A Practical Approach to Managing Intersection Traffic Data for Large Scale Studies

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As an increasing number of metropolitan areas study the possibility of enhancing the modal options of their transportation systems, the number of Environmental Impact Statements (EIS) that need to be prepared has increased significantly. A recent EIS was conducted that required peak hour intersection Level of Service (LOS) calculations for over 60 intersections for two base-year and seven future-year scenarios (nearly 1,100 intersection data records). Tight time constraints and the need for efficient stewardship of this large data set lent itself to employing a data management tool. The proper tool would encompass electronic data management as well as provide signal optimization and LOS calculations. The traffic engineering software package Synchro was chosen for this task. Existing turning movement counts (TMC), geometric conditions, and signal timing were entered into peak period Synchro files. The Synchro base year TMC were exported in comma delimited (CSV) file format and converted to approach turn percentages using a spreadsheet program. The regional transportation planning model output provided daily link volumes for each scenario. Intersection approach volumes were then determined using historical K and D factors. Incorporating the approach volumes into the TMC spreadsheet provided horizon year TMC. The TMC were then imported back into the Synchro file and optimized to provide future year intersection LOS. This innovative procedure saved considerable time in both data error checking and traffic analysis. Once the data set was entered into Synchro, all further data management and analysis was electronically handled, therefore reducing data entry time and the potential for data handling errors. Key words: turn movement counts, level of service, universal traffic data format (UTDF), Synchro.

INTRODUCTION

As an increasing number of metropolitan areas study the possibility of enhancing the modal options of their transportation systems, the number of Environmental Impact Statements (EIS) that need to be prepared has increased significantly. A typical EIS contains numerous sections addressing impacts such as noise, air quality, and traffic. This paper summarizes an innovative methodology for conducting traffic analysis as required by an EIS or any other large-scale traffic analysis effort.

A recent EIS for Tampa, Florida was conducted that required AM and PM peak-hour intersection Level of Service (LOS) calculations for over 60 intersections for two base year and seven future year scenarios (nearly 1,100 intersection data records). Tight time constraints and the need for efficient stewardship of this large data set lent itself to employing a data management tool. Innovations in standardized traffic data formatting have made electronic data management a practical tool for all practitioners. The Tampa EIS serves as the case study for this paper.

It is not the intention of this paper to endorse or discredit any traffic engineering software package. This paper simply identifies a case study and the methodology the authors used to conduct the traffic analysis portion of an EIS. It is hoped that practitioners will benefit from the methodology and other information presented in this paper.

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BACKGROUND

Current Practice

A widely accepted standard for signalized intersection LOS analysis is the Highway Capacity Software (HCS). The most recent version of HCS is 3.1, which was recently converted to a windows-based software program. HCS 3.1 is a direct application of the 1997 Highway Capacity Manual. Signalized intersection analysis requires data inputs such as lane geometry, peak-hour turning volumes, and signal phasing and timing as a minimum. Additional inputs are numerous and can range from ideal saturation flow rate to right turn treatment. Figure 1 illustrates a typical methodology for HCS analysis.

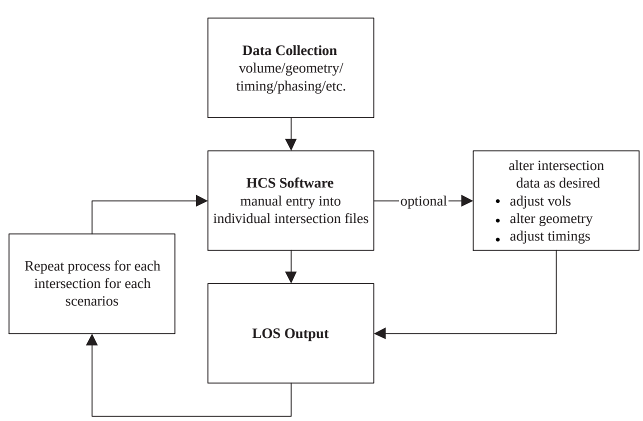

FIGURE 1 Typical HCS analysis process

Tampa Case Study

The Tampa case study required nearly 1,100 signalized intersection LOS analyses (60 intersections, 2 peak periods, and 9 scenarios). The traditional approach would require one file for each intersection for each scenario. It is easy to see using the standard HCS methodology would require significant resources, both manpower and time, to complete the analysis task. The tight time constraint of the project deadline required the traffic analysis team to seek out a LOS analysis package that incorporated electronic data management. The appropriate package had to encompass electronic data management as well as provide signal optimization and LOS calculations. The ideal analysis tool required entering intersection characteristics (geometry, volume, and signal data) only once and then allowed manipulation of the electronic data by scenarios to complete the required analysis. Additional project needs included a turning movement count (TMC) review mechanism for local experts as well as a project quality review mechanism for the traffic analysis team.

LOS Analysis Package

The traffic engineering software package Synchro (version 3.2) was chosen as the analysis tool. Synchro is a macroscopic, deterministic, signalized intersection LOS analysis software program utilizing the 1994 HCM methodologies. Synchro has a companion model called SimTraffic, which is a microscopic, stochastic simulation package. Additionally, Synchro has the ability to interface with database files using a universal traffic data format (UTDF). UTDF is explained in greater detail later in this section.

To begin the process, the traffic analysis team developed a link-node system corresponding directly to the desired traffic network under study. The network development was streamlined by using a “dxf” formatted graphics file as a background base map. The ability to develop a network of signalized intersections allowed for system analysis—i.e. use of offsets for progression, queueing and blocking problem identification, etc.—rather than analyzing each individual intersection independently. A more subtle advantage to a system analysis—i.e. PM peak hour with existing geometric conditions—compared to individual intersection analyses—i.e. Elm and Main for PM peak with existing geometric conditions—would simply be minimization of errors due to confusion. Additionally, individual files would not be required for each intersection greatly reducing the number of files to manage. For example, in this case study the 1,080 files that would have been required if individual intersection analysis were used (60 intersections; 2 peak periods; 9 scenarios) was reduced to 18 files (2 peak periods; 9 scenarios) with the system approach. Practitioners dealing with stacks of signal timing sheets, peak hour volume reports, and geometric drawings would most likely agree that handling all intersections in a system is less confusing than the alternative and more importantly results in fewer errors.

Initial intersection data input was accomplished through successive input screens for traffic volume, geometry, and signal timing. Once each intersection data was input, a calibration effort was initiated. Calibration of the macroscopic analysis model entailed adjustment of the saturation flow rates, startup loss times, and right turn on red treatment to name a few. Further, the SimTraffic option of Synchro was used for visual quality review. No additional programming is required to use the features of SimTraffic since Synchro serves as the input editor for SimTraffic.

Traffic analysis of this scale has a high potential for input or analysis errors due in most part to the size of the project and the enormous amount of data involved. Common errors that were observed using SimTraffic for quality review were mainly geometric problems such as turn lane assignments and turn bay lengths. The traffic analysis team, being knowledgeable on the study corridor, easily reviewed the input data for errors within a short time using the SimTraffic program. Figure 2 illustrates the typical methodology for using Synchro.

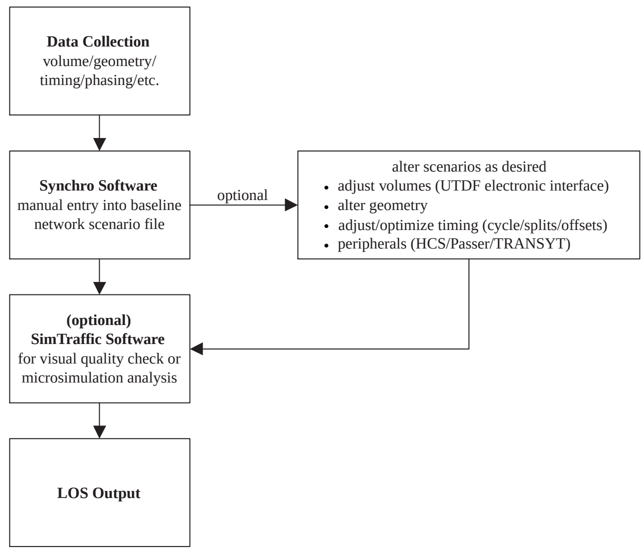

FIGURE 2 Typical Synchro analysis process

UTDF

UTDF was developed by Trafficware—the developer of Synchro—in an effort to spur a standard format for traffic engineering variables. UTDF enables data access through open-ended or nonproprietary software programs such as spreadsheets, text editors, or database programs. UTDF simply provides a means to electronically manipulate standard traffic data, in this case traffic volumes. For instance, imagine reentering the turning movement volumes for an intersection 17 times, then moving onto the next intersection as in this case study. Wouldn’t you rather spend your project budget analyzing the traffic conditions, testing alternatives, or developing mitigation concepts rather than entering data?

UTDF uses text files to store and share data. Both comma delimited (CSV) and column aligned text files are supported. The column aligned files can easily be manipulated with a text editor. For this study, the CSV format was used since the data can be modified with a spreadsheet program. Figure 3 illustrates traffic volume data for several intersections in the case study. The first two rows are header information with specific details to the UTDF file. In Figure 3, the header indicates that these are turning movement counts, and the counts are in vehicles per hour (60 minute counts). Each possible turn movement (NBL, NBT, etc.) is identified in the third row, with

Turning Movement Count
60 Minute Counts

DATE	TIME	INTID	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
8/19/99	1700	1	275	462			1424	726	852		727			
8/19/99	1700	2		652	237	241	2568					160		22
8/19/99	1700	3	121	542	201	665	1555	460	349	1182	328	186	701	184
8/19/99	1700	4	76	775	227	294	1632	111	121	201	144	69	40	39
8/19/99	1700	5	24	1246	215	129	1552	49	75	85	50	26	15	24
8/19/99	1700	6	140	631	285	512	810	354	522	1663	196	232	1093	498
8/19/99	1700	27	51	297	230	78	712	340	152	1407	97	274	1971	59
8/19/99	1700	32	80	22	111	4	11	3	10	1936	87	31	1351	21
8/19/99	1700	34	51	135	23	50	253	55	51	507	39	38	955	49
8/19/99	1700	37	72	112	62	104	187	42	133	1109	62	93	1380	56

FIGURE 3 Base year multiple intersection volumes, UTDF format

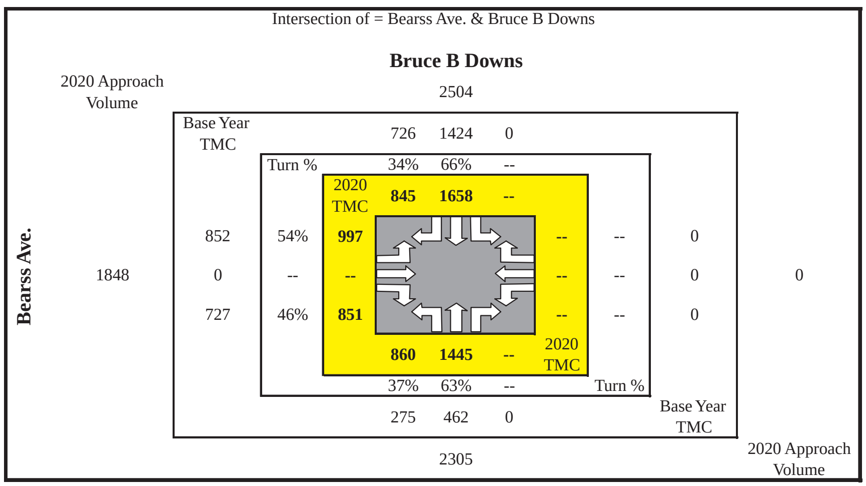

FIGURE 5 Graphical representation of turning movement data

the intersection identification (INTID) number in the third column. The intersection identification number corresponds to the node number assigned in Synchro when the network was initially built. For example, node #1 is a "T" intersection with 275 vehicles approaching the intersection from the south and turning left. Other data are provided (date and time) which allows multiple counts by date and time to be stored in a single database file. For this case study, the turning movement counts for all 60 intersections for each peak period were stored in a single UTDF file.

METHODOLOGY/APPLICATION

Case Study

A Light-Rail Transit (LRT) EIS was conducted in Tampa, Florida that required nearly 1,100 intersection LOS analyses. The large number of intersection analyses was desired to document the impacts of LRT right-of-way takes and traffic volume changes on the study corridor intersections. The use of UTDF incorporated with a standard spreadsheet program provided a very powerful methodology to accomplish the required task. Figure 4 illustrates the methodology developed for this project.

The first step was to enter the traffic data into base year, or existing conditions, Synchro files for both peak periods. This process is discussed in the LOS Analysis Package section of this paper. These files served as the platform for all subsequent analyses. Existing peak period LOS was then determined as a direct output from the existing conditions files.

The next step was to develop future year traffic conditions based on planning model growth and existing traffic turning movement percentages. The Synchro base year TMC were exported in CSV file format (Figure 3) and converted to approach turn percentages using a spreadsheet program (Figure 5). This established the basic traffic flow patterns for the study corridor. The intersection identification number, originally assigned as the node number in Synchro, serves as the key to connecting intersection data. The regional transportation planning model output provided daily link volumes for each of the nine scenarios. These data were provided in plot format and were manually entered into a separate spreadsheet corresponding to the assigned intersection identification number from the Synchro file. Intersection approach volumes were then determined using historical K and D factors. Linking the approach volumes to the TMC spreadsheet provided horizon year TMC (future year turning volumes). Figure 5 illustrates this process. The project further required providing base year TMC as a review mechanism for local

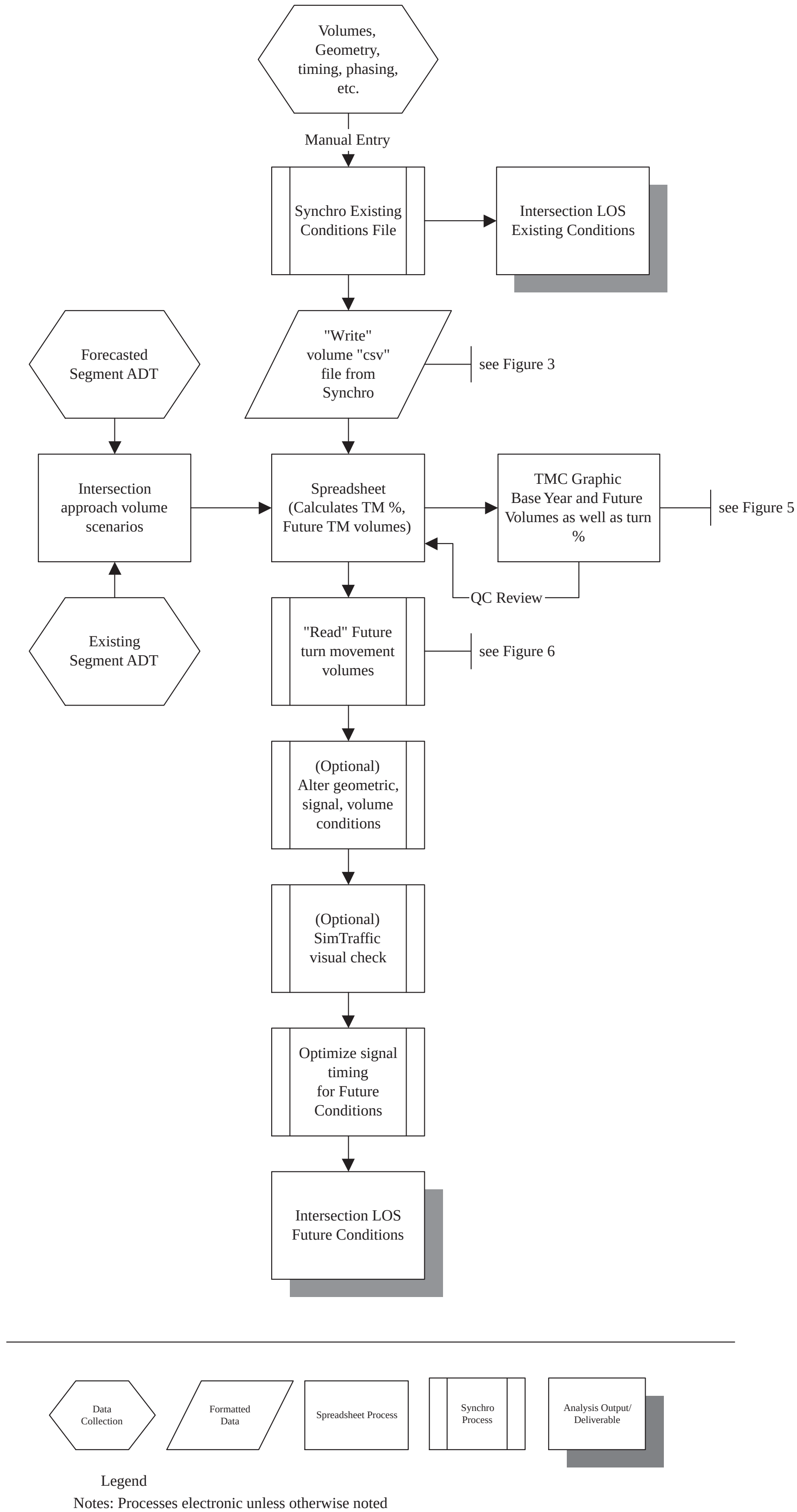

FIGURE 4 Case study methodology application

Turning Movement Count
60 Minute Counts

DATE	TIME	INTID	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
8/19/20	1700	1	860	1445	--	--	1658	845	997	--	851	--	--	--
8/19/20	1700	2	--	1563	568	236	2511	--	--	--	--	159	--	22
8/19/20	1700	3	290	1299	482	630	1474	436	401	1359	377	457	1721	452
8/19/20	1700	4	176	1797	526	356	1977	134	383	637	456	71	41	40
8/19/20	1700	5	45	2352	406	249	2996	95	75	85	50	27	15	25
8/19/20	1700	6	187	844	381	1020	1614	705	925	2946	347	432	2034	927
8/19/20	1700	27	157	917	710	105	963	460	189	1748	121	346	2491	75
8/19/20	1700	32	168	46	233	4	12	3	22	4287	193	78	3408	53
8/19/20	1700	34	166	439	75	132	668	145	108	1078	83	53	1329	68
8/19/20	1700	37	232	361	200	174	313	70	229	1912	107	159	2353	95

FIGURE 6 Future year volumes, UTDF format

experts. The visual presentation of the TMC allowed for a quick turnaround for data review, as opposed to a tabular format. Figure 5 illustrates the graphical representation of the base year TMC, turn percentages, future year approach volume, and future year TMC. For example, intersection number 1 (Bearass Ave. and Bruce B. Downs) has 462 northbound through vehicles under existing conditions. The regional planning model forecasted a year 2020 northbound approach volume of 2,305 vehicles in the peak hour. Multiplying the approach volume by the existing turn percentage (63%) yields the future year turn volume for this movement (1,445 vehicles per hour).

The future year TMC were then entered into the Synchro file (maintaining UTDF) under the future year scenarios. At this point, geometric changes or other network changes can be conducted to reflect the scenario being analyzed. In the case study, the LRT impacts resulted in lane takes. This adjustment was easily accomplished as well as the quality review by the traffic analysis team using SimTraffic. After all changes are complete the signal system can be optimized to provide future year intersection LOS. Mitigation steps can be quickly analyzed to achieve preimpact LOS. Figure 4 illustrates the entire process used to develop LOS analyses for each scenario with only one traffic data entry step.

CONCLUDING REMARKS

A methodology was presented for a practical approach to managing intersection traffic data for large-scale traffic analysis efforts. An EIS in Tampa, Florida served as the case study in which nearly 1,100 intersection LOS analyses were required. The methodology presented allowed for manual intersection data entry to occur once, reducing time and data handling errors. The catalyst for the electronic data handling was the use of a universal traffic data format.

ACKNOWLEDGEMENTS

The Environmental Impact Statement used as the case study in this paper was prepared for Hillsborough Area Rapid Transit (HART) in Tampa, Florida. Special thanks to the technical review committee consisting of representatives from the City of Tampa, Florida Department of Transportation and HART for their input.