazardous spill management information, vehicle tracking, and dispatch functions.

e. Developed user friendly interfaces for using applications and demonstrated the GIS applications to other agencies.

Task 5. Urban Planning Studies and Technical Assistance

This task provides for the collection, reduction, and analysis of transportation and related socio-economic data in support of TxDOT studies relevant to urban planning. The data collected under this task include traffic movements, vehicle volumes, types of vehicles, passenger volumes and distributions, operational speeds and travel times, roadway physical features, and other areas of special interest (such as environment) that are required for urban planning studies. These data are processed and maintained by computer files for summary tabulation, statistical analysis, and/or simulation modeling as directed by TxDOT. TTI also provided technical assistance as directed by TxDOT in performing travel demand estimations and origin-destination surveys.

The following activities were conducted under this contract:

1. Travel time and speed surveys were conducted on 150 separate facilities covering 2600 miles of roadways. Data was collected for the AM, OFF, and PM peak periods and were published in two reports (16, 17).
2. 24-hour vehicle classification studies were conducted at 16 locations, with vehicles being counted in both directions at 15-minute intervals and classified into nine categories (18).
3. Roadway inventory studies were conducted on 2500 miles in the Houston-Galveston Regional Transportation Study (H-GRTS) area. This work is completed on a three-year rotation schedule with the inventory database updated.

4. Travel time and speed studies were conducted with special emphasis on the activity centers (19) and the Sam Houston Tollway and East Belt frontage roads. Data was collected during the AM, OFF, and PM peak periods and reported in a technical memorandum.
5. Coordinated the distribution of data collected under Task 6 to the Houston District's Planning Department as the needs were identified.

This work was completed under the supervision of the Houston District Planning Staff.

Task 6. Traffic Data Collection, Database, and Computer Management

This task provides technical services necessary for the continuation of the freeway traffic database model for TxDOT. This task includes the field acquisition of freeway, ramp, frontage road, and major intersection vehicular volumes and movements. Computer assimilation of this data was conducted with analysis and outputs as directed by TxDOT. Under this task TTI also developed a database for intersection control to include inventory of traffic signal equipment, timing patterns, scheduled and performed maintenance. From this database, a listing of traffic signal records is provided to the Department each month from which various statistics, such as number of emergency calls and a list of locations that require four or more visits are determined. In the general task of data collection, turning movement counts were made at 120 intersections and five diamond interchanges; manual counts were made at three freeway mainlane locations; and automatic counts were taken at more than 500 locations, with the duration of the counts being in a range of three to ten days. The data are presented in freeway mainlane
spreadsheets for each of the major freeways. A summary of all counts and 24-hour totals is submitted to the Department each month (20).

A sample of the many studies and data collection activities conducted under this task follows:

1. All existing freeway mainlane loop detectors in Houston were examined to obtain detailed information on location and status.
2. An inventory of businesses along U.S. 59 Southwest Freeway frontage roads was conducted to evaluate lane closure strategies during reconstruction (21).
3. Conducted traffic studies to document the use of the HOVL for traffic management during nighttime pavement overlay construction (22).
4. Monitored the use of alternate routes by motorists during the Economic Summit in July 1990 (23).
5. Acquired the GRiD Systems hand-held computer equipment for collection of signal maintenance records in the field.
6. Major traffic studies were conducted at six-month intervals near two shopping malls in the Southwest Freeway area to assess the impact of the reconstruction project on traffic patterns (24).
7. Completed freeway mainlane traffic counts to supplement yearly ramp counts completed by D-10 (25).
8. Conducted quarterly detailed traffic studies on I-610 West Loop Freeway (26).
9. Conducted 24-hour vehicle classification studies on the I-610 East Loop at the Ship Channel Bridge (27).

This task has been one of the primary sources of information on traffic characteristics on freeways and frontage roads in the Houston area for several years. This information is used by the Planning, Construction, Design, Maintenance, and Operations Departments of TxDOT and others.

Task 7. Public Surveys and Information

This task provides technical services to TxDOT for the conduct of public opinion surveys to obtain data relevant to the presentation of public information. This task established market areas for general survey purposes and project specific surveys. Survey questionnaires were designed for response utility and statistical analysis. From the results

of the surveys, public information documents were prepared to increase communication and understanding by the public of the TxDOT activities.

Some of the activities and accomplishments of this task are listed:

1. Information was collected, processed, and evaluated for the TxDOT which enabled the Department to prepare a proposal for public education concerning accidents and disabled vehicle problems on freeways. This proposal which was prepared in conjunction with the Safety Council of Greater Houston, included the development of a "Fender Bender" pamphlet and a traffic safety video.
2. Assisted in the preparation of the "Press Kit" for the Fred Hartman Bridge in Baytown. The proposed brochures and information packets for this kit were patterned after those prepared for the U.S. 59 Southwest Freeway Reconstruction Project.
3. Prepared and evaluated the Texas Transportation Information Program ("TIP") brochures and assisted in the distribution to the public at the 1990 Houston Auto Show.
4. Prepared and conducted a survey of motorists using the I-10 Katy Freeway HOV Lane during a pavement overlay project. Vehicle license plates were recorded and surveys were mailed to the owners to ask several questions concerning their reasons for using the HOV Lane to bypass the construction operations. A technical memorandum summarizing the findings was prepared.
5. Developed and evaluated a survey of motorist comprehension and response to changeable message sign display information. Two reports were prepared from the results of these surveys. Guidelines for the operations of the signs in Houston were established (28, 29).
6. Assisted in the preparation of public opinion surveys for TxDOT. Surveys conducted by other states were investigated.

Task 8. Central Control System Design and Software Development

This task provides technical assistance in the development of specifications for the surveillance, communication, control, and computer hardware to be installed in the Central Control Facility for the Computer Traffic Management System (CTMS).

Some of the activities conducted under this task are:

1. For the first CTMS contract let for I-45 North and Gulf Freeways, TTI provided support in the development of the specifications.
2. The staff assisted the TxDOT in the review of the cutsheets of equipment proposed by the contractor.
3. In the design of the Central facility, TTI developed preliminary estimates of space requirements and conceptual designs. Consultations were held with the various agencies to assess their personnel and space requirements (30, 31, 32).
4. TTI developed coordinated tours to existing operational facilities for fact finding efforts and developed guidelines for the operations plans for the Central facility.
5. Under this task, TTI is helping the TxDOT determine the computer and communications design for the Central facility. The proposed design is outlined in a technical memorandum on CTMS Operations Theory. Modifications to this design may be made when detail design efforts on the Central facility begins (33, 34).

Task 9. Intelligent Vehicle/Highway Systems (IVHS) Development

This task is designed to develop proposals for implementation and evaluation of IVHS demonstration projects. The first project selected under this task was to establish and operate a Traveler Information Center as part of a demonstration project in the North Houston Corridor.

Some of the activities and accomplishments under this task are:

1. After one year of monthly meetings with public and private agencies, a project was established in the study area. A one-week test was conducted in October 1990 to establish the requirements for staffing and equipping an office to receive and process the real time data.
2. An agreement was negotiated with a local cellular telephone company to provide free air time for the traffic reports for one year.
3. A lease was negotiated with a Houston office development company to provide office space for the Interim Communication Center at cost. TTI arranged for the furnishings and telephone equipment and the Southwest Region University Transportation Center provided the computer system.
4. An agreement was drawn with the Houston traffic advisory services to provide operators to receive the traffic reports over the telephones and to input the information into the computer system.
5. TTI met with various private and public agencies to enroll their employees to serve as participants (probes) in the study. A goal of 200 volunteers will be reached in November 1991.
6. Specifications were developed and a contract was awarded to a local cellular telephone agent to provide, install, and maintain the 200 cellular telephones (35).
7. The study was initiated in early September 1991 and data and information on real time travel and roadway conditions are being collected, processed, and disseminated to a number of agencies that have various needs for this type of information. This study will be conducted for a minimum of twelve months.
8. Plans and specifications are being developed for an Automatic Vehicle Identification (AVI) system using transponder technology to replace the cellular telephone project after one year. The TxDOT will request bids for the installation of the system in 1992.

Task 10. Deployment of Advanced Technology to Improve Mobility

A joint project, sponsored by the Harric County METRO and the Houston District of TxDOT, was formed to examine IVHS technologies in regard to multimodel transportation alternatives. Specifically, this project, called the Houston Smart Commuter IVHS Demonstration Project, was to determine if the provision of current information on traffic conditions, bus, and carpool options to travelers in the home or work place would increase the use of HOVL's.

The following is a summary of the accomplishments under this task:

1. Several marked surveys and literature reviews were conducted to determine the market potential for this type of service.
2. Studies were conducted to assess the technologies available to deliver the information to the potential transitway users.
3. A proposal for a demonstration project that matches the information needs and technologies to cause a modal shift to high-occupancy travel modes was developed (36).
4. Meetings were held with FHWA and UMTA to seek additional funding to expand and implement the project. The result of this project was the development of a proposal for an IVHS project entitled, "Smart Commuter." The proposal is for a four-year project, funded at $14 million, to be jointly funded by FHWA, UMTA, METRO, and TxDOT. The proposal has been submitted to all of the sponsors for their review and approval. The project is expected to begin in FY 1991, when the Federal Budget is approved.

Task 11. Study of Infrared Vehicle Detectors

This task was conducted by the Center for Transportation Research at the University of Texas. Two detection installations were made in Houston: the first on the I-610 eastbound freeway connector to U.S. 59 northbound to measure speed and length of vehicles

with a height of greater than seven feet; the second installation on the I-10 Katy HOVL flyover ramp at Post Oak Road was to measure speeds, vehicle lengths, and direction of travel.

This project examines the application of infrared beams to detect vehicles. Two beams are used to develop a speed trap and to determine the direction of travel. A micro processor is used to calculate vehicle length and speed. This study will continue in FY 1992 as part of a new project.

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 are often asked to 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 are asked to participate.

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