



Houston TranStar Annual Report–2003

Prepared by
**TEXAS TRANSPORTATION INSTITUTE
THE TEXAS A&M UNIVERSITY SYSTEM
701 NORTH POST OAK, SUITE 430
HOUSTON, TEXAS 77024-3827**

for
TEXAS DEPARTMENT OF TRANSPORTATION



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October 2004

INTRODUCTION

Houston TranStar was created in 1993 to coordinate and enhance surface transportation operations and respond to incidents and emergencies in Harris County and beyond. Houston TranStar is a partnership among the four principal transportation and emergency management agencies in Harris County:

- Texas Department of Transportation (TxDOT);
- Metropolitan Transit Authority of Harris County (METRO);
- Harris County; and
- City of Houston.

Houston TranStar moved into its Old Katy Road location in 1996. Prior to completion of the permanent facility, the four agencies operated for two years in an interim traffic management center. Houston TranStar is the first center to include both transportation and emergency management agencies and is recognized both nationally and internationally as a model for combining resources across modal and jurisdictional boundaries.

Houston TranStar’s Mission: It is the mission of Houston TranStar and its partner agencies to provide highly effective transportation and emergency management services through the combined use of the partners’ collective resources to maximize safety and mobility to the public.

Summary of Benefits

This report highlights activities of Houston TranStar in 2003 and develops estimates of quantifiable benefits. These quantifiable benefits are savings in motorist delay attributable to the existence of Houston TranStar. Estimated motorist delay savings were over **8.3** million vehicle-hours. These estimated delay saving benefits (travel time and fuel savings), attributable to Houston TranStar operation, are compared to annualized capital and operating cost to develop a benefit/cost ratio. Annual benefits were estimated to be **\$167.3** million and annual cost at **\$24.0** million, yielding a benefit/cost ratio of **7.0**.

Congestion and cost savings from 1997 through 2003 are summarized in Table 1. Since 1997 over **39** million vehicle-hours of congestion have been saved at a cost savings of over **\$742** million.

Houston TranStar Organization

Houston TranStar uses a three-tiered management structure with representation of each of the four agencies on each committee (Figure 1). Functions of the three committees are:

<i>Year</i>	<i>Congestion Savings (vehicle-hours)</i>	<i>Traveler Cost Savings (\$)</i>
1997	2,719,300	\$ 46,266,000
1998	4,075,800	69,219,000
1999	5,439,000	95,509,000
2000	5,866,000	110,914,000
2001	6,945,800	133,155,000
2002	8,559,200	166,310,000
2003	8,338,800	167,261,000
Totals	39,224,600	\$742,368,000

- Executive Committee—sets policy and manages fiscal and staffing matters;
- Leadership Team—administers implementation of various projects and activities and reviews funding commitments; and
- Agency Managers Committee—comprised of managers of the transportation and emergency management groups; the agency managers are responsible for daily operations.

Houston TranStar is staffed by employees from the member agencies that support the three levels of management in operating the systems and programs housed in the Center. Operation of the Center is coordinated by a small management staff that is responsible for operating and maintaining Houston TranStar facilities, coordinating multi-agency activities, coordinating budget preparation, workshops, meetings, and facility tours, and managing public information activities.

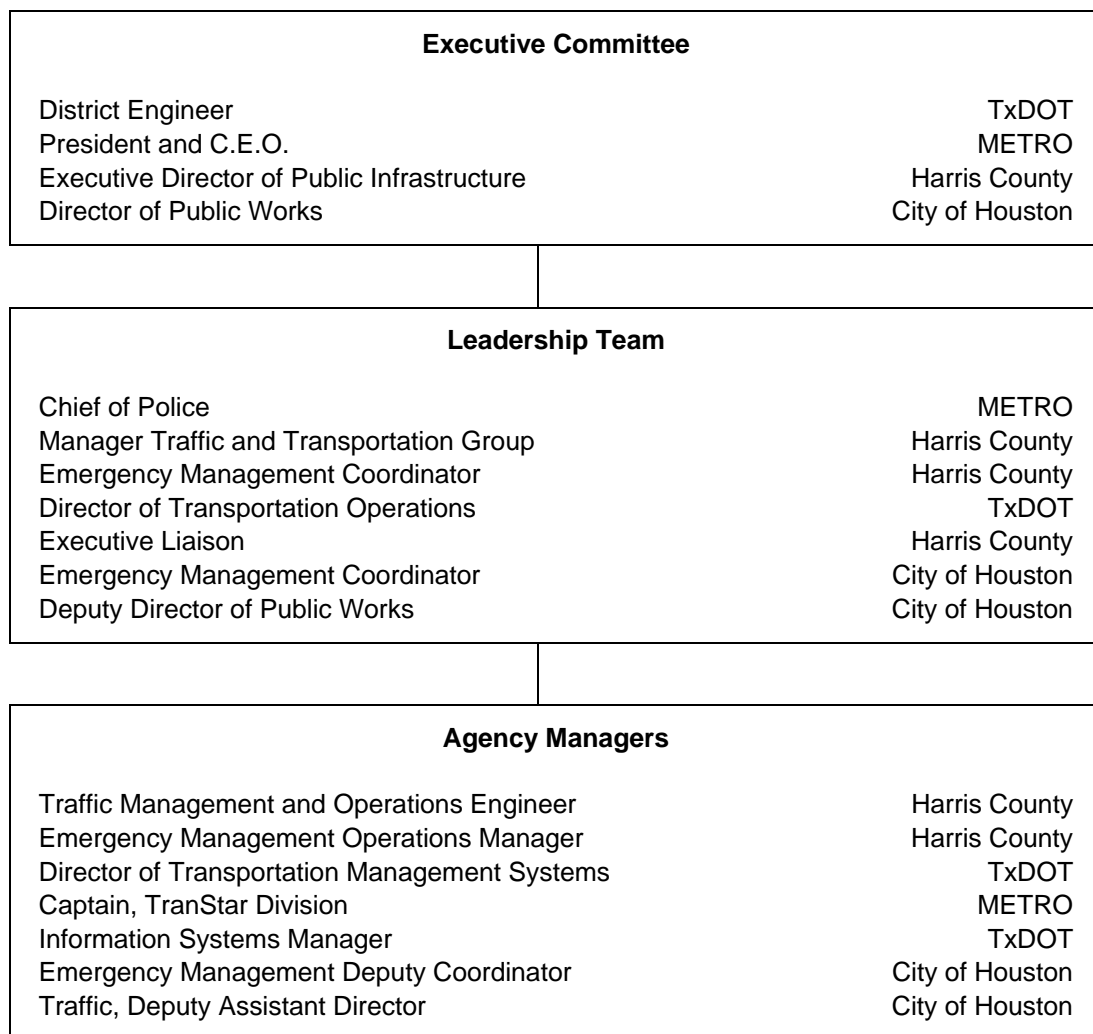


Figure 1. Houston TranStar Organization

Each of the four Houston TranStar partner agencies has different functions and responsibilities relative to transportation. The Texas Department of Transportation (TxDOT) is the only partner that focuses its resources primarily on transportation; as such, TxDOT is the largest transportation agency in the area. METRO provides transit services as its core function but is also involved in other transportation and law enforcement as significant functions. The City of Houston and Harris County have very broad responsibilities, only one of which is transportation. Both the city and county also have emergency management functions that are a part of TranStar. Law enforcement is an important component in functions coordinated through TranStar. Nevertheless, the concept underlying TranStar and essential for its success is teamwork, e.g., action by all four agencies together to monitor, provide information about, respond to, and manage, where appropriate, both emergency and transportation operations conditions.

SUMMARY OF ACTIVITIES

Houston TranStar is a flexible and dynamic partnership whose scope and services have been evolving since its inception. Houston TranStar continues to improve its operational effectiveness and expand its transportation and emergency management facilities and systems. Cooperative working relationships, fostered by daily interaction of staffs of various agencies in the region and frequent coordination and training meetings are invaluable to the operations of Houston TranStar. Activities and accomplishments for the Year 2003 are highlighted in the following sections.

Houston TranStar Operations

Houston TranStar staff provides administrative, coordination, and systems support for the facility and partner agencies. Representative activities for the year include:

- Hosted 113 tours with 2,468 visitors to Houston TranStar (Table 2);
- Conducted 9 “special visits” including elected officials and national transportation professionals;
- Hosted 11 news conferences by partner agencies;
- Hosted 7 conferences and exercises including national ITS workshop;
- Discovery Times television featured Houston TranStar in its program;
- Significantly expanded traveler information website;
- Participated in Homeland Security planning for the Houston region;
- Continued systems upgrades and integration migration to ATM (asynchronous transfer mode) communication system;
- Integrated METRO Dispatch (bus and rail) into Houston TranStar.
- TxDOT initiated reconstruction of the Katy Freeway; and
- METRO initiated service on the Main Street rail line.

Year	Number of Tours	Number of Visitors
1997	57	n/a
1998	99	n/a
1999	168	3,149
2000	191	3,515
2001	187	3,834
2002	114	2,086
2003	113	2,468

Traffic Management

The Computerized Transportation Management System (CTMS) has been in continuous deployment on Houston area freeways since the late 1980s with 10 miles added in 2003. Total extent of the system now exceeds 235 miles. Components of the CTMS include closed circuit television, dynamic message signs (DMS), highway advisory radio (HAR), flow signals, travel time monitoring (AVI), and related fiber/communications systems and central facility computer systems. The extent of the freeway management components is listed in Table 3.

Field Devices	Number of Devices
Closed Circuit Television	337
Dynamic Message Signs	155
Highway Advisory Radio	12
Flow Signals Operating	113
Fiber Optic Cable (miles)	235
Automatic Vehicle Identification Locations	232

Flow signals provide a positive means for managing freeway demand and enhancing safety with 113 ramps operating in 2003. The location of flow signals by freeway is listed in Table 4.

Freeway	Number of Flow Signals
IH 10 Katy	19
IH 45 North	20
US 290 Northwest	20
US 59 Southwest	14
IH 45 Gulf	26
IH 610 Loop	<u>14</u>
Total	113

Deployment of the Regional Traffic Signal System (RCTSS) accelerated significantly in 2003. The area wide system located on bus routes primarily inside the Beltway will ultimately deploy a 1,347 signal system to be operated from Houston TranStar. The system is comprised of four primary elements: central control (TranStar), intersections, communications, and transit vehicle interface (for transit signal priority). Over 700 intersection installations had been completed with 400 transitional to operating agencies by the end of 2003. The RCTSS is planned for completion in 2004.

Partner agencies under the leadership of TxDOT are participating in federally sponsored ITS Priority Corridor and ITS deployment program. These two programs have added significantly to Houston TranStar’s functionality, as well as providing funding for development of innovative demonstration projects.

The Sugar Land railroad monitoring project was evaluated in 2003. This system provides the status (location, direction, speed, train length) of trains in a six-mile segment parallel to US 90A to the City’s police/fire dispatch center and at two fire stations near the railroad. Police and fire personnel use the real-time information in making decisions on emergency runs across the tracks. The evaluation found the system functions well and is valuable to its public service agency users.

Under METRO’s direction, a Mobile Operations Center (MOC) was developed for use in management of major incidents and special events. The MOC is equipped with advanced surveillance and communications equipment.

The Priority Corridor program was adjusted to add an additional project which will implement and evaluate an FHWA area wide traffic signal control system: Claire/DYNASMART. The system will be deployed and evaluated in the next two to three years.

A number of freeway-to-freeway connectors are being instrumented with a detection/warning system aimed at preventing truck rollover accidents. The prototype of this technology was deployed and evaluated as a Priority Corridor project. In addition, the Priority Corridor and ITS Deployment programs have resulted in deployment of DMS and HAR units in the region, development of database technology for traffic detectors, and development and expansion of environmental monitoring systems on roadways.

Traveler Information Systems

Traveler information systems are a significant traffic management function, and Houston TranStar is a leader in the scope and timeliness of its real-time traveler information systems. Monitoring systems at Houston TranStar provide extensive information of value to motorists as well as traffic management operators at Houston TranStar. Information is provided to motorists

by four means: dynamic message signs (DMSs), highway advisory radio (HAR), the Internet, and the local media. The 155 DMSs provide information on traffic incidents and planned construction, giving location, travel direction, and nature of incident or activity. There were 18,929 messages displayed on DMSs in 2003. HAR broadcast similar information at the 12 sites located throughout the area. CCTV provides a means for operators and the media to view traffic conditions and verify incidents.

Local radio and television stations have access to Houston TranStar’s travel time data, incident data, and the freeway cameras and use this information frequently during peak period broadcasts. In addition, traffic service organizations are housed on the operations floor of Houston TranStar.

The Houston TranStar website has experienced an evolution with new information being added on an on-going basis. Highlights and enhancements to the website in 2003 include:

- Total web page accesses increased from 55.5 million in 2002 to 66.8 million in 2003, a 24 percent increase;
- Because of a number of weather events, a record number of total monthly web accesses (6.94 million) were observed for the month of November 2003;
- The Sugar Land Rail Monitoring System was made accessible to the public in June 2003;
- The construction reporting system for the Houston District was modified such that icons are displayed on the traffic map in real time;
- Automated display of real-time travel times to DMS;
- Development of the Regional Incident Management System (RIMS);
- Display of DMS information on traffic map;
- Redesigned the interface and developed new content for www.houstontranstar.org, and integrated website navigation between traffic.tamu.edu and www.houstontranstar.org;
- Enhanced real-time speed charts by including multiple year comparisons;
- Deployed a web-based, traffic signal outage data entry and dissemination system; and
- Described as the “Holy Grail of Traffic Websites” by *Forbes* magazine.

The Traffic Alert Incident Notification System completed its first full year of usage in 2003. Over 2.6 million email alerts were sent with the monthly activity shown in Table 5.

With the added features and increasing visibility and knowledge of the website, access activity increased significantly in 2003 to nearly 67 million. Accesses by month are shown in Table 6 with November being the highest month and May the lowest. Yearly trends are shown in Table 7.

Month	New Subscribers	E-Mail Alerts Sent
January	230	125,248
February	215	158,487
March	209	180,118
April	194	205,699
May	126	192,925
June	152	253,485
July	179	245,006
August	146	225,589
September	102	230,324
October	155	312,529
November	161	227,858
December	134	262,706
Total	2003 ⁽¹⁾	2,619,974

¹ Total enrolled is 2,929 including 926 in 2002.

Month	Number of Users	Number of Accesses
January	112,020	4,949,190
February	109,844	4,560,303
March	110,148	5,545,068
April	107,466	5,321,977
May	109,114	4,971,526
June	117,860	5,117,149
July	135,241	5,673,270
August	127,237	5,629,489
September	128,406	5,187,484
October	140,515	6,474,755
November	164,954	6,945,760
December	137,288	<u>6,436,323</u>
Total		66,812,294

Year	Number Of Accesses
1998	6,853,628
1999	10,690,290
2000	16,609,507
2001	48,781,408
2002	55,507,870
2003	66,812,294

The four most active days for website usage occurred during weather events (Figure 2), when street flooding made traveler information more critical. Usage of the web site on November 17, 2003 was so high it could not serve the demand. Additional capacity was later added to accommodate higher demands.

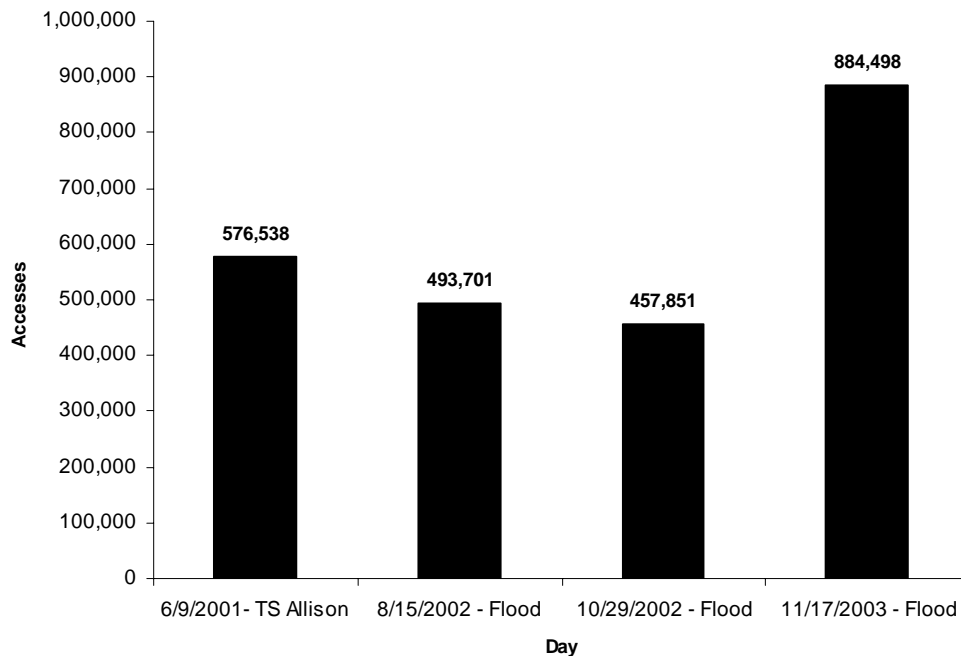


Figure 2. Four Most Active Days on Traffic Web Site

Incident Management/Emergency Response

The Office of Emergency Management (OEM) for Harris County operates from Houston TranStar. The City of Houston Office of Emergency Management relocated its operation to the

City’s Houston Emergency Center, although close coordination is maintained with Houston TranStar. A fully equipped operations center provides the connectivity for the OEMs to effectively respond to emergency activations and conduct training programs. Harris County operates a stream flood monitoring system and, with TxDOT, a roadway flood and ice monitoring system. Both of the systems are accessible on the Internet.

Houston TranStar enhances the operations of the OEMs through the availability of the facilities for monitoring transportation and weather conditions, communicating with the appropriate agencies and jurisdictions, and meeting and training with other Houston TranStar agency staffs.

This region is vulnerable to natural and technological emergencies and disasters such as flooding, tornadic thunderstorms, tropical storms and hurricanes, hazardous material spills, fires, and industrial accidents. Activations may include such events as hazardous material incidents, truck crashes, pipeline ruptures, train derailment, and chemical explosions. Other Houston TranStar partners assist the OEMs during the activations by providing unique technical and managerial expertise as well as additional manpower and facilities support. The joint effort by the Houston TranStar agencies enables quicker response times in dispatching the appropriate equipment and manpower, resulting in more effective and efficient responses that reduce the cost of activations. The community also benefits by reductions in the impact of the emergencies. On November 17, 2003, heavy rains caused extensive street flooding. Houston TranStar agencies worked together to minimize the impacts on travelers.

Freeway incidents are a major cause of congestion in the Houston area, and the detection, response, and clearing of incidents is an important function of Houston TranStar. The Houston TranStar agencies play a major role in incident response management and information dissemination. There were 9,493 incidents recorded by Houston TranStar operators. Distribution of incident by freeway and month are shown in Tables 8 and 9.

Table 8. TranStar Recorded Freeway Incidents by Month–2003

Month	Number of Incidents
January	645
February	589
March	690
April	689
May	714
June	916
July	855
August	792
September	815
October	1,035
November	835
December	<u>918</u>
Total	9,493

Table 9. TranStar Recorded Incidents by Freeway–2003

Freeway	Number of Incidents	
	Main Lanes	HOV Lanes
IH 10 East	481	–
IH 10 Katy	1,307	217
IH 45 Gulf	1,278	88
IH 45 North	1,309	203
SH 288	257	–
US 290 Northwest	513	125
US 59 Eastex	302	38
US 59 Southwest	1,128	148
IH 610 East Loop	216	–
IH 610 North Loop	406	–
IH 610 West Loop	935	–
IH 610 South Loop	392	–
SH 225	<u>150</u>	<u>–</u>
Subtotal	8,674	819
Total	9,493	

Incident location and status are automatically provided on the traffic website. Operators develop and activate DMS messages providing information on the incident (e.g., traffic direction, location, type incident, lanes blocked). Temporal patterns of incidents by hour of day and by day of week are illustrated in Figures 3 and 4.

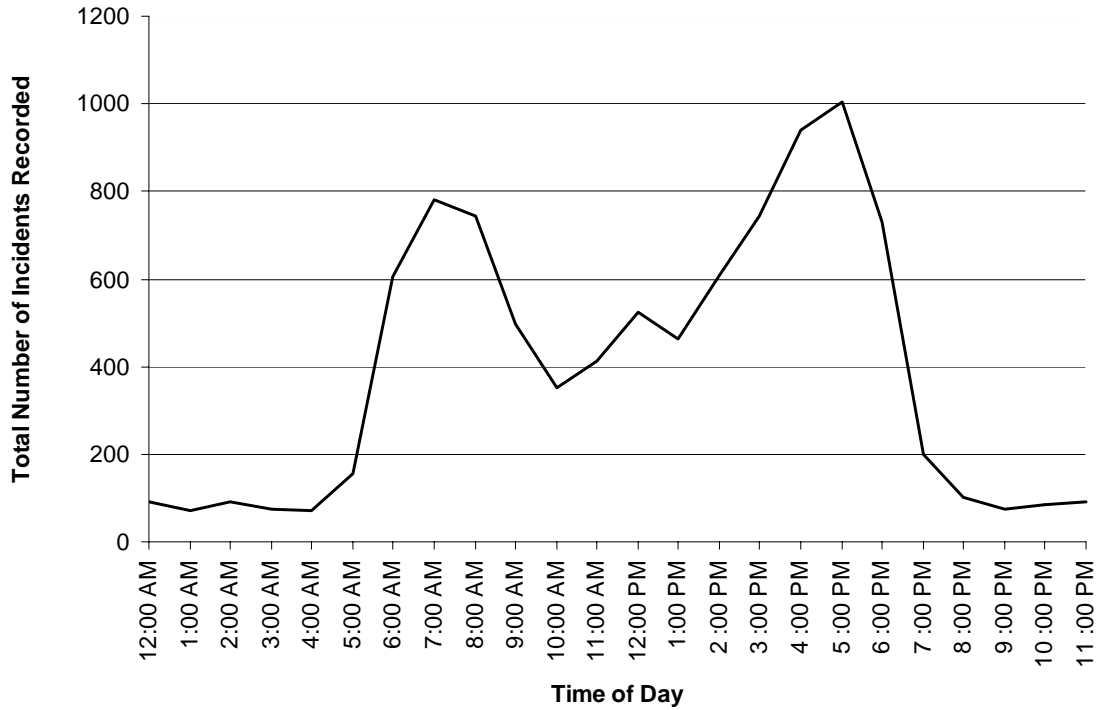


Figure 3. Freeway Incidents by Time of Day

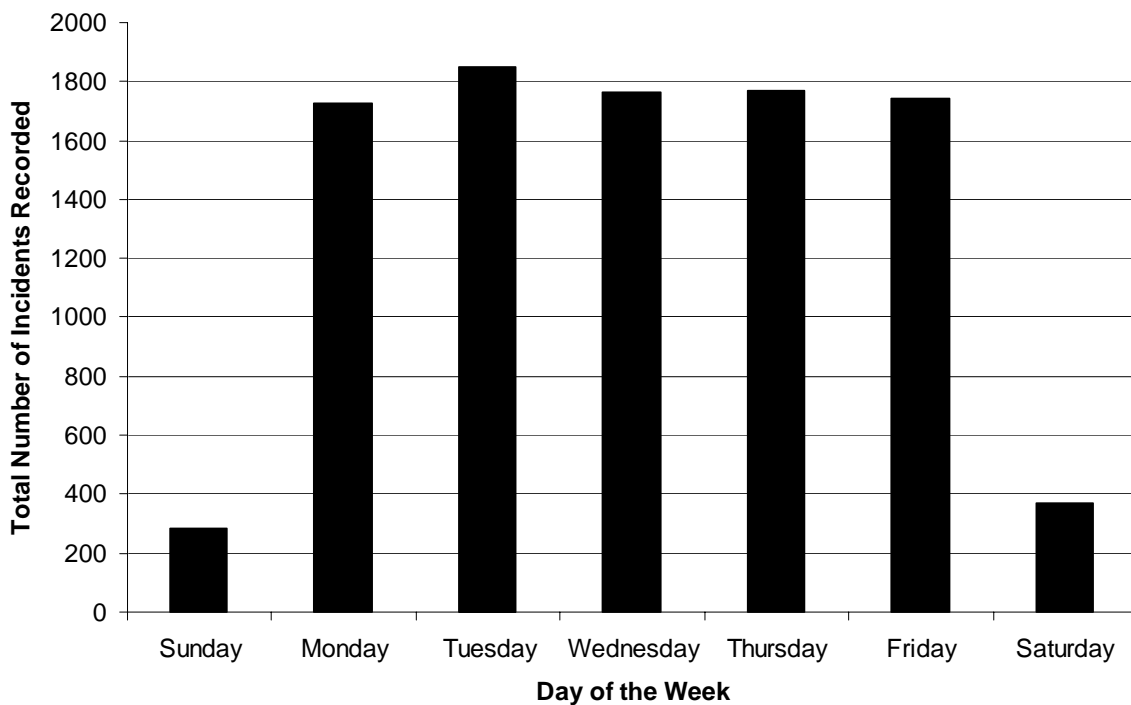


Figure 4. Freeway Incidents by Day of Week

TxDOT initiated a resource recovery contract in 1998 to provide heavy-duty wreckers for crashes and spilled loads involving tractor-trailer trucks. The contract was modified in 2002 to extend coverage to include the area inside Beltway 8. Houston TranStar operators request the heavy-duty wreckers with truck owners paying the cost for the wrecker service. In 2003, there were 90 incidents requiring dispatch of wreckers under this contract.

The Motorist Assistance Program (MAP) is one of the most visible services operated by Houston TranStar, in partnership with the private sector. There were 32,424 incidents handled by MAP in 2003 with 33,329 persons receiving assistance (Figure 5). A breakdown of the types of services provided by MAP personnel is shown in Table 10.

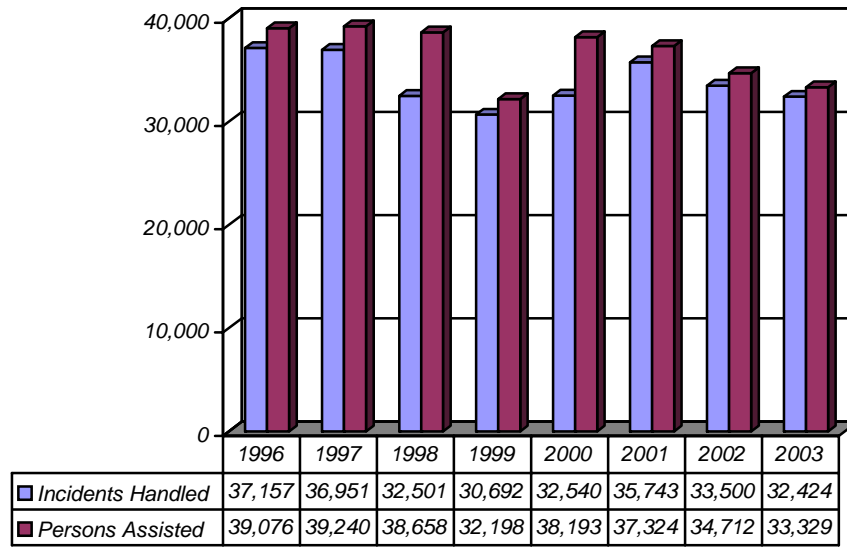


Figure 5. Motorist Assistance Program Activity from 1996 to 2003

<i>MAP Activity</i>	<i>Number</i>
Abandoned Vehicle	9,694
Mechanical Problem	7,165
Flat Tire	4,939
Stalled Vehicle	4,019
Directions/Information	3,839
Motorist Used MAP Phone	1,607
Accident Assistance	1,457
Wrecker Needed	1,212
Provide Fuel	1,289
Debris Removal	1,077
Other	4,965
Total	41,263 ¹

¹Total exceeds number of incidents (32,424) as multiple activities occurred for some incidents.

The roadway weather information system developed by TxDOT and Harris County provides information on current weather and roadway environmental conditions to the Houston TranStar control room and on the Internet. The system includes 38 locations with additional sites planned for the future. The system provides critical information on roadway flooding and icing, as well as other site specific weather information. The information is displayed on the Harris County OEM website, which receives 5-6 million accesses per month.

Transit Operations

METRO operates several important functions from Houston TranStar, including dispatching of the METRO bus fleet, monitoring and operation of park and ride facilities, and the high occupancy vehicle (HOV) lane system. In 2003, rail dispatch for the Main Street light rail line was integrated into TranStar. METRO dispatchers at Houston TranStar are responsible for the dispatch of over 1,400 buses.

The HOV lane system has evolved since 1979 to include over 95 miles of one-way reversible lanes, primarily in freeway medians for use by buses and carpools. Historical daily person trip trends on the HOV lane system are plotted in Figure 6. Total HOV system utilization in December 2003 was measured at 39,958 daily vehicle trips and 127,845 daily person trips. Park and ride facilities were used by approximately 17,000 vehicles each day. METRO police assigned at Houston TranStar are responsible for operation and policing of the HOV facilities.

HARRIS COUNTY HOV LANE UTILIZATION TOTAL DAILY VEHICLE TRIPS

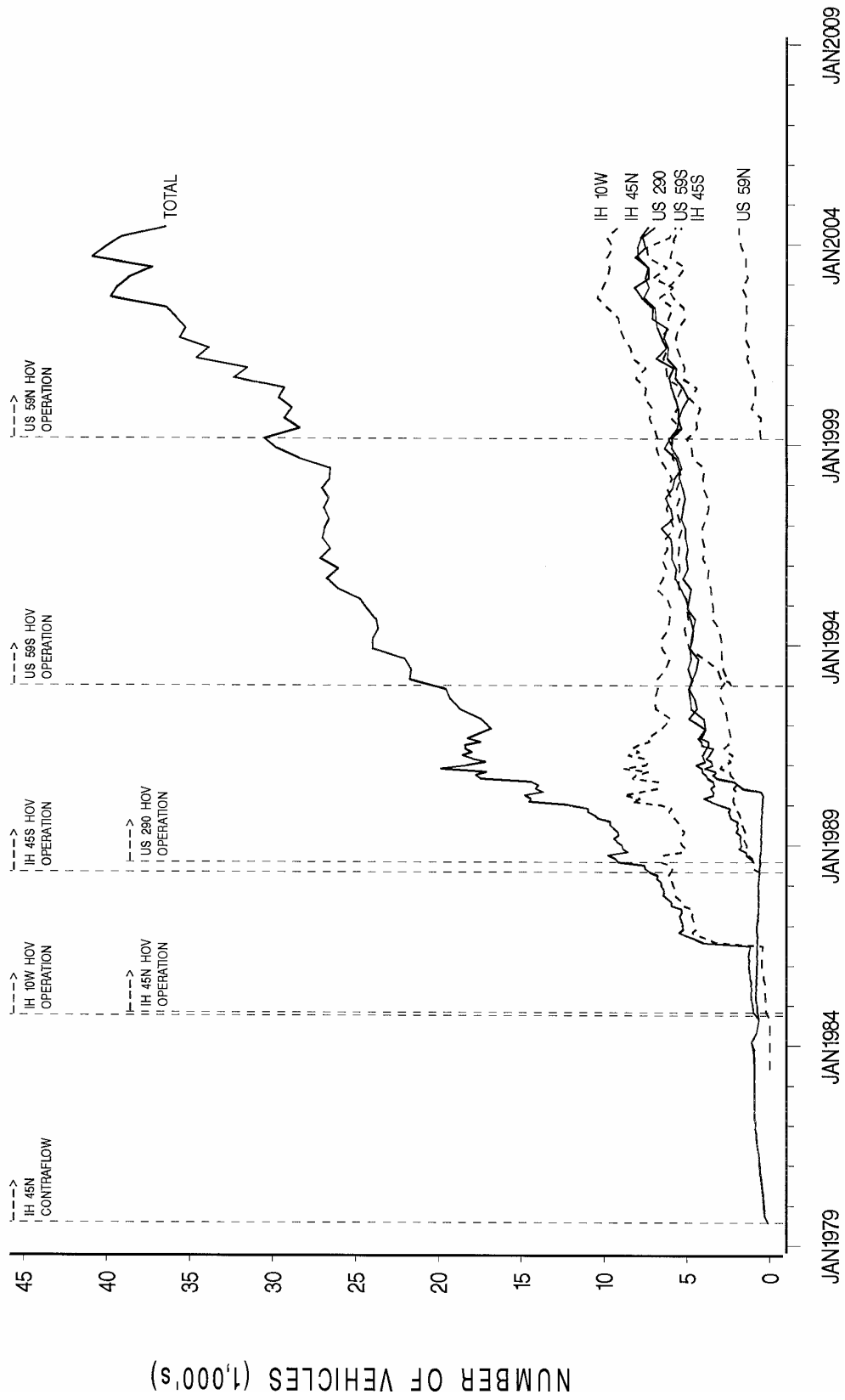


Figure 6. Historical Daily Person Trip Trends on HOV Lanes

ESTIMATED BENEFITS

Determining the benefits of Houston TranStar is limited and conservative since many of the benefits are not quantifiable and some are intangible. An attempt is made to develop estimates of those benefits, which are quantifiable, e.g., the cost of motorist delay savings, fuel savings, and emissions savings. An approach was established in preparing annual reports for prior years, which estimates the operational benefits in terms of freeway motorist delay savings.

Traffic congestion on the freeway system was determined from the automatic vehicle identification (AVI) travel time monitoring system and traffic volumes from the TxDOT annual volume-roadway inventory files. The procedure for evaluation uses national experience to establish Houston TranStar quantitative goals for expected benefits and the expertise of Houston TranStar staff to estimate performance of the transportation systems in terms of percent attainment of the goals.

The projected costs of congestion for the year 2003 were calculated to be over \$640 million. Annual benefits in the reduction of travel time were estimated to be 8.3 million vehicle-hours with an estimated monetary value of \$145 million. A summary of estimated operational savings is provided in Table 11. The savings in travel time are equivalent to reducing fuel consumption by 15 million gallons for an additional savings of over \$23 million. Thus, total 2003 motorists' savings exceed \$167 million. Since 1997 (when benefits were first estimated), Houston TranStar has saved Houston area motorists \$742 million in reduced delay cost as summarized in Table 12.

Table 11. Houston TranStar Transportation Management Estimates of Benefits for 2003		
<i>Transportation Management Deployments</i>	<i>Annual Benefits Resulting from Transportation Management Deployments</i>	
	<i>Reduction in Congestion in Vehicle Hours</i>	<i>Value of Time Saved in Dollars*</i>
Transportation Management Center	830,100	\$ 14,394,000
Traveler Information	2,981,500	51,699,000
Incident Management	3,070,000	53,234,000
Flow Signals (Ramp Metering)	1,457,200	25,268,000
Totals	8,338,800	\$144,595,000

* A value of time of \$17.34 per vehicle hour is used in this analysis.

<i>Year</i>	<i>Congestion Savings (vehicle-hours)</i>	<i>Traveler Cost Savings (\$)</i>
1997	2,719,300	\$ 46,266,000
1998	4,075,800	69,219,000
1999	5,439,000	95,509,000
2000	5,866,000	110,914,000
2001	6,945,800	133,155,000
2002	8,559,200	166,310,000
2003	8,338,800	167,261,000
Totals	39,224,600	\$742,368,000

Reduction in the amount of fuel consumed also results in a reduction of exhaust emissions. Based on U.S. DOT statistics, the reduction of 15 million gallons of gasoline is equivalent to 331 tons of hydrocarbons, 2,138 tons of carbon monoxide, and 481 tons of nitrogen oxides.

A benefit/cost analysis was conducted, comparing the benefits discussed previously to the annual costs of Houston TranStar. Annual costs include annualized capital costs, annual operational costs of the Houston TranStar systems, and the annual cost of operation and maintenance of the field installations. The annual costs estimates are \$24.0 million, which divided into the annual benefit of \$167 million, yields a benefit/cost ratio of 7.0. Benefit and benefit/cost information is illustrated in Figure 7.

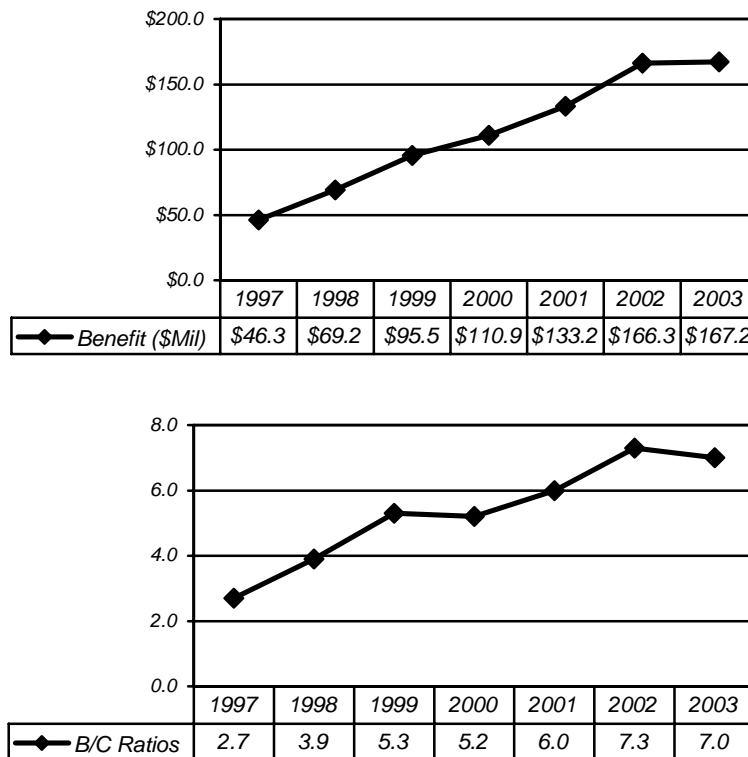


Figure 7. Benefits and Benefit/Cost Ratios for Houston TranStar—1997 to 2003

It should be noted that congestion was actually reduced from 2002 to 2003, a positive indication of the effectiveness of Houston TranStar. However, the congestion savings and benefit/cost ratio also saw modest reductions as a consequence of the methodology used to estimate benefits in this report. Benefits (travel time savings) are expressed as a percent of congestion, thus, even with a higher percent reduction factor in 2003, congestion savings were slightly less than in 2002.

APPENDIX. BENEFIT COST ANALYSIS

Houston TranStar was officially opened on April 15, 1996, and the deployment and integration of the transportation and emergency management systems are being accomplished on a project-by-project basis. The evaluation of the operations of Houston TranStar for 2003 is based on those systems that were operational for all or part of the year.

The Houston TranStar evaluation uses the travel conditions as the base line for estimating the benefits of those systems that were in operation for all or part of the 2003 calendar year. The procedure for evaluation uses national experience to establish the Houston TranStar goals for expected benefits and the expertise of the Houston TranStar staff to estimate the performance of systems against these goals.

Travel conditions in terms of traffic congestion of the freeways of Houston were determined from the Automatic Vehicle Identification (AVI) travel time monitoring system and traffic volumes developed from the Texas Department of Transportation (TxDOT) Annual Volume-Roadway Inventory Files. Annual congestion for 2003 was calculated to be over 37 million vehicle-hours (Table A-1). This is a conservative estimate because of the resolution of the traffic volume data used and the design of the AVI system.

The Houston TranStar Agency Managers reviewed the results from other national transportation management centers and developed operational goals for Houston (Table A-2). The Houston TranStar Agency Managers then reviewed the current status of deployment of systems and the operating efficiencies of the transportation management systems and strategies in Houston TranStar and rated these systems in terms of the percent attainment of national goals (Table A-3). For flow signal operation, data taken from Houston TranStar records were used to calculate the benefits by freeway (Table A-4). Procedures for establishing ratings involved the development of lists of factors for each of the deployments, the establishment of assigned weights of importance to the factors, and finally the assessment by the agency managers of the progress in the deployment and operation of the various factors in 2003. Results of this process are shown in Table A-5.

The benefits of operating the transportation management systems of Houston TranStar in 2003 were determined from the Agency Managers' assessments of progress to the adopted operational goals and the levels of congestion determined from the AVI/TxDOT Volume-Roadway Inventory Files. Annual benefits in the reduction of travel time were calculated to be 8.339 million vehicle hours, which represents a monetary value of \$144.595 million (Table A-6). The savings in travel time are equivalent to reducing fuel consumption by 15.32 million gallons—an additional savings of \$22.666 million. The total 2003 benefits to the motorists are valued at \$167 million.

The reduction in the amount of fuel consumed also results in a reduction of exhaust emissions. Based on U.S. DOT Bureau of Transportation Statistics, the reduction of 15.32 million gallons of fuel is equivalent to a reduction of:

- 331 tons of hydrocarbons (HC);
- 2,138 tons of carbon monoxide (CO); and
- 481 tons of nitrogen oxides.

The annual costs of deploying, operating, and maintaining Houston TranStar systems were determined for the transportation management systems that were operational in 2003. The cost analysis includes the annualized capital costs of the Houston TranStar facility, the annual operational costs of the Houston TranStar systems, and the annual cost of operations and maintenance of the field installations. The annualized capital and operating cost estimate is \$23.969 million, which divided into the annual benefits of \$167.261 million, yields a benefit/cost ratio of 7.0 (Table A-7).

Table A-1. Summary of Estimated Base Freeway Congestion-2003

<i>Freeway Section</i>	<i>Length of Section (miles)</i>	<i>Estimated Annual Congestion (vehicle hrs/year)</i>	<i>Annual Cost of Congestion (\$/year)*</i>
IH 10 East Freeway			
County Line to South Belt	15.20	304,000	\$ 5,271,400
South Belt to East Loop	6.85	274,600	4,761,600
East Loop to IH 45	<u>5.40</u>	<u>527,300</u>	<u>9,143,400</u>
Subtotal	27.45	1,105,900	\$ 19,176,400
IH 10 Katy Freeway			
Grand Parkway to Barker-Cypress	5.50	1,068,700	\$ 18,531,300
Barker-Cypress to West Belt	7.60	2,254,200	39,087,800
West Belt to West Loop	6.30	3,434,000	59,545,600
West Loop to IH 45	<u>6.05</u>	<u>620,500</u>	<u>10,759,500</u>
Subtotal	25.45	7,377,400	\$127,924,200
IH 45 North Freeway			
Hardy Tollroad to FM 1960	5.70	118,900	\$ 2,061,700
FM 1960 to Aldine-Bender	7.00	92,600	1,605,700
Aldine-Bender to Crosstimbers	8.20	1,980,400	34,340,100
Crosstimbers to IH 10	<u>2.50</u>	<u>603,200</u>	<u>10,459,500</u>
Subtotal	23.40	2,795,100	\$ 48,467,000
IH 45 Gulf Freeway			
NASA 1 to Fuqua	7.90	583,400	\$ 10,116,200
Fuqua to Woodridge	7.65	1,242,900	21,551,900
Woodridge to Scott	4.15	814,200	14,118,200
Scott to IH 10	<u>4.20</u>	<u>1,425,800</u>	<u>24,723,400</u>
Subtotal	23.90	4,066,300	\$ 70,509,700
US 59 Southwest Freeway			
Grand Parkway to SH 6	4.91	3,733,400	\$ 64,737,200
SH 6 to West Loop	13.16	1,881,700	32,628,700
West Loop to Fannin	5.60	1,439,200	24,955,700
Fannin to IH 10	<u>1.80</u>	<u>529,600</u>	<u>9,183,300</u>
Subtotal	25.47	7,583,900	\$131,504,900
US 59 Eastex Freeway			
Townsen to North Belt	5.10	129,200	\$ 2,240,300
North Belt to North Loop	10.00	68,400	1,186,100
North Loop to IH 45	<u>4.45</u>	<u>713,200</u>	<u>12,366,900</u>
Subtotal	19.55	910,800	\$ 15,793,300
US 290 Northwest Freeway			
Mason to Barker-Cypress	4.80	53,100	\$ 920,800
Barker-Cypress to West Belt	9.15	538,200	9,332,400
West Belt to Pinemont	4.45	1,026,500	17,799,500
Pinemont to West Loop	<u>3.55</u>	<u>1,594,200</u>	<u>27,643,400</u>
Subtotal	21.95	3,212,000	\$ 55,696,100
SH 288 South Freeway			
South Belt to South Loop (Holly Hall)	5.80	103,700	\$ 1,798,200
South Loop to US 59	<u>3.30</u>	<u>211,700</u>	<u>3,670,900</u>
Subtotal	9.10	315,400	\$ 5,469,100

Table A-1. Summary of Estimated Base Freeway Congestion-2003			
<i>Freeway Section</i>	<i>Length of Section (miles)</i>	<i>Estimated Annual Congestion (vehicle hrs/year)</i>	<i>Annual Cost of Congestion (\$/year)*</i>
SH 225 LaPorte Freeway			
SH 146 to East Belt	7.60	164,100	\$ 2,845,500
East Belt to East Loop	<u>7.00</u>	<u>601,400</u>	<u>10,428,300</u>
Subtotal	14.60	765,500	\$ 13,273,800
Hardy Toll Road	22.05	61,000	\$ 1,057,700
Sam Houston Toll Way			
Eastex CC to Southwest	34.60	991,600	\$ 17,194,300
Southwest CC to IH 10 East	<u>35.85</u>	<u>1,016,900</u>	<u>17,633,000</u>
Subtotal	70.45	2,008,500	\$ 34,827,300
IH 610 Loop			
North Loop (N. Wayside to Ella)	9.25	968,900	\$ 16,800,700
West Loop (Ella to S. Post Oak)	11.00	5,374,300	93,190,400
South Loop (S. Post Oak to S. Wayside)	8.25	247,800	4,296,900
East Loop (S. Wayside to N. Wayside)	<u>10.20</u>	<u>248,500</u>	<u>4,309,000</u>
Subtotal	38.70	6,839,500	\$118,597,000
TOTALS	322.07	37,041,300	\$642,296,500

*A value of time of \$17.34 per vehicle-hour is used in this analysis.

Table A-2. Houston TranStar Transportation Management Goals for Reducing Congestion		
<i>Deployment Description</i>	<i>% Reduction of Congestion</i>	
	<i>Non-Recurrent</i>	<i>Recurrent</i>
Transportation Management Center	08	04
Traveler Information (RSS)	29	12
Incident Management	26	10
Ramp Metering	35	30

Table A-3. Houston TranStar Transportation Management Estimates of Deployment and Operational Efficiency for 2003–Related to Transportation Management Goals		
<i>Deployment Description</i>	<i>Estimated Percent Reduction of Congestion</i>	
	<i>Non-Recurrent</i>	<i>Recurrent</i>
Transportation Management Center	1.601	0.640
Traveler Information (RSS)	6.718	1.331
Incident Management	7.284	1.004
Ramp Metering (see Table A-4)	2.183	1.750
TOTAL	17.786	4.725

Table A-4. Houston TranStar Transportation Management Estimates of Benefits For Freeway Flow Signals-2003		
<i>Freeway Corridors</i>	<i>Annual Benefits Resulting from Freeway Flow Signal Deployments</i>	
	<i>Reduction in Congestion in Vehicle Hours</i>	<i>Value of Time Saved in Millions of Dollars*</i>
IH 10 Katy Freeway	414,400	\$ 7,185,700
IH 45 North Freeway	150,000	2,601,000
US 59 Southwest Freeway	260,300	4,513,600
US 290 Northwest Freeway	385,900	6,691,500
IH 45 Gulf Freeway	158,000	2,739,700
IH 610 Loop Freeway		
West Loop	17,700	306,900
North Loop	70,900	1,229,400
Totals	1,457,200	\$25,267,800

*A value of time of \$17.34 per vehicle hour is used in this analysis.

Table A-5. Summary of Benefit Calculations for 2003

Traffic Management Center:

Non-Recurrent = 0.01601 x TC*

Recurrent = 0.00640 x TC

Subtotal for Traffic Management Center

0.02241 x TC

Traveler Information Systems:

In-Vehicle

Special In-Vehicle

Non-Recurrent = 0.00255 x TC

Recurrent = 0.00185 x TC

Public Radio

Non-Recurrent = 0.00174 x TC

Recurrent = 0.00084 x TC

Cellular Telephone

Non-Recurrent = 0.00081 x TC

Recurrent = 0.00042 x TC

Subtotal for In-Vehicle

0.00821 x TC

Roadside

Dynamic Signs

Non-Recurrent = 0.03816 x TC

Recurrent = 0.00879 x TC

Subtotal for Dynamic Signs

0.04695 x TC

Pre Trip

Non-Recurrent = 0.05505 x TC

Recurrent = 0.00950 x TC

Subtotal for Pre Trip

0.06455 x TC

Subtotal for Traveler Information Systems (RSS)

0.08049 x TC

Incident Management:

Non-Recurrent = 0.07284 x TC

Recurrent = 0.00950 x TC

Subtotal for Incident Management

0.08049 x TC

Ramp Metering/Flow Signals:

Non-Recurrent = 0.02183 x TC

Recurrent = 0.01750 x TC

Subtotal for Flow Signals

0.03933 x TC

TOTAL BENEFITS =

0.22511 x TC

* TC is Total Annual Congestion

Table A-6. Houston TranStar Transportation Management Estimates of Benefits for 2003		
<i>Transportation Management Deployments</i>	<i>Annual Benefits Resulting from Transportation Management Deployments</i>	
	<i>Reduction in Congestion in Vehicle Hours</i>	<i>Value of Time Saved in Millions of Dollars*</i>
Transportation Management Center	830,100	\$ 14.394
Traveler Information	2,981,500	51.699
Incident Management	3,070,000	53.234
Flow Signals (Ramp Metering)	1,457,200	25.268
Totals	8,338,800	\$144.595

* A value of time of \$17.34 per vehicle hour is used in this analysis.

Table A-7. Benefit Cost Analysis for 2003

<u>Summary of Capital Expenditures</u>	
Houston TranStar Facilities	\$ 13.500 M
CTMS Installations Completed	112.451 M
AVI Installations	<u>7.800 M</u>
Total Capital Expenditures	\$133.751 M
 <u>Annual Operations and Maintenance Costs:</u>	
Houston TranStar	\$ 2.450 M
CTMS	2.984 M
Motorist Assistance Program	1.531 M
AVI Traffic Monitoring System	<u>0.332 M</u>
Total Annual O&M Costs	\$ 7.297 M
 <u>Total Annual Costs:</u>	
Annualized Capital Expenditures (15 yrs. @ 6 % for Houston TranStar)	\$ 1.390 M
(10 yrs. @ 6% for CTMS and AVI)	15.282 M
Annual Operations and Maintenance Costs	<u>7.297 M</u>
Total Annual Costs	\$ 23.969 M
 <u>Summary of Benefits</u>	
Value of Annual Delay Savings	\$144.595 M
Value of Annual Fuel Savings	<u>22.666 M</u>
	\$167.261 M

Benefit/Cost Ratio

The 2003 Benefit/Cost Ratio is calculated by dividing total annual benefits by total annual costs.

Benefit/Cost Ratio is equal to: \$167.261 M / \$23.969 M = 7.0