During the fall of 1999 and spring of 2000, a series of aerial photo-surveys, showing highway traffic performance, were conducted in the Dallas-Fort Worth Metropolitan Area. The purpose of this survey was to facilitate a detailed assessment of both system-wide and site-specific freeway system deficiencies. This information will help to identify potential locations for freeway bottleneck improvements as well as major corridor needs. It will also enable decisionmakers to compare long-term congestion trends and to evaluate the benefits of the transportation improvement strategies being implemented over the next few years.

This publication highlights the data collection methodology used and provides an overview of the results from the data collection effort.

Commuters, elected officials, and transportation professionals in the Dallas-Fort Worth Metropolitan Area will find the information from this data collection effort useful. The findings highlight the locations of peak period traffic bottlenecks, identify heavy truck traffic corridors, and assess the impacts of congestion caused by incidents and accidents. Level-of-service estimates are derived from the data for both the morning and evening peak travel periods. It is anticipated that this approach to surveying traffic conditions will be used in the future and will provide a valuable comparative analysis now that the baseline conditions have been established.
Program Highlights

Using fixed-wing aircraft, a photographic inventory of approximately 750 miles of highways was conducted during the peak morning and evening periods of commuter travel. During this survey, 100 percent overlapping photographic coverage was obtained for designated highways, repeated once an hour over four weekday mornings and evenings. The morning and evening coverage times were from 6:30 a.m. to 9:00 a.m. and 3:30 p.m. to 6:30 p.m., respectively. Survey flights were conducted on weekdays with the exception of Monday mornings, Friday evenings, and mornings after holidays.

Area of Coverage

The traffic data collection covered the entire Dallas-Fort Worth Metropolitan Area. All major highways in the Metropolitan Area were included in the aerial photography.

Vehicle Performance Measures - Vehicle Counts, Delay, and Speed

Vehicle counts and the corresponding level of service (LOS) for each of the roadways were determined and summarized in the final report and corresponding CD-ROM. Vehicle speeds were not directly identified from the aerial photographs collected in this survey. However, a speed/density graph (see page 6) developed from previous research and validated with local data allows the estimation of vehicle speeds, travel times, and flow rates from the densities observed in this congestion survey. An important part of this survey was the identification and estimation of incident impacts. The aerial photography identified 65 traffic incidents. These incidents had substantial impacts on vehicle speed, emissions, flow rates, queuing, delay, and level of service. The severity of each incident was determined by several factors including the percentage of lanes blocked, the duration of the incident, and the number of vehicles entering the incident area.
Vehicle Types

From the aerial photographs, manual counts were conducted of the number of vehicles in each highway segment during each flight. While being counted, vehicles were classified as "cars," "buses," "trucks," "tractor-trailers," or "tandem-tractor-trailers." A product of this methodology is the calculation of the percentage of each of these vehicle types in the traffic stream (vehicle mix). The table below indicates the average percent of trucks and buses observed in the survey, as well as the range of observations, by roadway type. A detailed summary of vehicle mix data by highway facility can be found in Part Four of the main report and in the Traffic Mix database.

Traffic Vehicle Mix - Percent Trucks and Buses

<table>
<thead>
<tr>
<th>Roadway Classification</th>
<th>A.M. Average</th>
<th>A.M. Range</th>
<th>P.M. Average</th>
<th>P.M. Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interstate Highway</td>
<td>6%</td>
<td>1-34%</td>
<td>4%</td>
<td>1-29%</td>
</tr>
<tr>
<td>U.S. Routes</td>
<td>6%</td>
<td>0-26%</td>
<td>4%</td>
<td>1-31%</td>
</tr>
<tr>
<td>State Routes</td>
<td>3%</td>
<td>0-9%</td>
<td>2%</td>
<td>0-12%</td>
</tr>
<tr>
<td>Other</td>
<td>2%</td>
<td>0-10%</td>
<td>2%</td>
<td>0-12%</td>
</tr>
</tbody>
</table>

Data Reduction Procedures

From the aerial photographs, densities by highway segment were determined by manually counting the vehicles along each segment length. The count data that was atypical due to construction or suspected incidents were coded for exclusion from the averaging process. All data were then entered into a microcomputer database program, which performed the following tasks:

1) samples were grouped by hourly time slice;
2) average vehicle densities were calculated; and
3) densities were converted into service levels "A" through "F."
   (These values are similar in meaning to report card grades.)

The program then prepared matrices showing each averaged service level rating plotted by time and highway segment. These data matrices were then copied into the traffic quality tables found in the main report.

In the tables, all LOS F conditions (congested traffic flow) were highlighted; this permits quick identification of locations experiencing demand at levels exceeding capacity.

While examining the photography, data technicians also identified side streets and on/off ramps that were congested. Where these problems were observed to recur daily, descriptive narratives were prepared. These narratives, together with other observations, are provided on "narrative" maps which accompany each traffic quality table.

High-level 35mm aerial photography such as this I.H. 35E photo were the basis for vehicle counts and determination of roadway densities.
Recurring Congestion

Recurring congestion is predictable and usually occurs on a daily basis. Congestion occurs when demand exceeds the capacity of the facility. Typical causes of recurring congestion include bottleneck locations associated with geometric design deficiencies, weaving/merging locations, long-term construction work zones, poor traffic signal timing, and over-capacity locations.

Recurring congestion along I.H. 635 at the Dallas North Tollway shows how congestion on one facility (I.H. 635) can queue vehicles back onto another facility.

A.M. Congestion Locations

FREEWAY TRAFFIC QUALITY
- Heavy traffic flow or intermittent congestion
- Congested traffic flow

SIGNALIZED HIGHWAY TRAFFIC QUALITY
- Intermittent congestion or slow moving platoons along a highway segment
- Congested Signalized Intersection (intermittent)
- Congested Signalized Intersection (continuous)
Congestion can be measured in varying levels of performance and duration. For the figures on this page and the previous page this level of duration is defined by intermittent and continuous congestion. Both the morning and evening peak periods exhibit heavy continuous congestion throughout the Dallas-Fort Worth Metropolitan Area. The report and interactive CD-ROM highlight specific levels of service for the highway segments identified in these figures.
The LOS ratings are presented in graphical format by highway segment, direction, and time slice. Each rating represents the average of approximately four flights per hourly time slice, minus any data affected by incidents. For uninterrupted-flow facilities, such as freeways, the ratings are density-based level-of-service designations “A,” “B,” “C,” “D,” “E,” and “F,” as defined in the 1997 Update to the Highway Capacity Manual (HCM). These ratings are shown graphically below.

**Congestion Results**

As documented in the "Aerial Survey Report" and the CD-ROM interactive slide show, highway level-of-service (LOS) ratings and detailed bottleneck summaries have been developed for each segment of the surveyed highways. The highly directional nature of the S.H. 183 corridor for the morning and evening peak periods is highlighted on page 7.

The LOS ratings are presented in graphical format by highway segment, direction, and time slice. Each rating represents the average of approximately four flights per hourly time slice, minus any data affected by incidents. For uninterrupted-flow facilities, such as freeways, the ratings are density-based level-of-service designations “A,” “B,” “C,” “D,” “E,” and “F,” as defined in the 1997 Update to the Highway Capacity Manual (HCM). These ratings are shown graphically below.

**Summary of Freeway Traffic Condition Ratings**

(Density-Based Level-of-Service)

<table>
<thead>
<tr>
<th>Density (passenger cars per lane per mile)</th>
<th>No significant delays</th>
<th>Steady progress through congestion</th>
<th>Stop-and-go traffic flow</th>
<th>Extended delays</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOS A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOS B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOS C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOS D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOS E</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOS F</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Expected average travel speeds:</th>
<th>70-50 mph</th>
<th>50-30 mph</th>
<th>30-20 mph</th>
<th>20-10 mph</th>
<th>10 mph and below (usually incident related)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>20</td>
<td>45</td>
<td>60</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>120</td>
<td>140</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Another way to visualize the graph above is to plot the relationship of vehicle density and vehicle speed. As the density of vehicles increases, the corresponding speed of vehicles decreases.

For interrupted-flow facilities (arterials with traffic signals), the level of service is based on platoon sizes and queuing characteristics at signalized intersections – not travel times, which is the traditional defining parameter for arterial LOS.
Texas State Highway 183

Morning

EASTBOUND

F - Level-of-Service
(45) - Passenger cars per lane per mile

Texas State Highway 183

Evening

WESTBOUND
Detailed Narratives

Detailed bottleneck summaries were prepared for each highway facility. These summaries clarify the severity and frequency of congestion found along each highway segment. Where evident, causes of the congestion are described. Congestion on crossing highways and interchange ramps are also depicted and discussed. The bottleneck summary for the S.H. 183 p.m. peak period is illustrated below. This summary corresponds with the p.m. peak period level-of-service diagram on the previous page.

Bottleneck Summary for the S.H. 183 A.M. Peak Period

During the peak period, southbound congestion was typically found on Norwood Dr. approaching the signalized intersections at S.H. 183; queue populations typically ranged from approximately 20-30 vehicles (left lane).

During most observations, moderate to severe eastbound congestion was found on S.H. 183 between I.H. 820 and S.H. 121; average estimated speeds ranged from approximately 20-40 mph. Traffic entering at Precinct Line Rd., Norwood Dr., and Bedford Rd. appeared to cause the congestion. (See photos 245-251.JPG)

During most observations, southbound congestion was found on Murphy Rd. approaching the signalized intersections at the S.H. 183 interchange; queue populations typically ranged from approximately 20-40 vehicles (left lane). In some cases, congestion extended back through the upstream signal on the frontage road. (See photo 252.JPG)

During most observations, an extended zone of eastbound congestion was found on S.H. 183 between the vicinity of S.H. 360 and Loop 12; average speeds ranged widely, from approximately 20-45 mph. Congestion was particularly severe between S.H. 360 and S.H. 161; traffic entering at the freeway interchanges (S.H. 360 and International Pkwy) appeared to exacerbate this congestion (ongoing construction at the S.H. 161 interchange may also have contributed to the congestion).

S-97 / INTERNATIONAL PARKWAY

No congestion was found on S-97/International Pkwy during the morning survey period.
Non-Recurring Congestion

Non-recurring congestion is not predictable and can happen any time of day. Accidents, stalled cars, flat tires, and debris in the road are the primary reasons for non-recurring congestion. These primary reasons are referred to as incidents. Weather and special events such as sporting events and short-term construction can also cause non-recurring congestion. As shown in the following photo, one accident can spawn additional accidents that can create havoc with the highway and adjacent arterial systems.

As part of the data collection effort, incidents and construction schedules for all the surveyed highways were compiled for a two-week period in August 1999. Some incidents were identified through aerial photography while the majority of incidents were identified through Texas Department of Transportation (TxDOT) traffic management centers, traffic reporting companies, and local police departments. The agencies logged a total of 538 incidents. The aerial survey identified 65 incidents. The difference between the two databases was attributed to the fact that the aerial photography only occurred during select times and days.

Incident Impacts

The impacts of traffic incidents were also analyzed. A detailed analysis of the top 20 most significant incidents was conducted and highlighted in the Non-Recurring Assessment Report. The severity of the incidents varied from a shoulder closure to the full closure of the highway facility. The average duration of these incidents was one hour and 22 minutes. The average time traffic was impacted by the incident was over three hours. Even after the incident was cleared from the scene, the residual effects of vehicle queuing were still impacting the roadway. The average vehicle speed before an incident was 51 miles per hour versus 21 miles per hour after an incident. The average vehicle flow varied from 7,600 vehicles per hour before an incident to 2,300 vehicles per hour after an incident.

Vehicle Emissions

The single largest source of emissions comes from vehicular traffic. These emissions which contribute significantly toward ozone pollution are the heaviest during times of recurring and non-recurring congestion. Volatile organic compounds and nitrogen oxide emissions are greatest at speeds under 25 miles per hour. Nitrogen oxide emissions are also significant at speeds greater than 60 miles per hour.

Construction

Highway construction schedules for the Texas Department of Transportation were obtained and reviewed for conflicts with the aerial survey flights. Any construction during the aerial surveys would have inflated the level of congestion. Fortunately, almost all of the scheduled construction occurred between 9:00 a.m. and 3:00 p.m. or between 9:00 p.m. and 6:00 a.m., which were outside the survey time limits. No unscheduled construction occurred during the aerial survey.
Data Available

Several products were prepared from this study. These include a comprehensive report on traffic performance in the Dallas-Fort Worth Metropolitan Area, an interactive CD-ROM with project highlights, this Executive Summary, and a technical memorandum on non-recurring congestion during the data collection effort.

The following products are available from the traffic quality survey.

1. Traffic Conditions Report and Interactive Slide Show

   The CD-ROM interactive slide show of high-quality digital photographs, video, maps, charts, and performance indicators was developed to highlight the existing traffic conditions. This CD-ROM allows technical and non-technical users easy access to the vast amount of traffic information and serves as a reference tool in the planning process. Graphics and photographs on the CD-ROM can be imported into presentations, web-sites, and printed materials. Using a desktop computer, an aerial photograph and corresponding traffic qualities of any location on the surveyed highway system can be quickly located with a few clicks of the mouse.

2. Photolog of all surveyed roadways

   The photolog contains 100 percent overlapping coverage of all surveyed roadways with 2,800 photographs at 800 x 600 resolution (off peak photographs). This slide show allows quick access to aerial photographs of any location in the roadway system. The photolog can be used to document the number of lanes, interchange configuration and adjacent land use. High-resolution jpeg copies (1024 x 768) of all 2,800 photographs are also available from NCTCOG.

3. Additional databases encompassing the full volume of collected traffic data are also available for reference and analysis. Specific traffic data can be found in the following databases:

   - SEGMENT.DBF: Lists physical characteristics of each of the surveyed highway segments: length, number of lanes, and the presence of HOV lanes, shoulders and/or frontage roads.
   - TRAFFIC DATA.DBF: Contains the basic survey findings: average densities, estimated average speeds, and levels of service, by segment and by time slice.
   - TRAFFIC MIX.DBF: Contains the raw data used for the determination of vehicle mix.
   - RAW DATA.DBF: Contains all individual vehicle counts.
   - NON-RECURRING CONGESTION.DBF: Contains the incident data underlying the analysis of non-recurring events.

All of these products are available through the NCTCOG Transportation Department. An e-mail address and phone number are located on the back cover.
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What Is NCTCOG?

The North Central Texas Council of Governments (NCTCOG) is a voluntary association of local governments within the 16-county North Central Texas region. The agency was established in 1966 to assist local governments in planning for common needs, cooperating for mutual benefit, and coordinating for sound regional development. North Central Texas is a 16-county region with a population of 4.6 million and an area of approximately 12,800 square miles. NCTCOG has 232 member governments, including all 16 counties, 163 cities, 26 independent school districts, and 27 special districts.

Since 1974, NCTCOG has served as the Metropolitan Planning Organization (MPO) for transportation in the Dallas-Fort Worth Metropolitan Area. The Regional Transportation Council is the policy body for the Metropolitan Planning Organization. The Regional Transportation Council consists of 37 members, predominantly local elected officials, overseeing the regional transportation planning process. NCTCOG’s Department of Transportation is responsible for support and staff assistance to the Regional Transportation Council and its technical committees, which comprise the MPO policy-making structure.

We would like your comments...

If you have questions or comments regarding the transportation and air quality programs of the North Central Texas Council of Governments and the Regional Transportation Council or need additional information, please contact the NCTCOG Transportation Department at (817) 695-9240, by fax at (817) 640-3028, via e-mail: transinfo@dfwinfo.com, or visit our website at www.dfwinfo.com/trans.

Regional Mobility Initiatives Issues

<table>
<thead>
<tr>
<th>Issue</th>
<th>Date</th>
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<tbody>
<tr>
<td>Advanced Transportation Management</td>
<td>March 1996</td>
</tr>
<tr>
<td>Air Quality</td>
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<tr>
<td>Traffic Congestion</td>
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<tr>
<td>Multimodal Solutions in the North Central Corridor</td>
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<td>Toll Roads</td>
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<td>Major Investment Studies</td>
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<tr>
<td>The Transportation Equity Act for the 21st Century</td>
<td>October 1998</td>
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<td>High Occupancy Vehicle (HOV) Lanes</td>
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<tr>
<td>Mobility Initiatives for the 21st Century (video)</td>
<td>April 1999</td>
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<td>Travel Demand Forecasting Procedures</td>
<td>June 1999</td>
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<tr>
<td>Commuter Traffic</td>
<td>December 2000</td>
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The contents of this report reflect the views of the authors who are responsible for the opinions, findings, and conclusions presented herein. The contents do not necessarily reflect the views or policies of the Federal Highway Administration, the Federal Transit Administration, or the Texas Department of Transportation. This document was prepared in cooperation with the Texas Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration, and Federal Transit Administration.