Moving-Analysis Program to Evaluate Geometric and Operational Feasibilities of Exclusive Truck Facilities

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Traffic growth in Texas has resulted in a study to investigate the feasibility of exclusive truck facilities (ETFs) in the median area of existing Interstate highways. A moving-analysis computer program was developed to identify candidate sections of a selected corridor for addition of truck lanes. A case study was conducted using the I-35 corridor between Dallas and San Antonio to demonstrate the program's usefulness. The program was designed to evaluate a selected length of Interstate highway by individual half-mile or other length segments and to print the results in an easily interpreted format. The output allows the user to evaluate a given corridor by two basic criteria: volume-to-capacity (V/C) ratios and effective median widths. The program calculates V/C ratios with and without trucks using the techniques published in the *Highway Capacity Manual.*

Traffic growth on the Texas highway system has prompted the State Department of Highways and Public Transportation (SDHPT) to examine various techniques for handling the simultaneous increase in truck traffic demand. The Texas SDHPT decided to evaluate special truck lane needs along the I-35 corridor between Dallas and San Antonio. The overall objectives of the study were to identify areas of high truck volumes, to establish operational and design procedures to deal with truck traffic, and to evaluate the corridor and system-wide effects of the proposed recommendations.

One alternative of particular interest was the feasibility of using existing median rights-of-way for an exclusive truck facility (ETF). The analysis procedure involved two distinct phases. The first phase included the review of current geometric design policy to determine applicability to ETFs *(1)*. Major elements of the study included geometrics, right-of-way availability, operations, safety, pavement requirements, and costs of the potential improvements. Roadway geometry was the critical element in the first phase. The second phase, which is the subject of this paper, resulted in a computer program to evaluate the feasibility of providing exclusive truck lanes in the median area of Interstate highways *(2)*. Other options not currently evaluated by this program that could be added in the future include evaluation of nonexclusive (mixed-traffic or auto only) lanes versus exclusive truck lanes and evaluation of areas besides the median.

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The computer program calculates the level of service (LOS) of each half-mile segment of a selected highway with and without trucks. The quality of total traffic flow of cars and trucks and the difference in quality after trucks are removed are expressed in terms of volume-to-capacity (V/C) ratios as computed by techniques published in the 1985 *Highway Capacity Manual* (HCM) *(3)*.

ACCOMMODATING EXCLUSIVE TRUCK FACILITIES

Typical ETF Cross Sections

The median area of I-35 was selected as the portion of the cross section to accommodate trucks. Because the available median width varied throughout the selected corridor, several options were reviewed. Other strategies, such as a parallel alignment on separate right-of-way or truck lanes between the mainlanes and frontage roads, are being investigated in another study *(4)*.

Figure 1 shows typical exclusive truck facility cross sections. All except Cross Section M-2 place trucks in the median area. The development of these cross sections considers typical SDHPT median widths—36, 44, 48, 60, and 76 ft. The first (M-1A) shows minimum widths, the second (M-1B) desirable widths. These two cross sections do not physically separate trucks from other traffic by positive barriers. Special lane designations, unique raised pavement markers, and regulatory signing such as "Trucks Only" could be used to define the authorized lane. Option M-4 in Figure 1 shows an existing 76-ft median that can accommodate an additional lane in each direction using a depressed median. This same median width is sufficient for three lanes, providing for passing maneuvers by alternating the passing lane by direction of travel, as shown in Cross Section M-5. Cross Sections M-5, M-6, and the outside truck lane are particularly relevant to urban areas.

Where positive barriers are needed to separate directional flows of trucks or to separate trucks from other vehicles, a substantially taller barrier is needed such as that developed by Hirsch et al. *(5)*. This is an important safety issue because of possible restrictions in sight distances caused by the taller barrier (7.5 ft). Current truck driver eye heights are typically in the 7.5- to 8.0-ft range.

The minimum effective median width is one of the most important considerations when evaluating truck lane feasibility. The effective median widths is the available clear width of a median measured from the nearest edge of each inside travel lane. Any obstacles such as piers for overhead structures are subtracted from this clear width. The width of a positive barrier such as the concrete safety shape is also subtracted from the total median width to establish the effective median width. Figure 2 shows these measurements.

STUDY PROCEDURE

Corridor Selection

Corridor selection criteria included average daily traffic (ADT), number of trucks, percent trucks, existing and predicted population growth, size of urban areas, and horizontal and vertical alignment of the highway. The length of I-35 from San Antonio to Dallas covered a distance of almost 250 mi.

Corridor Description

The major urban areas within the selected corridor are Austin, Temple, Waco, and small portions of San Antonio and Dallas. The terrain is flat to gently rolling. Most of the corridor, 228 mi, has two lanes in each direction; 19 mi of urban freeway has three or more lanes in each direction.

Daily traffic volume along rural areas of the corridor ranged from 15,000 to 25,000 vehicles per day (vpd). Urban area

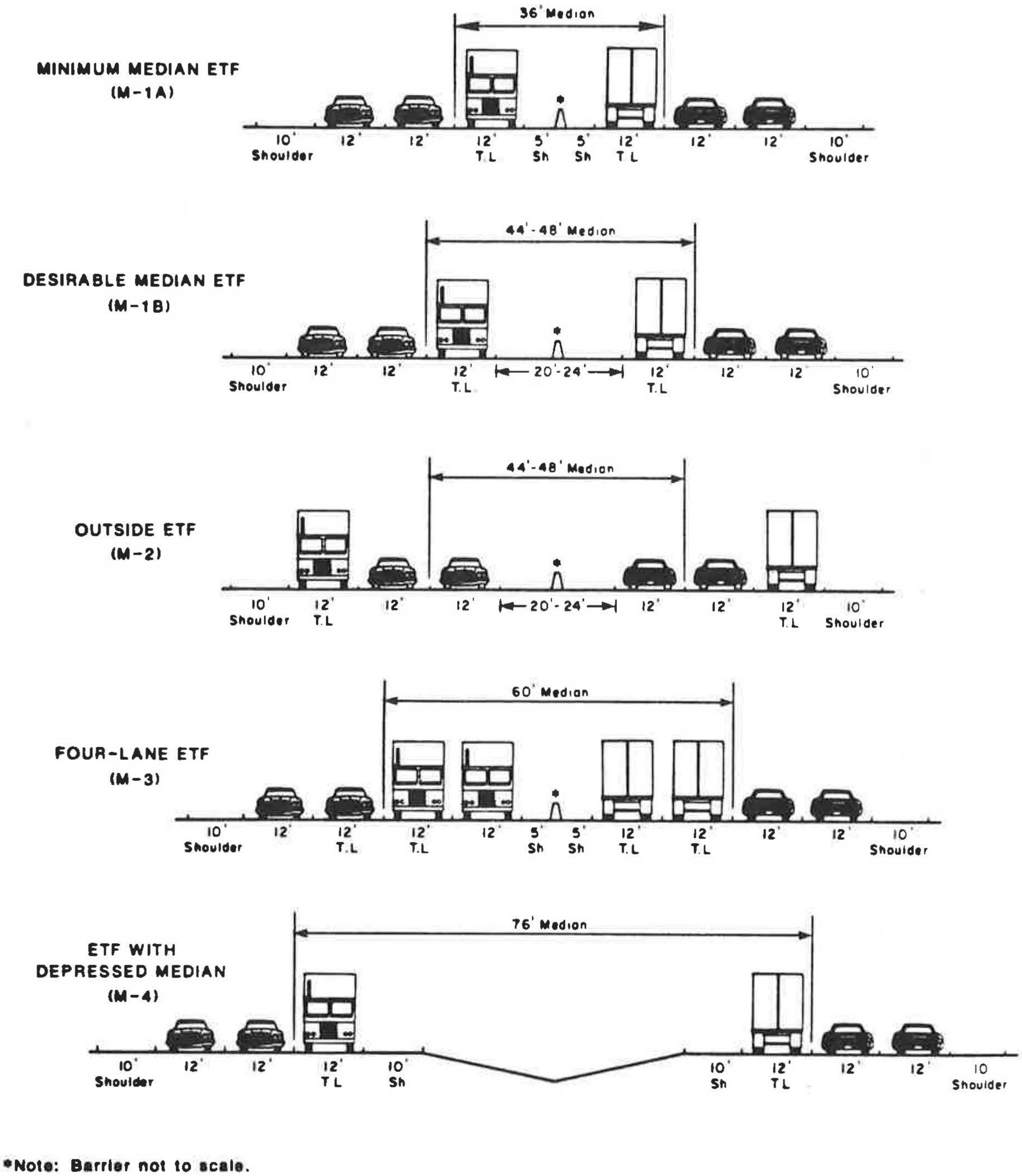

FIGURE 1 Typical exclusive truck facility (ETF) cross sections.

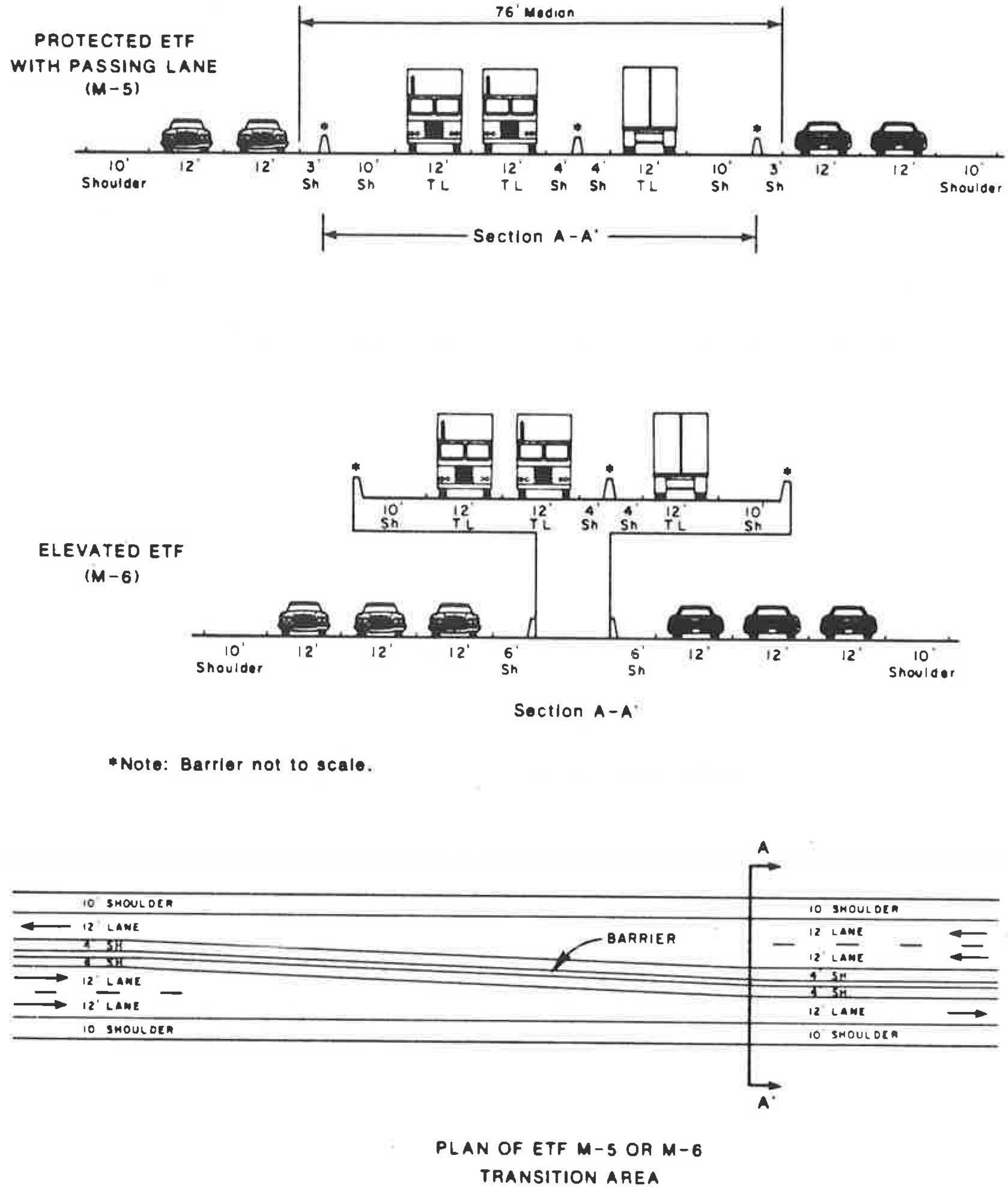

FIGURE 1 continued

traffic volumes were as follows: San Antonio, 71,000 vpd near that project terminus; Austin, 70,000 to 130,000 vpd; Temple, 40,000 vpd; Waco, 50,000 vpd; and Dallas, 44,000 vpd south of the I-20 interchange, 51,000 vpd just north of this interchange. Table 1 presents some unadjusted raw traffic counts found at critical locations along the corridor. Peak-hour truck traffic, peak-hour total traffic, and percent trucks determined from these counts are also given in this table.

Strip Map

A strip map was developed showing a schematic plan view of the roadway at a scale of 1 in. = 1 mi. Figure 3 shows the general concept. Additional information included mileposts at 10-mi increments, bridges, overpasses, interchanges, and their ramp configurations, median obstructions, county lines, city limit boundaries, rivers, and other pertinent geographic features. This information was positioned on the top one-third of the strip map.

Information contained on the lower two-thirds of the map was plotted to scale to pictorially identify problem areas at a glance. The items of concern include ADT, number of trucks, percent of trucks, median width, median obstructions, grade, number of lanes, shoulder width, vertical clearance, right-of-way, and level of service (LOS). The thickness of the black bands is an indicator of the severity of each of the 11 criteria. Specific information came from the detailed design and as-built drawings.

Particular geometric information was verified by aerial photographs of the entire study corridor at a scale of 1 in. = 200 ft.

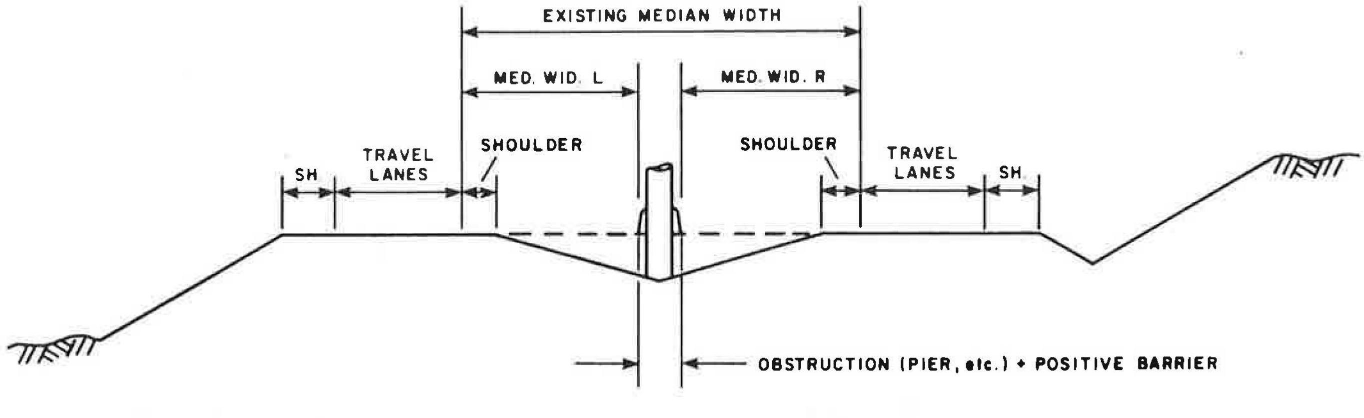

FIGURE 2 Effective median width.

TABLE 1 I-35 TRAFFIC COUNT SUMMARY[a]

MP	Location	24-Hour Traffic	Peak Hour Volume		% Trucks	
			Truck[(b)] Traffic	Total Traffic	Day	Peak Hour
185.0	6 mi. S. New Braunfels	32,158	188	1,191	17	16
209.5	5 mi. N. San Marcos	34,498	153	1,521	16	10
253.5	1 mi. N. Round Rock	37,985	159	1,917	18	8
283.0	1 mi. N. Prairie Dell	14,288	104	549	31	19
305.5	4 mi. N. Temple	16,452	135	964	25	14
326.5	8 mi. N. Waco	20,648	151	833	27	18
351.5	15 mi. N. Waco	19,474	164	1,026	30	16
371.0	I-35 E @ Hillsboro	12,203	130	480	32	27

(a) Raw traffic count, no adjustment factors have been applied.

(b) Trucks: excludes panel, pickup truck, and bus.

The aerials were helpful in determining changes made since the original construction of the corridor.

Because the strip map provided a means of visually evaluating many factors along a selected highway corridor, it was decided that this concept of pictorial evaluation should be maintained; however, a more efficient method was needed to expedite the process. Evaluation by computer was the answer.

Computer Program

A computer program was thus developed as the next step in the truck lane evaluation process because each segment of highway must be individually examined to determine the practicality and benefits of truck lane construction. To expedite this evaluation process, a methodology was developed that considered appropriate variables of each roadway segment in terms of accepted criteria.

It was decided that a moving-analysis computer program could most effectively evaluate each individual segment and print the results in an easily interpreted format. Such a technique required an iterative, multistep type of development to identify the pertinent variables, while presenting the results in a meaningful manner.

Data input in half-mile segments are milepost, peak-hour volume, number or percent of trucks, percent of grade, length of grade, terrain factor, number of lanes, distance to lateral obstructions, total median width, and effective median width. The program evaluates each half-mile segment independently and calculates a volume-to-capacity (V/C) ratio. Two V/C ratios are computed by the HCM *(3)* method: V/C with total traffic and V/C without trucks. This comparison is used to

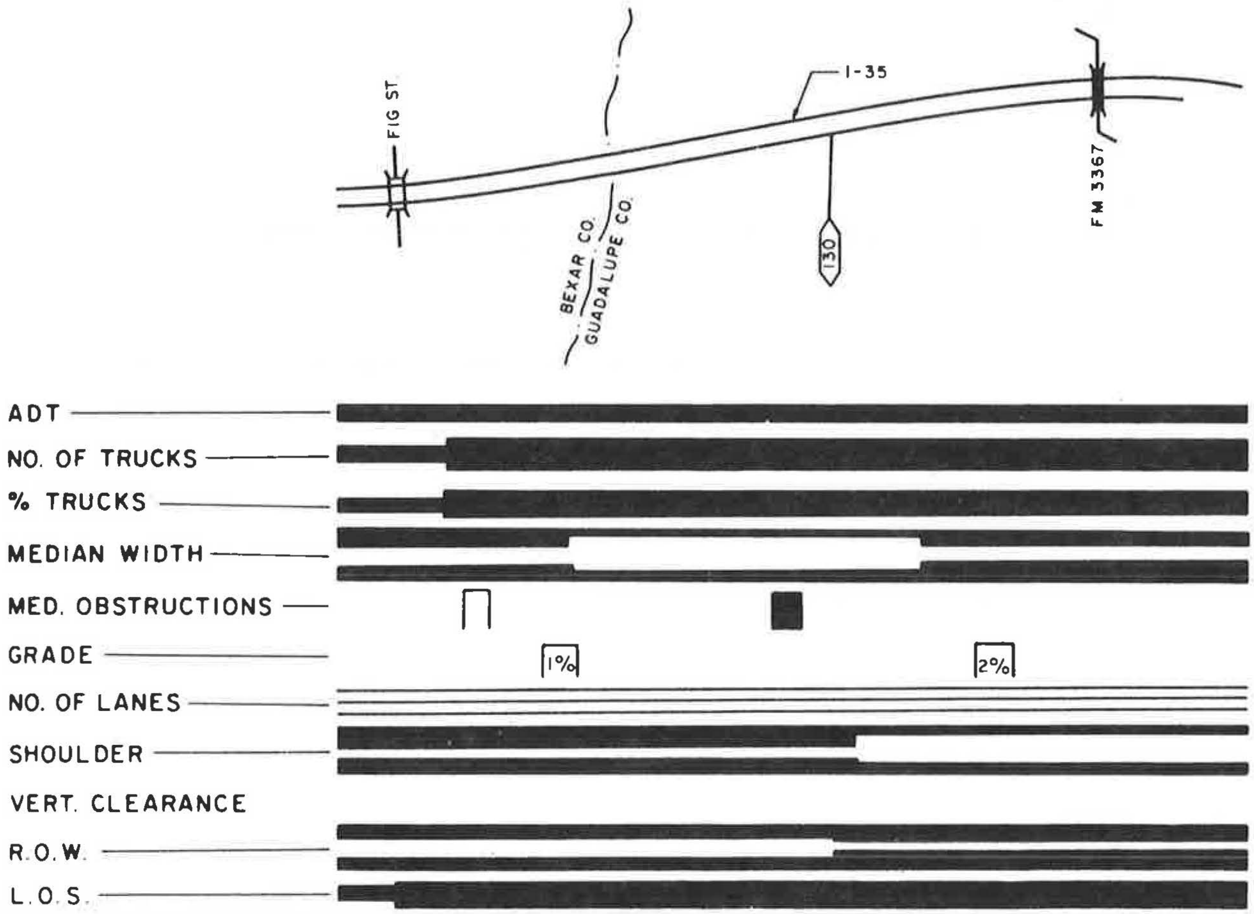

FIGURE 3 Strip map.

determine the impact of removing trucks from the main stream of traffic. Two key parameters are determined by the program: effective median width (Figure 2) and improvement in V/C ratio by removing trucks. The computer program is described in detail elsewhere *(2)*.

THE COMPUTER PROGRAM

Program Development

The general analysis methodology selected was to use a Fortran program on a mainframe computer to analyze the candidate corridor in half-mile segments, printing out a continuous strip of information for evaluation. Before development of the model, the necessary input parameters, the desired analysis output, and the initial model to be used were determined. Available data were examined, and further needs were identified. The model was developed and programmed, and test runs were made on coded data. The resulting computer printouts were then analyzed to determine the correctness and usefulness of the output.

The computer program was developed in Fortran as a moving-analysis program that sweeps through the data and analyzes each half-mile segment of the corridor. An existing program *(6)* that simulated high-speed train operations was rewritten to examine geometric constraints and to perform V/C computations. The revised program separated each function into a unique subroutine, each called in turn by the master control subroutine. This change resulted in much greater ease of revising parts of the program and model to reflect the changing developmental needs during analyses of the output. Operation of the final program is described later.

Program Architecture

General architecture and operation of the program are shown in Figures 4 and 5. The master program, which is short, reads the first lines of DATAFILE and initializes the table arrays. Then, depending on options selected, control is passed to one of the controlling MODEL subroutines, which takes over and selects the desired subroutines according to the options selected, looping until all segments have been evaluated. The end of the section being evaluated is marked by the milepost value of 999. When this is encountered, the selected controlling subroutine may call a summary subroutine and return control to the main program. An option that may be selected is the capability of the program to write its results to a computer file for storage and analysis by another program such as Statistical Analysis System (SAS) *(7)*. The program could also be modified to synthesize multiple files, possibly using data output by other computer programs or taken from files on tape.

This type of architecture, using a short main program that controls multiple operational subroutines, has a number of

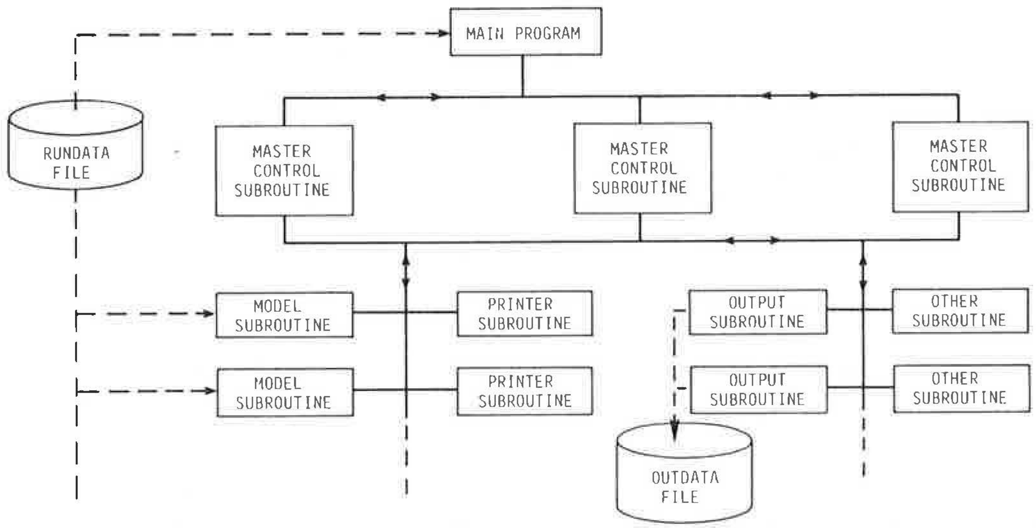

FIGURE 4 Computer program operation.

advantages over a series of programs with few or no subroutines. It results in a single program that is extremely flexible and capable of many different types of analyses, depending on options selected from the beginning of the RUNDATA file. Developmental changes are easily made, with only a few subroutines involved with any changes. Old options can be retained for comparison through the addition of new subroutines, and it is not necessary to maintain a large library of many analysis programs (one for each desired function).

One problem with this type of architecture appears to be the large size of the program, which contains many more subroutines than those used in any single run. This not only results in a long program, but it makes it necessary to either store a compiled version of the Fortran program that cannot be easily read or reprogrammed or to recompile all portions of the program each time it is run, increasing the expense. The developmental advantages and flexibility of the program, however, more than offset these disadvantages.

Data

Data are read from the RUNDATA file, which began with an options line to tell the program which model to use and the desired output, followed by a heading line; the formatted highway and traffic data followed these first lines.

The entire length of I-35 from San Antonio to Dallas, a distance of approximately 250 mi, was selected for analysis and coded into RUNDATA. Specific information was taken from detailed design and as-built drawings, aerial photographs, and the strip map.

Current roadway and traffic count information was then entered into the computer by half-mile segments for the entire length of the corridor. This information was coded into DATAFILE by highway milepost. Following data entry, the two initial lines containing options and heading were entered, and the file saved.

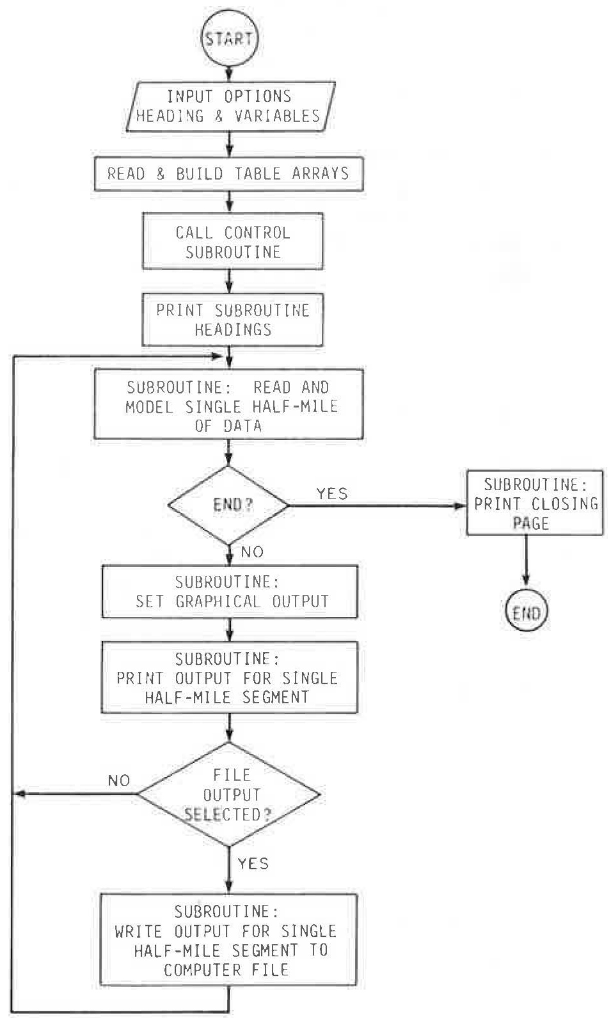

FIGURE 5 Program flowchart.

Model Development

As a first-trial model, two indices were generated, one for geometric feasibility and the other for traffic conditions. These indices along with a visual profile of a third, combined index were printed for each half-mile segment. Further analysis of the indices suggested that they were not the most desirable output. Need for a better model was acknowledged early in the design process because a satisfactory, justifiable method of combining the indices could not be found.

Traffic V/C ratio, calculated according to the HCM *(3)*, proved to be more meaningful. The end results could also be interpreted using traditional LOS comparisons. For each half-mile segment, the program calculated V/C ratios with and without trucks on the segment, using the procedures outlined in the HCM for basic freeway segments.

Upon starting each run of the program, the passenger car equivalent Table 3–6 of the HCM *(3)* for heavy trucks (300 lb/hp) was read into a four-subscript array. It should be noted that Table 3–4 of the HCM *(3)*, which gives passenger car equivalents for typical trucks (200 lb/hp), could also be entered if appropriate. After data for a single half-mile segment were read, the computer located the appropriate table value by calculating the correct subscripts based on number of lanes in a single direction, percent of trucks, percent of grade, and length of grade. The array was then entered at the proper location to obtain the relevant value of E_T, passenger car equivalents. Next, trucks were subtracted from total traffic to give the number of passenger cars. The proportion of trucks (P_T) was then determined; proportion of recreational vehicles and buses were not separately considered. If 24-hr traffic volume was input, the program calculated peak-hour volume V by multiplying the ADT by a recommended K value (where K = ratio of peak-hour traffic volume to average daily traffic) entered in the RUNDATA file.

The adjustment factor for heavy vehicles f_{HV} was then calculated using Equation 3–4 in the HCM *(3)*:

$$f_{HV} = 1/[1 + P_T (E_T - 1)] \quad (1)$$

where P_T is the proportion of trucks in the traffic stream, and E_T is the passenger car equivalent for trucks.

Service flow rate SF was calculated for existing traffic with and without trucks by dividing the corresponding peak-hour volumes by the peak-hour factor (*PHF*) in RUNDATA. The V/C ratios were determined using the rearranged Equation 3–3 from the HCM *(3)*:

$$V/C = SF/(c_j \times N \times f_w \times f_{HV} \times f_p) \quad (2)$$

where

- V/C = ratio of demand volume to roadway capacity;
- *SF* = service flow rate, *V/PHF*;
- c_j = capacity under ideal conditions (2,000 passenger cars per hour per lane for 60- and 70-mph design);
- N = number of freeway lanes in one direction;
- f_w = factor to adjust for restricted lane widths and lateral clearances from Table 3-2 of the HCM *(3)* or input in RUNDATA;
- f_{HV} = factor to adjust for heavy vehicles; and
- f_p = factor to adjust for the effect of driver population (input from RUNDATA).

The percentage of V/C improvement was calculated by dividing the difference between the V/C ratio with trucks by the V/C ratio without trucks, and multiplying the quotient by 100. This percentage improvement in V/C was then plotted for visual analysis.

Each grade could be individually evaluated by the program, or a general terrain factor could be entered for each half-mile segment. If there were no grade data entered, the program used Table 3–3, "Passenger-Car Equivalents on Extended General Freeway Segments," of the HCM *(3)*, instead of the values in Table 3–6 for specific grades. An effective median width (the width between mainlanes less shoulders and obstructions), as described earlier and shown in Figure 2, was then computed and plotted for a particular half-mile segment. The computer output was verified by comparison with selected manually calculated V/C ratios and median widths; these gave identical results.

Even though the percent improvement in the V/C ratio was computed and printed by the program, no criteria were developed for its evaluation. The graphical portion of the printout was therefore revised to plot the percent improvement in V/C ratio only when a predetermined threshold value was exceeded. If the V/C ratio with trucks was less than 0.54 (LOS B or better, 70-mph design speed), the V/C improvement plot for that half-mile segment was replaced by a series of dashes to flag the fact that no improvement was needed.

A portion of the computer program output for I-35 is reproduced in Figure 6. This information represents the base year (1985) traffic demand. The section begins at milepost 230.0 and ends at milepost 243.0. Input variables printed with the associated output are milepost (*MP*), peak-hour volume (*PHV*), number of trucks (*TRUCKS*) or percent of trucks (*%T*), percent grade (*%GRADE*), grade length (*L*), terrain factor (*T*), number of lanes in each direction (*N*), and distance to lateral obstructions (*LAT*). The evaluation criteria (actual computer-generated output) are shoulder-to-shoulder median width (*MEDW*), effective median width (*TW*) as shown in Figure 2, volume-to-capacity ratio for all traffic (V/C), volume-to-capacity ratio for traffic without trucks (*V/CA*), improvement in V/C (%V/C), and level of service at 70-mph design (LOS70), each printed out by half-mile segment.

The effective median width is evaluated according to the following categories: less than 36 ft, between 36 and 52 ft, and over 52 ft. Exclusive truck facilities can be built at grade if the effective median width is at least 36 ft (Figure 1). If the width is less than 36 ft and if other messages are not called, a message is printed out under the heading IMPROVEMENT IN V/C, which overrides the actual plot of change in V/C. A good example is the section from milepost 230.0 to 231.5. If the computed volume-to-capacity ratio for all traffic (V/C) is greater than 1.0, the message "LOS = F" is printed instead of median width information or improvement in V/C. The obstruction OBS column is not currently used; the COMMENTS column can be used for any 20-character comment statement.

Another model was developed that used the same input criteria for a particular half-mile segment and then applied a growth factor to existing traffic data so that various traffic growth scenarios could be evaluated over time. This model also differs in that it prints a single page of output for each half-mile segment selected for application of growth factors. For the I-35

TTI TRUCKLANE ANALYSIS PROGRAM OUTPUT

ANALYSIS OF FULL ADT DATA: I-35

MP	PHV	TRUCKS	%T	%GRADE	L	T	N	LAT	MEDW	TW:	-36	36-52	52+	V/C	V/CA	%V/C	LOS70	IMPROVEMENT IN V/C 0% 50% 100% 150% 200%	OBS	COMMENTS
230.0	2160	173	8	5	1100	0	3	6	20	19	•			0.56	0.39	43	C:B	MEDIAN TOO NARROW	0	4MID
230.5	2160	173	8	-3	1500	0	3	6	20	25	•			0.56	0.39	43	C:B	MEDIAN TOO NARROW	0	
231.0	2160	173	8	0	0	0	3	6	20	25	•			0.45	0.39	15	B:B	MEDIAN TOO NARROW	0	
231.5	2160	173	8	0	0	0	3	6	20	25	•			0.45	0.39	15	B:B	MEDIAN TOO NARROW	0	WILLIAMSON CR
232.0	4360	349	8	4	1500	0	3	6	20	19	•			1.13	0.79	43	F:D	#### LOS = F ####	0	4MID
232.5	4360	349	8	0	0	0	3	6	20	25	•			0.90	0.79	15	D:D	MEDIAN TOO NARROW	0	
233.0	4360	349	8	5	1100	0	3	6	20	17	•			1.13	0.79	43	F:D	#### LOS = F ####	0	NO PLANS?
233.5	4360	349	8	5	1000	0	3	6	20	17	•			1.13	0.79	43	F:D	#### LOS = F ####	0	
234.0	4360	349	8	0	0	0	3	6	20	17	•			0.90	0.79	15	D:D	MEDIAN TOO NARROW	0	NO PLANS?
234.5	4360	349	8	-4	1584	0	3	6	20	17	•			1.13	0.79	43	F:D	#### LOS = F ####	0	
235.0	4360	349	8	6	1000	0	3	6	20	17	•			1.13	0.79	43	F:D	#### LOS = F ####	0	NO MED./NO E.H.
235.5	4360	349	8	0	0	0	3	6	20	17	•			0.90	0.79	15	D:D	MEDIAN TOO NARROW	0	
236.0	4360	349	8	4	1600	0	3	6	20	11	•			1.13	0.79	43	F:D	#### LOS = F ####	0	4MID
236.5	4360	349	8	-5	2600	0	3	6	20	17	•			1.20	0.79	52	F:D	#### LOS = F ####	0	NO PLANS?
237.0	4360	349	8	0	0	0	3	6	20	17	•			0.90	0.79	15	D:D	MEDIAN TOO NARROW	0	
237.5	4360	349	8	0	0	0	3	6	20	17	•			0.90	0.79	15	D:D	MEDIAN TOO NARROW	0	
238.0	4360	349	8	0	0	0	3	6	20	17	•			0.90	0.79	15	D:D	MEDIAN TOO NARROW	0	
238.5	4360	349	8	0	0	0	3	6	20	17	•			0.90	0.79	15	D:D	MEDIAN TOO NARROW	0	
239.0	4360	349	8	0	0	0	3	6	32	37		•		0.90	0.79	15	D:D	• I	0	
239.5	3760	301	8	3	2300	0	8	6	32	31	•			0.36	0.25	43	B:A	MEDIAN TOO NARROW	0	3MID
240.0	2800	224	8	0	0	0	8	6	32	37		•		0.22	0.19	15	A:A	- - - -I- - - -	0	
240.5	2800	224	8	-2	3000	0	8	6	32	37		•		0.27	0.19	43	A:A	- - - -I- - - -	0	
241.0	2800	224	8	0	0	0	8	6	32	37		•		0.22	0.19	15	A:A	- - - -I- - - -	0	
241.5	2800	224	8	-2	2700	0	8	6	32	37		•		0.27	0.19	43	A:A	- - - -I- - - -	0	
242.0	2800	224	8	0	0	0	3	6	54	59			•	0.58	0.51	15	C:B	• I	0	
242.5	2800	224	8	0	0	0	3	6	54	59			•	0.58	0.51	15	C:B	• I	0	
243.0	2800	224	8	0	0	0	3	6	54	53			•	0.58	0.51	15	C:B	• I	0	4MID

FIGURE 6 Computer program output for I-35, base year.

TTI TRUCKLANE ANALYSIS PROGRAM OUTPUT

ANALYSIS OF I-35 GROWTH: ADT * K AT MILEPOST 250.0 GROWTH FACTORS USED: 7.15% 1985 - 1989; 7.36% 1990 +

WILLIAMSON COUNTY; CRITICAL (HIGHEST) V/C PHV OCCURS BETWEEN MP 250.0 & MP 250.5

YEAR	PHV	TRUCKS	%T	%GRADE	L	T	N	LAT	MEDW	TW: -36 36-52 52+		V/C	V/CA	%V/C	LOS70	IMPROVEMENT IN V/C 0% 50% 100% 150% 200%	OBS	COMMENTS
1985	1680	134	8	2	5000	0	2	4	54	53	: . . * :	0.70	0.46	52	C:B	: * I . :	0	2MID
1986	1800	144	8	2	5000	0	2	4	54	53	: . . * :	0.71	0.49	43	C:B	: *. I . :	0	2MID
1987	1929	154	8	2	5000	0	2	4	54	53	: . . * :	0.80	0.53	52	D:B	: * I . :	0	2MID
1988	2067	165	8	2	5000	0	2	4	54	53	: . . * :	0.86	0.57	52	D:C	: * I . :	0	2MID
1989	2215	177	8	2	5000	0	2	4	54	53	: . . * :	0.92	0.61	52	D:C	: * I . :	0	2MID
1990	2373	190	8	2	5000	0	2	4	54	53	: . . * :	0.93	0.65	43	D:C	: *. I . :	0	2MID
1991	2548	204	8	2	5000	0	2	4	54	53	: . . * :	1.00	0.70	43	E:C	: *. I . :	0	2MID
1992	2736	219	8	2	5000	0	2	4	54	53	: . . * :	1.07	0.75	43	F:C	: #### LOS = F #### :	0	2MID
1993	2937	235	8	2	5000	0	2	4	54	53	: . . * :	1.15	0.80	43	F:D	: #### LOS = F #### :	0	2MID
1994	3153	252	8	2	5000	0	2	4	54	53	: . . * :	1.31	0.86	52	F:D	: #### LOS = F #### :	0	2MID
1995	3385	271	8	2	5000	0	2	4	54	53	: . . * :	1.33	0.93	43	F:D	: #### LOS = F #### :	0	2MID
1996	3634	291	8	2	5000	0	2	4	54	53	: . . * :	1.43	0.99	43	F:E	: #### LOS = F #### :	0	2MID
1997	3901	312	8	2	5000	0	2	4	54	53	: . . * :	1.62	1.07	52	F:F	: #### LOS = F #### :	0	2MID
1998	4188	335	8	2	5000	0	2	4	54	53	: . . * :	1.74	1.14	52	F:F	: #### LOS = F #### :	0	2MID
1999	4496	360	8	2	5000	0	2	4	54	53	: . . * :	1.76	1.23	43	F:F	: #### LOS = F #### :	0	2MID
2000	4827	386	8	2	5000	0	2	4	54	53	: . . * :	2.01	1.32	52	F:F	: #### LOS = F #### :	0	2MID
2001	5182	414	8	2	5000	0	2	4	54	53	: . . * :	2.16	1.42	52	F:F	: #### LOS = F #### :	0	2MID
2002	5563	444	8	2	5000	0	2	4	54	53	: . . * :	2.31	1.52	52	F:F	: #### LOS = F #### :	0	2MID
2003	5972	477	8	2	5000	0	2	4	54	53	: . . * :	2.48	1.63	52	F:F	: #### LOS = F #### :	0	2MID
2004	6412	512	8	2	5000	0	2	4	54	53	: . . * :	2.67	1.75	52	F:F	: #### LOS = F #### :	0	2MID
2005	6884	550	8	2	5000	0	2	4	54	53	: . . * :	2.86	1.88	52	F:F	: #### LOS = F #### :	0	2MID
2006	7391	590	8	2	5000	0	2	4	54	53	: . . * :	3.07	2.02	52	F:F	: #### LOS = F #### :	0	2MID
2007	7935	633	8	2	5000	0	2	4	54	53	: . . * :	3.30	2.17	52	F:F	: #### LOS = F #### :	0	2MID
2008	8519	680	8	2	5000	0	2	4	54	53	: . . * :	3.54	2.33	52	F:F	: #### LOS = F #### :	0	2MID
2009	9146	730	8	2	5000	0	2	4	54	53	: . . * :	3.80	2.50	52	F:F	: #### LOS = F #### :	0	2MID
2010	9819	784	8	2	5000	0	2	4	54	53	: . . * :	4.08	2.68	52	F:F	: #### LOS = F #### :	0	2MID

FIGURE 7 Computer program output for I-35, future years.

corridor, only the worst half-mile segment with highest existing V/C in each county was chosen for analysis, and the traffic growth was calculated for 1985 to 2010. A single line is printed for each year.

In calculating traffic projections with this model, it was possible to calculate a V/C ratio of greater than 1.0, indicating that capacity of the highway segment has been exceeded; this was flagged with the message "LOS = F". Finally, those locations where median width was inadequate for exclusive truck facilities were flagged with a printed message.

Figure 7 shows a sample of the output of this model that is very similar in format to the base year tabulation described earlier. The output headings are exactly the same except the first, which is YEAR instead of MP (milepost). For each roadway, the current roadway geometry (number of lanes, etc.) is held constant. As the traffic volumes increase over time, the V/C ratios increase, indicating a need for expanded roadway capacity. Other values (percent trucks, driver population characteristics, and truck operating characteristics) were held constant over the projection period.

SUMMARY AND CONCLUSIONS

The process of comparing the V/C ratio with trucks to that without trucks readily gave a qualitative measure of improvement in traffic operating characteristics. Two evaluations are possible:

1. A comparison of changes in LOS on the existing facility with and without trucks.
2. A comparison of the length of time until traffic conditions reach undesirable levels.

Analysis of the I-35 corridor between San Antonio and Dallas revealed that the addition of exclusive truck facilities to remove trucks from the mainlanes of traffic would not be feasible for most of the study corridor under present traffic. Approximately 90 percent of the corridor operates at LOS A or B; only 3 percent (7.5 mi) of the entire length of 247 mi operates at LOS D or worse. These congested segments of the freeway are all in or near urban areas where available median width for truck lanes is insufficient for desirable at-grade truck lane cross sections. Therefore, the option in many of these critical sections will be an elevated truck lane (Cross Section M-6 in Figure 1).

Figure 7 shows the utility of the program for evaluating future traffic projections. The growth rate for the county represented is expected to be very high—more than 7 percent per year. The length of time remaining until capacity is reached on the mainlanes will be 6 years with trucks, and 11 years without trucks. Fortunately, on this particular section of I-35, sufficient median width remains for truck facilities.

The methodology used for determining candidate sections of roadway for truck lanes in the median area is equally appropriate for use in other corridors, and therefore can be immediately implemented elsewhere. In fact, it has already been used for evaluation of the I-10 corridor between Houston and Beaumont *(4)*.

To make the program more interactive for the user, it was adapted for use on the microcomputer using Turbo Pascal programming language. Unfortunately, time and resources did not permit modifications to either version of the program to include other desirable options. Such features might include simultaneous evaluation of added lanes as either mixed-use lanes or exclusive lanes, evaluation of LOS on the truck lanes, and evaluation of other locations besides the median area such as frontage roads or parallel existing rights-of-way.

Finally, other criteria besides those included herein, which are purely geometric and operational, must be considered in the more detailed evaluation process as candidate sections of freeway are identified.

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