INTERCHANGE MODIFICATION STUDY

INTERSTATE ROUTE 40

at

CANADA ROAD

in

SHELBY COUNTY, TENNESSEE

Prepared for the

TENNESSEE DEPARTMENT OF TRANSPORTATION
BUREAU OF PLANNING AND DEVELOPMENT

Prepared by

PARSONS TRANSPORTATION GROUP INC.

JANUARY , 2000

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CHAPTER 1 - INTRODUCTION

Purpose of Study

The purpose of this study is to request approval for modifications to the I-40 at Canada Road interchange in Shelby County. The study was initiated in response to a request from Mayor Jim Bomprezzi of Lakeland in a letter dated October 5, 1998. A copy of the letter is included in Appendix C.

The existing interchange is a tight diamond configuration with Canada Road grade separated over I-40. The proposed modifications include widening Canada Road, including the structure over I-40, within the interchange area to a nine-lane section, widening the eastbound and westbound off-ramps and the westbound on-ramp to provide multiple lanes at their termini with Canada Road, installation of traffic signals at the ramp terminals on Canada Road, and reconstruction of the I-40 ramp terminals to meet current design standards. This will not entail widening the I-40 ramp terminals, as all will remain one-lane terminals. These modifications are necessary to accommodate increased traffic demands resulting from increased commercial and residential development in the area served by the I-40 at Canada Road interchange.

Description of the Area

The I-40 at Canada Road interchange is located in east Shelby County within the Memphis metropolitan area as indicated on Figure 1. The interchange is located along I-40 approximately 3.9 kilometers (2.4 miles) northeast of the State Route 15 (U.S. 64) interchange, and approximately 6.3 kilometers (3.9 miles) southwest of the State Route 385 interchange currently under construction. In the vicinity of the interchange, Canada Road is a two-lane highway with shoulders. Canada Road serves the City of Lakeland north of the I-40 and connects with State Route 15 (U.S. 64) approximately 1.9 kilometers (1.2 miles) south of I-40. Right-of-way has been dedicated along the west side of Canada Road in the vicinity the interchange for the future widening of Canada Road.

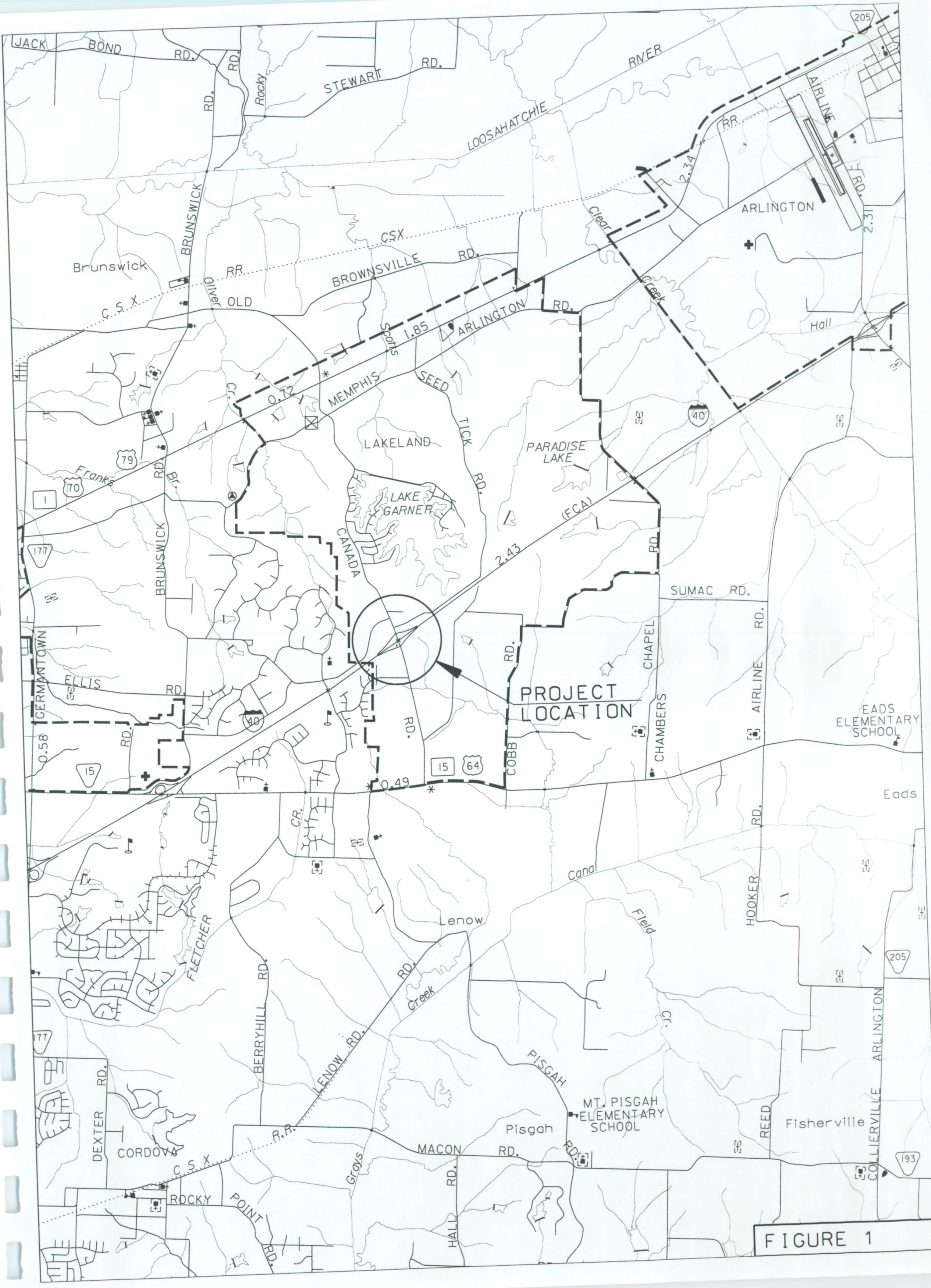

JACK
BOND
RD.
STEWART
RD.
Rocky
RIVER
LOOSAHATCHIE
BRUNSWICK
RD.
CSX
RR
AIRLINE
RD.
ARLINGTON
2.34
2.31
Clear
Creek
Brunswick
C.S.X.
RR.
Oliver
OLD
BROWNSVILLE
RD.
1.85
ARLINGTON
RD.
Sports
Hall
MEMPHIS
SEED
0.72
LAKELAND
TICK
RD.
PARADISE
LAKE
Franks
Cr.
Br.
LAKE
GARNER
(FCA)
CANADA
2.43
RD.
BRUNSWICK
SUMAC RD.
GERMANTOWN
ELLIS
RD.
RD.
PROJECT
LOCATION
CHAPEL
CHAMBERS
AIRLINE
RD.
EADS
ELEMENTARY
SCHOOL
0.58
RD.
RD.
COBB
0.49
Eads
CR.
Canal
Field
Lenow
HOOKER
RD.
FLETCHER
BERRYHILL
RD.
RD.
Creek
LENOW RD.
Cr.
PISGAH
ARLINGTON
COLLIERVILLE
DEXTER
RD.
MT. PISGAH
ELEMENTARY
SCHOOL
Pisgah
REED
Fisherville
CORDOVA
C.S.X
R.R.
MACON
RD.
RD.
Grays
ROCKY
POINT
RD.
RD.
HALL
205
79
70
1
177
40
15
64
193

FIGURE 1

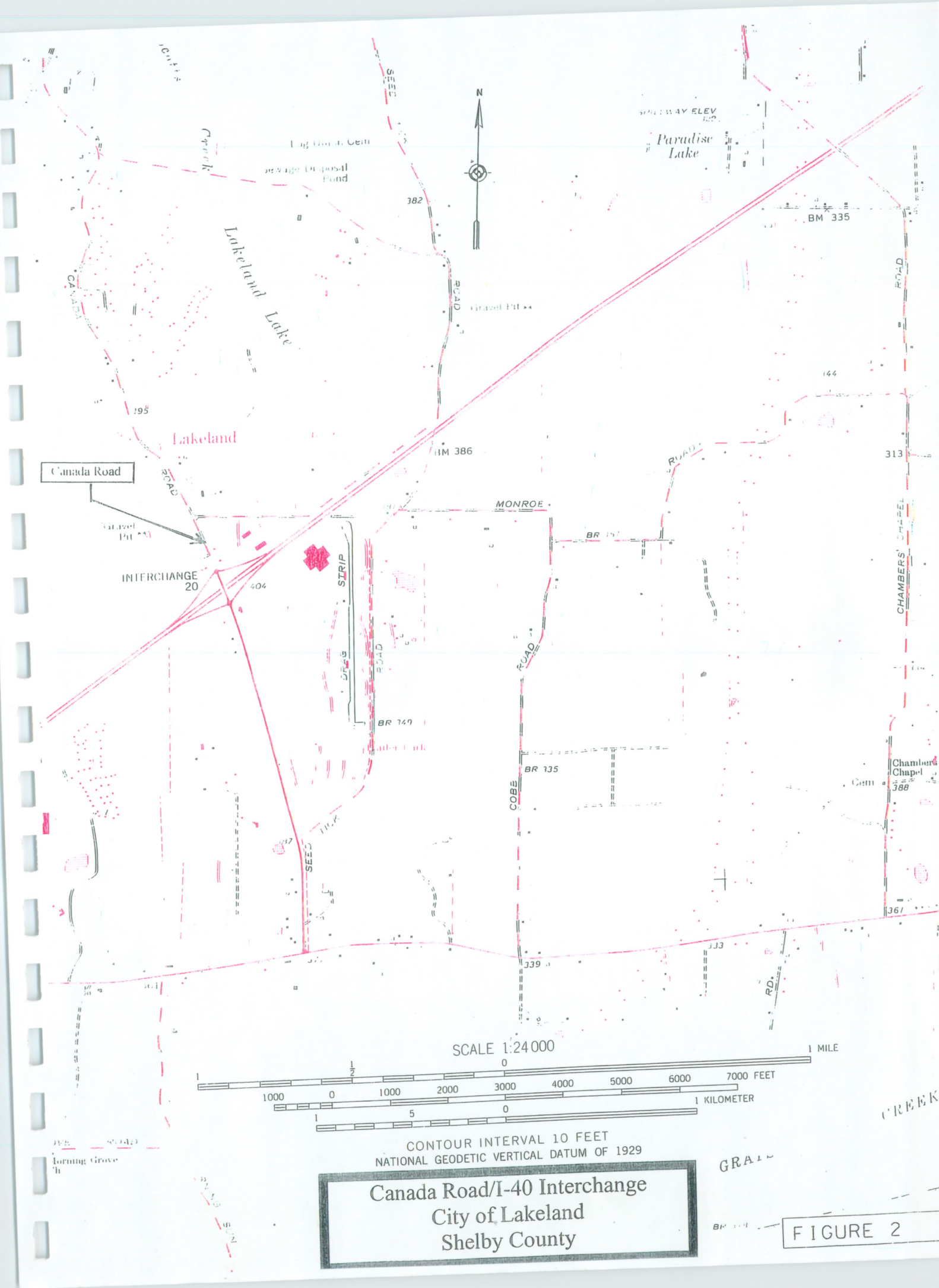
The existing I-40 at Canada Road interchange is a tight diamond design as indicated on Figure 2. At present, there are no traffic signals or left-turn lanes at the ramp terminals on Canada Road. Huff'n Puff Road, a two-lane facility that serves development in the northeast quadrant of the interchange including two motels, intersects Canada Road approximately 91 meters (300 feet) north of the north ramp terminal. From the interchange area, Huff'n Puff Road continues northeastwardly along I-40 approximately 1.4 kilometers (0.9 miles) before turning north. At this point the name of the road changes to Seed Tick Road and continues in a northerly direction through Lakeland before crossing Memphis Arlington Road, and terminating at its intersection with State Route 1 (U.S. 70). Another two-lane roadway, Davies Plantation East, intersects Canada road from the west approximately 152 meters (500 feet) north of Huff'n Puff Road. A private driveway that serves a major outlet mall located in the southeast quadrant of the interchange intersects Canada Road approximately 137 meters (450 feet) south of the south ramp terminal.

I-40 is a four-lane section through the interchange area. The taper lengths of the I-40 entrance and exit terminals are not to current design standards.

Relationship to Other Highway Improvement Plans and Programs

Within the interchange area, I-40 is an urban interstate facility on the National Highway System. Canada Road is an urban minor arterial on the Surface Transportation Program. There are no other projects currently scheduled by the Tennessee Department of Transportation (TDOT) for the area which would involve the I-40 at Canada Road interchange.

The Memphis Metropolitan Planning Organization's (MPO) Major Road Plan, which was last amended in February 1999, shows Canada Road in the vicinity of the interchange to be a six-lane undivided section with curb and gutter and a two-way left turn lane in a 108-foot wide right-of-way. The Major Road Plan also shows Huff'n Puff Road to be a four-lane undivided section within a 88-foot wide right-of-way, and I-40 to be a six-lane divided section, including HOV lanes. A park and ride lot is also proposed for the interchange area. The Major Road Plan shows the improvement of Canada Road as Priority 1, which indicates that the improvement is programmed to be made within



Canada Road/I-40 Interchange
City of Lakeland
Shelby County

FIGURE 2

the next ten years. The improvement of I-40 is shown as a Priority 3 meaning that this improvement is programmed for more than 20 years from now.

CHAPTER 2 - PRELIMINARY PLANNING DATA

Land Use

Land use in the vicinity of the interchange is primarily commercial. This includes convenience stores, a fast food restaurant, motels, a gift shop, an outlet mall, and a small office building. The immediate areas north and south of the interchange area are primarily undeveloped.

Traffic Served

Traffic data for this study was provided by the Tennessee Department of Transportation (TDOT). Average daily traffic (ADT) and design hourly volumes (DHV) were projected for the years 2004 and 2024. Traffic information is contained in Appendix A. The year 2004 ADT on I-40 is projected to be approximately 36,750 vehicles and 41,350 vehicles east and west of Canada Road, respectively. Also, year 2004 ADT on Canada Road is projected to be approximately 7,600 vehicles and 5,200 vehicles south and north of I-40, respectively. By year 2024, the ADT on I-40 east and west of Canada Road is projected to increase to approximately 55,100 vehicles and 60,850 vehicles, respectively. Year 2024 ADT on Canada Road is projected to reach approximately 30,700 vehicles south of I-40 and 14,050 vehicles north of I-40. The projected ADT on I-40 and Canada Road includes 34 percent and 5 percent trucks, respectively.

The concept of levels-of-service (LOS) uses qualitative measures that characterize operational conditions within a traffic stream and their perception by motorists and passengers. The descriptions of individual levels-of-service characterize these conditions in terms of such factors as speed and travel time, freedom to maneuver, traffic interruptions, and comfort and convenience. There are six (6) levels of service defined and given letter designations, from A to F. LOS A represents the best operating conditions and LOS F represents the worst. LOS E is the value that corresponds to the maximum flow rate, or capacity, on the facility. For most design and planning purposes, LOS D or C are usually used because they ensure a more acceptable quality of service to facility users.[1]

[1]Highway Capacity Manual, Special Report 209, TRB, Third Edition, Updated 1994

Based on projected traffic volumes, the current four-lane section on Interstate 40 through the interchange area will function at LOS D in the design year of 2024. The existing west oriented ramp terminals will function at LOS E in year 2024 based on projected volumes. The current two-lane section on Canada Road within the interchange area will function at LOS D in year 2004 and LOS F in year 2024.

Discussion of Alternatives

Two alternative interchange modifications were developed and evaluated during this study. These are denoted as Alternates A and B. Each of the two alternative modifications considered for this location would maintain provisions for all traffic movements. Functional Plans were developed for the two alternatives and are included in Appendix D.

The following is a discussion of alternatives considered in evaluating potential interchange modifications at Interstate 40 and Canada Road:

Alternate A

Alternate A is the preferred alternative. With this alternative, Canada Road, including the bridge over I-40, would be widened to a nine-lane section within the interchange area. This would provide three traffic lanes in each direction, double left-turn lanes for the northbound to westbound move, and a single left-turn lane for the southbound to eastbound move. The eastbound and westbound off ramps would be widened to provide double left-turn lanes and a right-turn lane at Canada Road. The westbound on ramp would be widened to provide two departure lanes at Canada Road. The eastbound on ramp would remain a single lane ramp. All ramp terminals on I-40 would remain as one-lane terminals; however, all of the I-40 terminals would be reconstructed to current standards, and the terminals on Canada Road would be signalized.

The widening of Canada Road would be primarily to the west. This minimizes right-of-way impacts

by taking advantage of right-of-way previously dedicated along the west side of Canada Road. Some right-of-way acquisition will be required from existing commercial properties that abut the interchange; however, no displacements are anticipated. Control of access will be extended along Canada Road to the required 30 meters (100 feet) from the ramp end of radius. This will impact existing access to commercial developments in three quadrants of the interchange.

The total estimated cost of Alternate A, including construction, right-of-way and utility relocation costs is $ 6,695,000.

Alternate B

Alternate B would entail widening Canada Road, including the bridge over I-40, to a seven-lane section consisting of six traffic lanes and a two-way left-turn lane. A loop ramp would be constructed in the northeast quadrant to accommodate the northbound to westbound movement. Construction of the loop ramp would necessitate the relocation of the west oriented ramps. This, in turn, would require the relocation of Huff'n Puff Road, and considerable right-of-way acquisition, including the relocation of four existing commercial establishments.

The total estimated cost of Alternate B, including construction, right-of-way and utility relocation costs is $ 15,865,000. This does not include the costs associated with the relocation of Huf'n Puff Road which is discussed below.

Due to the higher costs and more severe right-of-way impacts, Alternate B was discarded, and Alternate A was selected as the preferred alternative.

Huff'n Puff Road Relocation

As described above, the implementation of Alternate B would require that Huff'n Puff Road be relocated to the north. For Alternate A, the relocation of Huf'n Puff Road should be considered a desirable design option. Presently Huff'n Puff road, a two-lane facility that connects Canada Road with State Route 1 (U.S. 70), intersects Canada Road approximately 91 meters (300 feet) north of the north ramp terminal. The proximity of these two intersections adversely affects traffic operations at

this location, a condition that will only worsen as traffic volumes increase. Relocating Huff'n Puff Road approximately 152 meters (500 feet) to the north and opposite the intersection of Davies Plantation East would enhance traffic operations and safety at the north terminal on Canada Road. Existing Huff'n Puff Road would be terminated approximately 457 meters (1,500 feet) east of Canada Road, and would continue to serve the Days Inn as well as the Super 8 Motel, via the existing connection to Canada Road.

The total estimated cost of relocating Huff'n Puff Road, including construction, right-of-way and utility relocation costs, is $ 2,535,000.

Environmental Concerns

No environmental investigations were made in conjunction with this Interchange Modification Study. Other than underground storage tanks (UST's) associated with existing convenience store development, no apparent potential environmental concerns were noted during field reviews.

CHAPTER 3 - ENGINEERING INVESTIGATION

Traffic Operations

Capacity analyses were performed for Alternates A and B, utilizing the year 2004 and year 2024 average daily traffic (ADT) and design hour volumes (DHV). These volumes are included in Appendix A.

For the preferred alternative, Alternate A, the capacity analysis indicated that the current four-lane section on I-40 through the interchange area will operate at LOS C in year 2004, and LOS D in the design year of 2024. The west oriented terminals on I-40 will operate at LOS C and E, respectively, for years 2004 and 2024. The proposed six through lane section proposed for Canada Road will function at LOS A and B, respectively, for years 2004 and 2024. The north terminal on Canada Road will operate at LOS C for both 2004 and 2024, while the south terminal will function at LOS B and D, respectively, for 2004 and 2024.

As previously noted, I-40 will ultimately be widened to a six-lane section through the interchange area. This proposed widening is currently shown as a Priority 3 project on the Memphis Metropolitan Planning Organization's (MPO) Major Road Plan. This means that adding the additional laneage on I-40 is currently programmed for more than twenty years hence. With the six-lane section on I-40, the west oriented ramp terminals will operate at LOS C in year 2024.

Due to the proximity of the two terminals on Canada Road, which is approximately 131 meters (430 feet), the required storage length for the proposed left-turn lane on Canada Road was determined. The required storage for the northbound to westbound double left-turn lanes was determined to be approximately 69 meters (225 feet). For the southbound to eastbound left-turn, the required storage was determined to be approximately 38 meters (125 feet). Therefore, adequate storage will be provided by the proposed configuration for Alternate A.

For Alternate B, the current four-lane section on I-40 through the interchange area will function at LOS C and D, respectively, for years 2004 and 2024. The west oriented terminals on I-40 will

operate at LOS C in 2004, and LOS D in 2024. Canada Road, through the interchange area, will operate at LOS A and B, respectively, for years 2004 and 2024. The north terminal on Canada Road will function at LOS B for both year 2004 and year 2024. The south terminal will operate at LOS B in year 2004, and LOS D in year 2024. Levels of service for Canada Road, intersections with the ramp terminals, and Interstate 40 are summarized below.

Location	Existing		Alternate A		Alternate B	
	Year 2004	Year 2024	Year 2004	Year 2024	Year 2004	Year 2024
Canada Road	D	F	A	B	A	B
North Ramp Intersection	C	F	C	C	B	B
South Ramp Intersection	C	F	B	D	B	D
I-40	C	D	C	D	C	D

Access Analysis

This analysis was undertaken in accordance with the Federal Highway Administration's (FHWA) policy for granting new or revised interstate access. The FHWA policy is described in FHWA Docket No. 98-3460, "Additional Interchanges to the Interstate System," (Federal Register 63, No. 28, February 11, 1998). This analysis was conducted to demonstrate the impacts of a revised access point as opposed to providing a new access point to the interstate system. The FHWA requirements are provided in italics along with responses to those identified items.

It is in the national interest to maintain the Interstate System to provide the highest level of service in terms of safety and mobility. Adequate control of access is critical to providing such service. Therefore, new or revised access points to the existing Interstate System should meet the following requirements:

1. *The existing interchanges and/or local roads and streets in the corridor can neither provide the necessary access nor be improved to satisfactorily accommodate the design-year traffic demands while at the same time providing the access intended by the proposal.*

The proposed improvements are to the existing interchange. No additional access points to the interstate system are proposed. The proposed modifications consist of widening Canada Road over I-40, improvements to ramp roadways and terminals at Canada Road, and reconstruction of the ramp terminals with I-40 to comply with current design standards. The access point to I-40 is to be modified only to the extent necessary to upgrade the ramp terminals to meet current design standards.

Without the proposed modifications, the interchange at Interstate 40 and Canada Road will not provide a satisfactory level-of-service in 2024, the design year. The existing interchange will provide LOS F in year 2024 if additional laneage, including left-turn lanes are not provided on Canada Road within the interchange area. With the proposed widening of Canada Road and the addition of left-turn lanes and traffic signals at the terminals on Canada Road, the terminals on Canada Road can be expected to operate at LOS C in year 2024.

2. *All reasonable alternatives for design options, location and transportation system management type improvements (such as ramp metering, mass transit, and HOV facilities) have been assessed and provided for if currently justified, or provisions are included for accommodating such facilities if a future need is identified.*

The proposed interchange modifications, including the widening of Canada Road within the interchange area, are necessary to accommodate projected traffic demands. The critical elements are the operation of the ramp terminals on Canada Road. The deficiencies associated with the existing terminals cannot be adequately addressed through transportation demand management (TDM) strategies such as ramp metering, and improved mass transit. A park and ride lot at this location was included in the Major Road Plan. This lot could reduce the traffic congestion in the area, although not to the extent that would preclude the need for the proposed improvements. The addition of high occupancy vehicle (HOV) lanes along I-40 could reduce the rate of increase in the number of single occupant vehicles entering and exiting I-40 at Canada Road. However, the introduction of HOV lanes, other congestion management systems, or ITS applications on I-40 will not offset the need to provide additional laneage and to upgrade the ramp terminals on Canada Road.

3. *The proposed access point does not have a significant adverse impact on the safety and operation of the Interstate facility based on an analysis of current and future traffic. The operational analysis for existing conditions shall, particularly in urbanized areas, include an analysis of sections of the Interstate to and including at least the first adjacent existing or proposed interchange on either side. Crossroads and other roads and streets shall be included in the analysis to the extent necessary to assure their ability to collect and distribute traffic to and from the interchange with new or revised access points.*

The adjacent interchanges at State Route 15 (U.S. 64) and State Route 385 (under construction) are beyond the limits of analysis associated with weaving areas. Their influence has no impact on the analyses associated with the I-40 at Canada Road interchange.

As previously noted, the Memphis Metropolitan Planning Organization's (MPO) Major Road Plan shows Canada Road being improved to a six-lane section with a two-way left-turn lane in the vicinity of the interchange. This is shown as a Priority 1 improvement, meaning it is programmed to be completed within the next ten years. This improvement to Canada Road will accommodate the collection and distribution of year 2024 traffic to and from the interchange.

As proposed, the improvements to the interchange at I-40 and Canada Road will include the reconstruction of the terminals on I-40 to meet current design criteria relating to taper lengths. Also, the widening of I-40 to a six-lane section, as proposed by the Major Road Plan, will facilitate operational improvements of the west oriented ramp terminals on I-40 to a LOS C, based on year 2024 traffic projections.

4. *The proposed access connects to a public road only and will provide for all traffic movements. Less than "full interchanges" for special purpose access for transit vehicles, for HOV's, or into park and ride lots may be*

considered on a case-by-case basis. The proposed access will be designed to meet or exceed current standards for Federal-aid projects on the Interstate System.

The proposed modifications to the interchange will continue to provide for all traffic movements. The proposed modifications will maintain one off-ramp and one on-ramp in each direction, and will provide improvements to enhance turning movements at the ramp terminals on Canada Road. The proposed modifications will continue the "full interchange" status of the location by providing access for all directional movements.

All modifications will be designed to current federal standards for interstate highways, and will meet or exceed all American Association of State Highway and Transportation Officials (AASHTO) criteria.

5. *The proposal considers and is consistent with local and regional land use and transportation plans. Prior to final approval, all requests for new or revised access must be consistent with the metropolitan and/or statewide transportation plan, as appropriate, the applicable provisions of 23 CFR part 450 and the transportation conformity requirements of 40 CFR parts 51 and 93.*

This study addresses modifications to the I-40 at Canada Road interchange and is consistent with the local and state transportation plans. As previously noted, the Major Road Plan published by the Memphis Metropolitan Planning Organization (MPO) shows Canada Road in the vicinity of the interchange to be a six-lane undivided section with a two-way left-turn lane. This is consistent with the proposed widening of Canada Road within the interchange area.

6. *In areas where the potential exists for future multiple interchange additions, all requests for new or revised access are supported by a comprehensive Interstate network study with recommendations that address all proposed and desired access within the context of a long-*

term plan.

At this time, there are no plans for additional access points to Interstate 40 in or near the study area. An interchanges is located along Interstate 40 at State Route 15 (U.S. 64), approximately 3.9 kilometers (2.4 miles) southwest of Canada Road. An interchange is presently under construction at State Route 385 and Interstate 40 approximately 6.3 kilometers (3.9 miles) northeast of Canada Road.

7. *The request for a new or revised access generated by new or expanded development demonstrates appropriate coordination between the development and related or otherwise required transportation system improvements.*

The request for modification of the Interstate 40 at Canada Road interchange was not generated by a specific new or expanding development, but by general growth and development in the area served by Canada Road, a minor arterial roadway.

8. *The request for new or revised access contains information relative to the planning requirements and the status of the environmental processing of the proposal.*

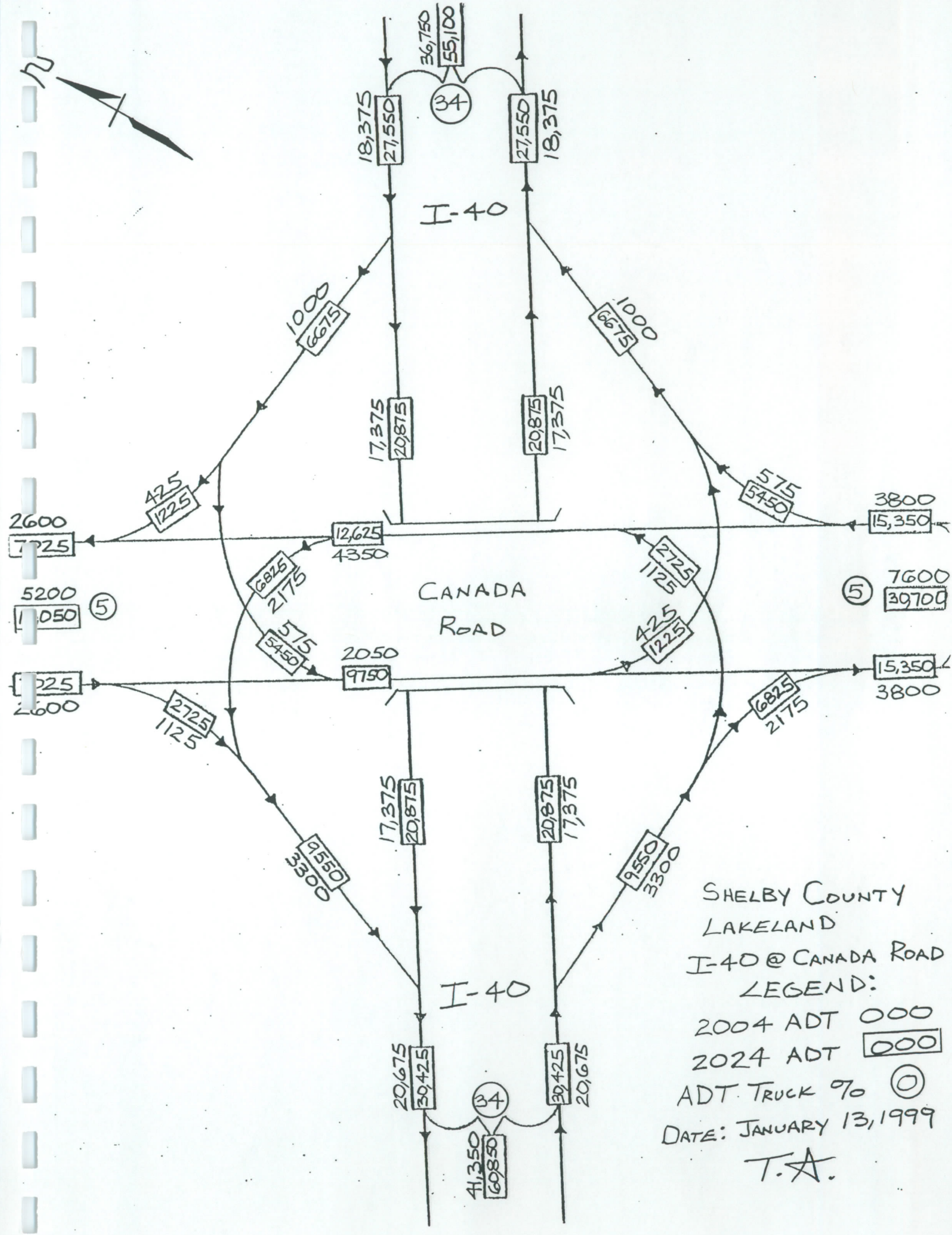
Traffic projections for years 2004 and 2024 were the bases of the traffic analyses performed as part of this study. This traffic data is contained in Appendix A. No environmental investigations were included in this study. These will be performed later in the project development process.

Cost

The total estimated project cost for the preferred alternative, Alternate A, as described in this report is approximately $ 6,695,000. The estimated project cost for the relocation of Huff'n Puff Road is $2,535,000. These estimated project costs include right-of-way, utility relocation, and construction costs. Cost data sheets are included in Appendix E.

Summary and Conclusions

The analyses and recommendations contained in this report support the proposed modifications to the interchange at Interstate 40 and Canada Road. Without these modifications, this facility will not function at an acceptable level-of-service as traffic demands increase due to growth and development in the area served by the interchange at Interstate 40 and Canada Road.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I-40
CANADA ROAD
I-40
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18,375
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18,375
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1000
6675
17,375
20,875
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425
1225
575
5450
2600
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9550
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34
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SHELBY COUNTY
LAKELAND
I-40 @ CANADA ROAD
LEGEND:
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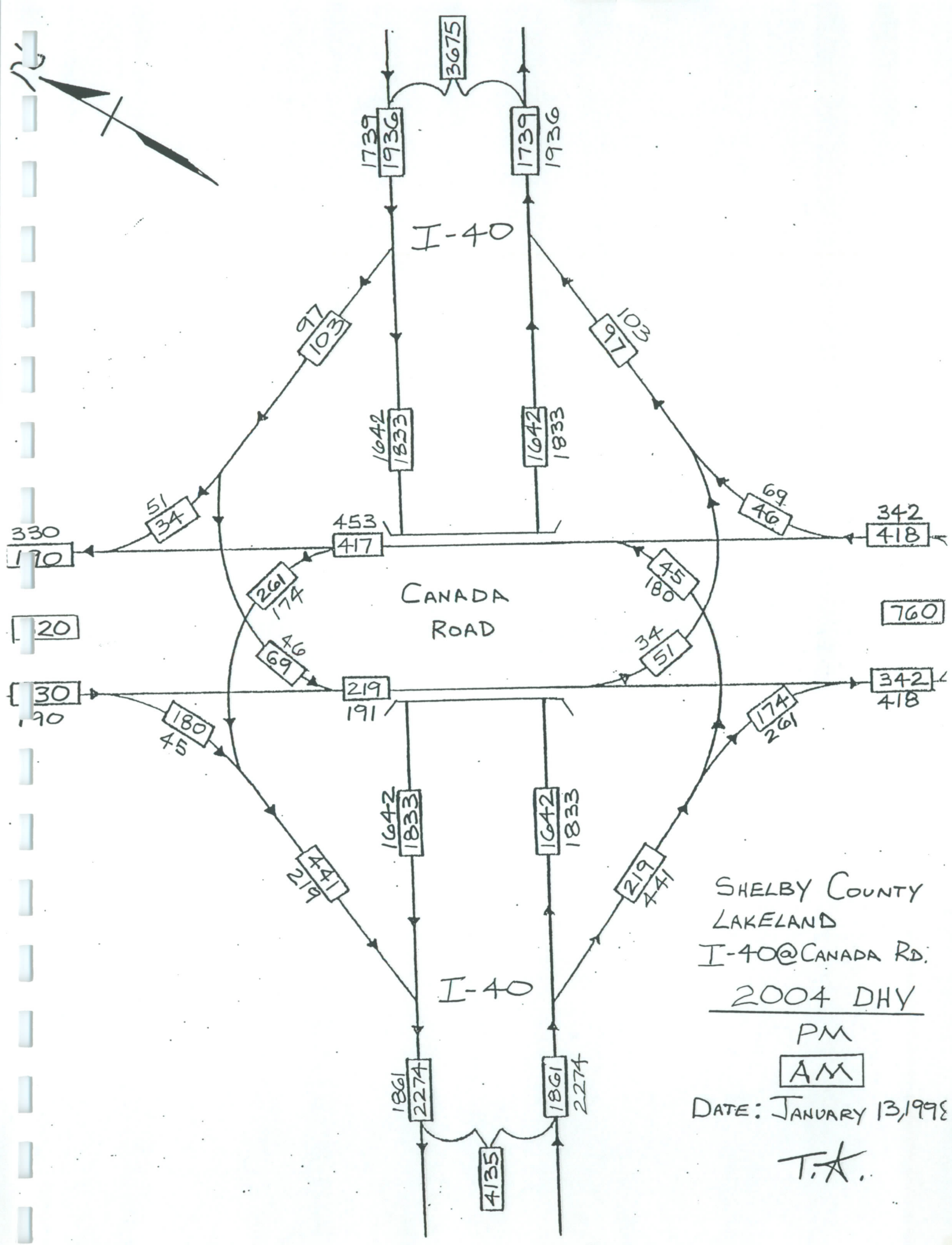
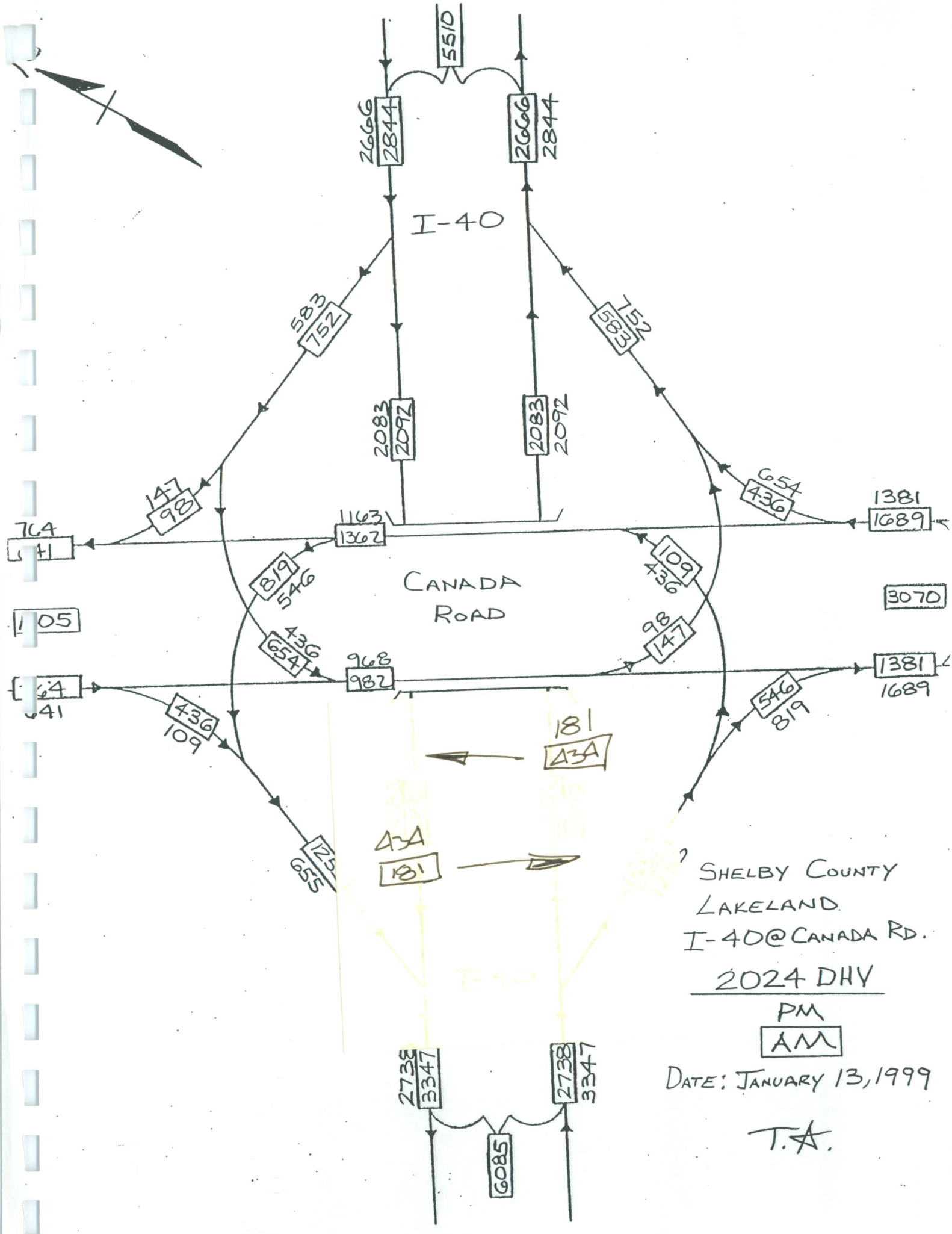
2024 ADT 000
ADT TRUCK % 0
DATE: JANUARY 13, 1999
T.A.



SHELBY COUNTY
LAKELAND
I-40@CANADA RD.
2004 DHV
PM
AM
DATE: JANUARY 13, 1998

T.A.



SHELBY COUNTY
LAKELAND
I-40@CANADA RD.

2024 DHV

PM

AM

DATE: JANUARY 13, 1999

T.A.

CAPACITY ANALYSIS

The analyses for this interchange modification study were prepared using the methodologies presented in the 1994 Highway Capacity Manual, Special Report 209 of the Transportation Research Board, including the 1997 update. Highway Capacity Software release 3.1b was utilized in the analysis of existing and proposed conditions. The AM (morning) peak period for the interchange occurs in the westbound direction, and the PM (evening) peak period occurs in the eastbound direction. All merge, diverge, and traffic signal analyses were conducted using the peak hour traffic volumes which represent the worst case condition for that location.

The traffic analyses conducted for this study includes:

(1) Existing conditions (2004 and 2024 DHV)
(2) Proposed conditions (2004 and 2024 DHV).

A schematic indicating results of the analyses is included.

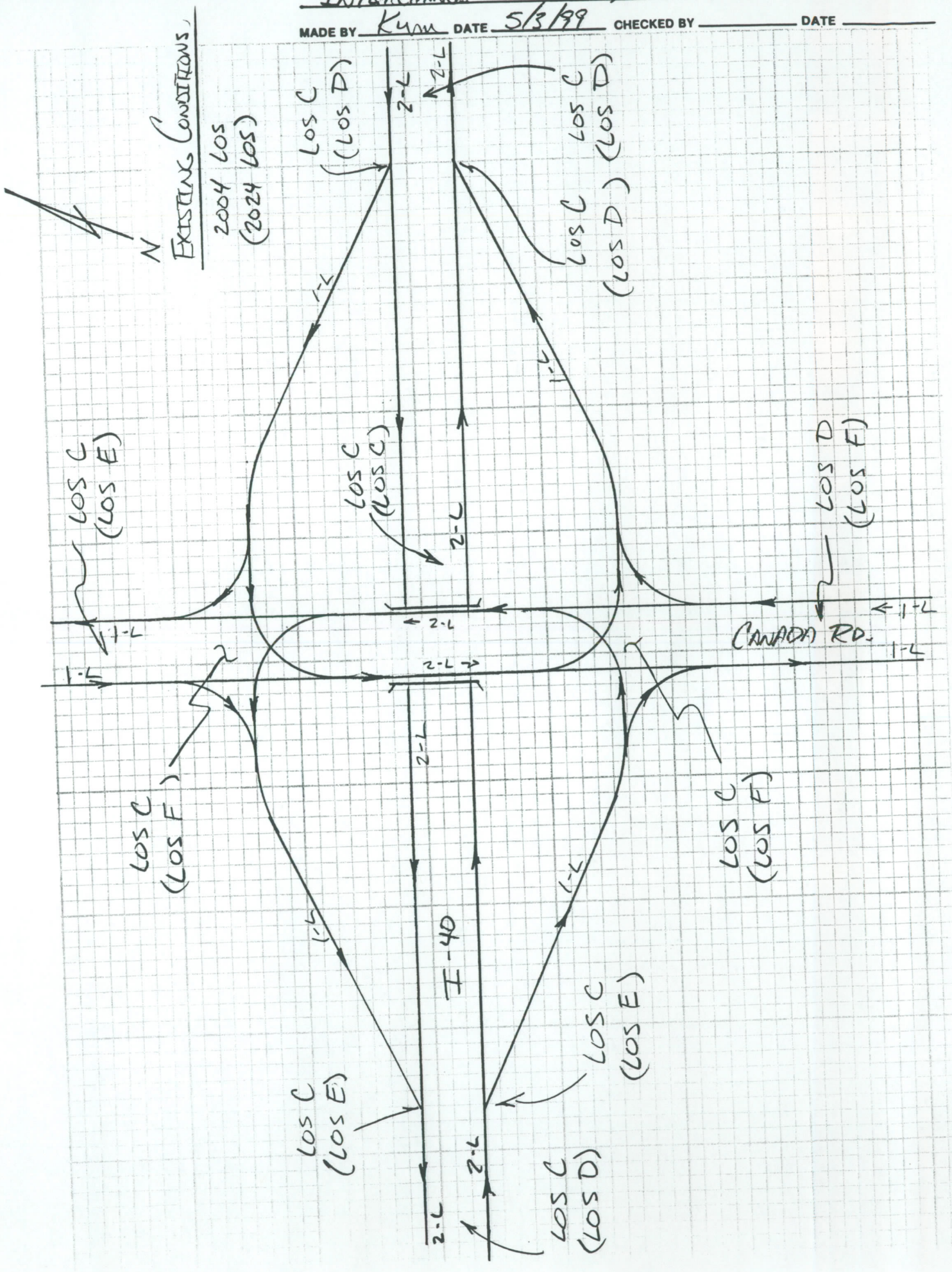
PARSONS TRANSPORTATION GROUP

SUBJECT I-40 / CANADA RD. INTERCHANGE MOD. STUDY

JOB NO. 64844/01811

SHEET NO. _____ OF _____

MADE BY KMM DATE 5/3/99 CHECKED BY _____ DATE _____



PARSONS TRANSPORTATION GROUP

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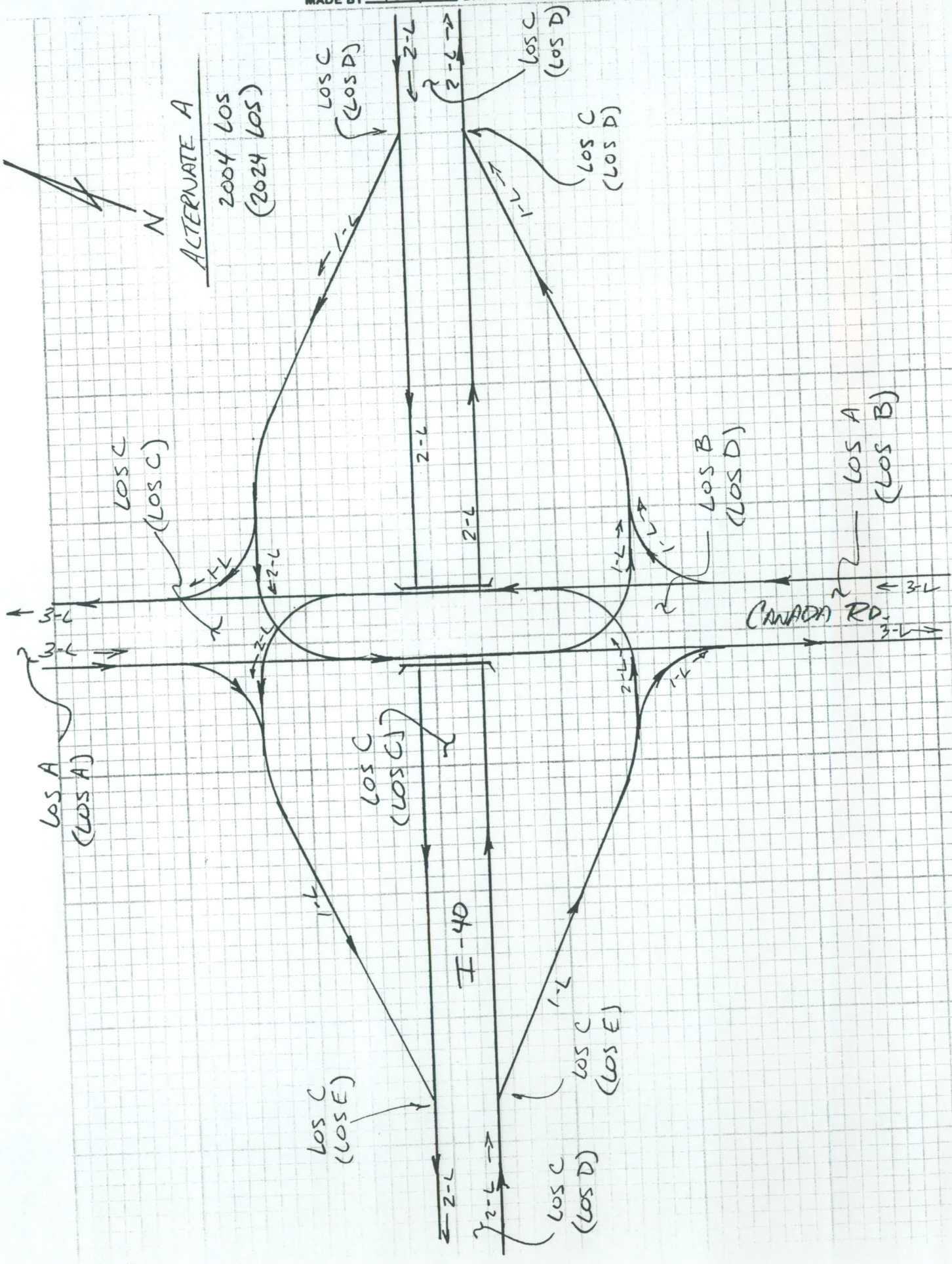

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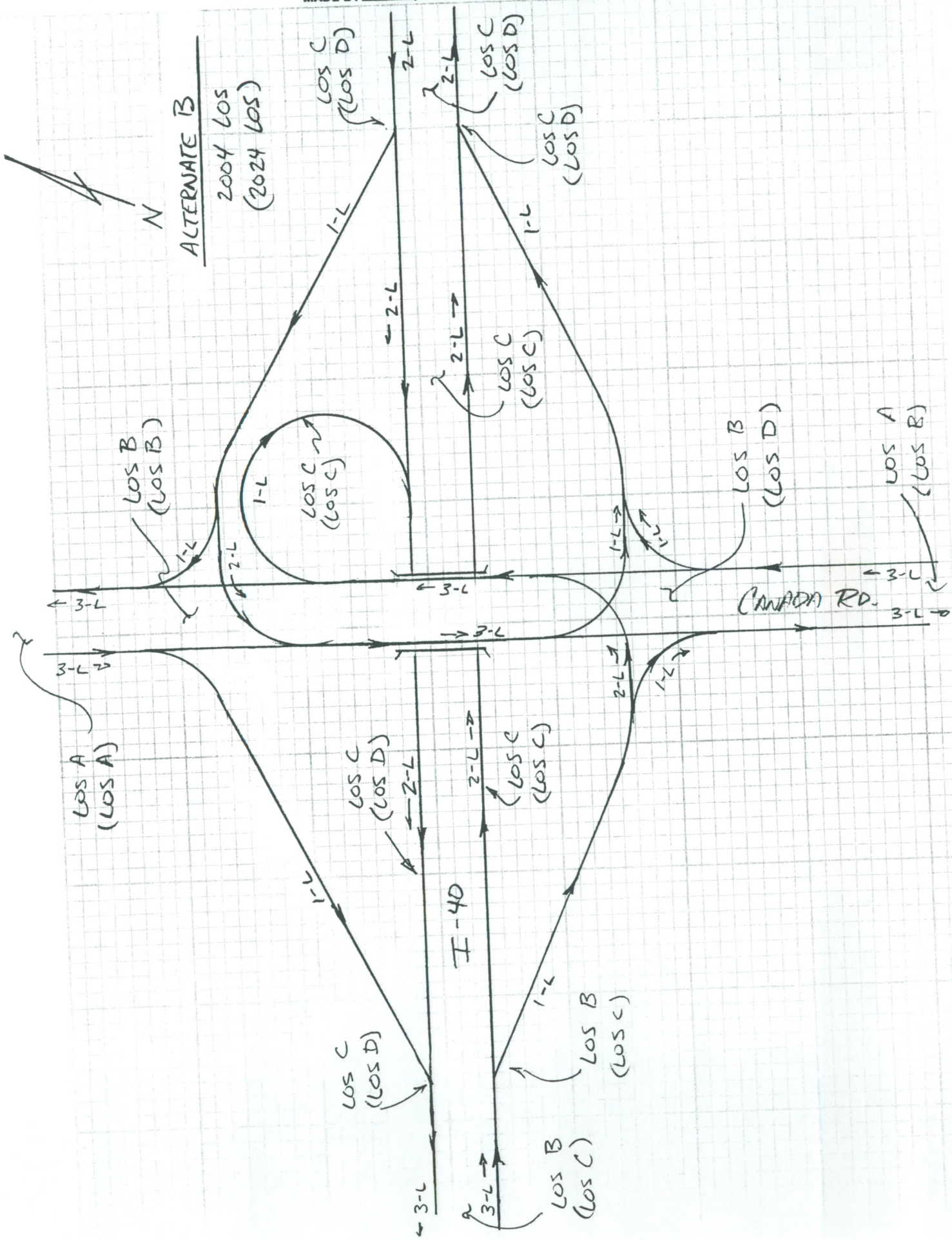


HCS: Freeways Release 3.1b

OPERATIONAL ANALYSIS

Highway/Dir. Travel:	Interstate 40
From/To:	U.S. 64 to Canada Road
Agency or Company:	Parsons Transportation Group
Analyst:	KWM
Analysis Time Period:	P.M. Peak Period
Jurisdiction:	Shelby County
Analysis Year:	Year 2004
Date Performed:	6/3/99

VOLUME

Volume, V	2274	vph
Peak-Hour Factor, PHF	0.95	
Peak 15-min Volume, v15	598	v
Number of Lanes, N	2	
Terrain Type	Level	
Grade	0.00	%
Segment Length	0.00	mi
Trucks and Buses	23	%
Trucks and Buses PCE, ET	1.5	
Recreational Vehicles	0	%
Recreational Vehicle PCE, ER	1.2	
Heavy Vehicle Adjustment, fHV	0.90	
Driver Population Adjustment, fP	1.00	
Service Flow Rate, vp	1333	pcphpl

FREE-FLOW SPEED

Free-Flow Speed:	Ideal	
FFS or FFSi	70.0	mph
Lane Width	12.0	ft
Lane Width Adjustment, fLW	0.0	mph
Right-Shoulder Lateral Clearance	6.0	ft
Lateral Clearance Adjustment, fLC	0.0	mph
Interchange Density	0.50	interchange/mi
Interchange Density Adjustment, fID	0.0	mph
Number of Lanes, N	2	
Number of Lanes Adjustment, fN	4.5	mph
Adjusted Free-Flow Speed	65.5	mph
	Regular Freeway	

Adjusted free-flow speed cannot be less than 55 mph.

RESULTS

Service Flow Rate, vp	1333	pcphpl
Adjusted Free-Flow Speed, FFS	65.5	mph
Average Passenger-Car Speed, S	65.5	mph
Number of Lanes, N	2	
Density, D	20.4	pc/mi/ln
Level of Service, LOS	C	

HCS: Freeways Release 3.1b

OPERATIONAL ANALYSIS

Highway/Dir. Travel:	Interstate 40
From/To:	U.S. 64 to Canada Road
Agency or Company:	Parsons Transportation Group
Analyst:	KWM
Analysis Time Period:	P.M. Peak Period
Jurisdiction:	Shelby County
Analysis Year:	Year 2004
Date Performed:	6/3/99

VOLUME

Volume, V	1833	vph
Peak-Hour Factor, PHF	0.95	
Peak 15-min Volume, v15	482	v
Number of Lanes, N	2	
Terrain Type	Level	
Grade	0.00	%
Segment Length	0.00	mi
Trucks and Buses	23	%
Trucks and Buses PCE, ET	1.5	
Recreational Vehicles	0	%
Recreational Vehicle PCE, ER	1.2	
Heavy Vehicle Adjustment, fHV	0.90	
Driver Population Adjustment, fP	1.00	
Service Flow Rate, vp	1075	pcphpl

FREE-FLOW SPEED

Free-Flow Speed:	Ideal	
FFS or FFSi	70.0	mph
Lane Width	12.0	ft
Lane Width Adjustment, fLW	0.0	mph
Right-Shoulder Lateral Clearance	6.0	ft
Lateral Clearance Adjustment, fLC	0.0	mph
Interchange Density	0.50	interchange/mi
Interchange Density Adjustment, fID	0.0	mph
Number of Lanes, N	2	
Number of Lanes Adjustment, fN	4.5	mph
Adjusted Free-Flow Speed	65.5	mph
	Regular Freeway	

Adjusted free-flow speed cannot be less than 55 mph.

RESULTS

Service Flow Rate, vp	1075	pcphpl
Adjusted Free-Flow Speed, FFS	65.5	mph
Average Passenger-Car Speed, S	65.5	mph
Number of Lanes, N	2	
Density, D	16.4	pc/mi/ln
Level of Service, LOS	C	

HCS: Freeways Release 3.1b

OPERATIONAL ANALYSIS

Highway/Dir. Travel:	Interstate 40
From/To:	U.S. 64 to Canada Road
Agency or Company:	Parsons Transportation Group
Analyst:	KWM
Analysis Time Period:	P.M. Peak Period
Jurisdiction:	Shelby County
Analysis Year:	Year 2004
Date Performed:	6/3/99

VOLUME

Volume, V	1936	vph
Peak-Hour Factor, PHF	0.95	
Peak 15-min Volume, v15	509	v
Number of Lanes, N	2	
Terrain Type	Level	
Grade	0.00	%
Segment Length	0.00	mi
Trucks and Buses	23	%
Trucks and Buses PCE, ET	1.5	
Recreational Vehicles	0	%
Recreational Vehicle PCE, ER	1.2	
Heavy Vehicle Adjustment, fHV	0.90	
Driver Population Adjustment, fP	1.00	
Service Flow Rate, vp	1135	pcphpl

FREE-FLOW SPEED

Free-Flow Speed:	Ideal	
FFS or FFSi	70.0	mph
Lane Width	12.0	ft
Lane Width Adjustment, fLW	0.0	mph
Right-Shoulder Lateral Clearance	6.0	ft
Lateral Clearance Adjustment, fLC	0.0	mph
Interchange Density	0.50	interchange/mi
Interchange Density Adjustment, fID	0.0	mph
Number of Lanes, N	2	
Number of Lanes Adjustment, fN	4.5	mph
Adjusted Free-Flow Speed	65.5	mph
	Regular Freeway	

Adjusted free-flow speed cannot be less than 55 mph.

RESULTS

Service Flow Rate, vp	1135	pcphpl
Adjusted Free-Flow Speed, FFS	65.5	mph
Average Passenger-Car Speed, S	65.5	mph
Number of Lanes, N	2	
Density, D	17.3	pc/mi/ln
Level of Service, LOS	C	

HCS: Freeways Release 3.1b

OPERATIONAL ANALYSIS

Highway/Dir. Travel:	Interstate 40
From/To:	U.S. 64 to Canada Road
Agency or Company:	Parsons Transportation Group
Analyst:	KWM
Analysis Time Period:	P.M. Peak Period
Jurisdiction:	Shelby County
Analysis Year:	Year 2024
Date Performed:	6/3/99

VOLUME

Volume, V	3347	vph
Peak-Hour Factor, PHF	0.95	
Peak 15-min Volume, v15	880	v
Number of Lanes, N	2	
Terrain Type	Level	
Grade	0.00	%
Segment Length	0.00	mi
Trucks and Buses	23	%
Trucks and Buses PCE, ET	1.5	
Recreational Vehicles	0	%
Recreational Vehicle PCE, ER	1.2	
Heavy Vehicle Adjustment, fHV	0.90	
Driver Population Adjustment, fP	1.00	
Service Flow Rate, vp	1962	pcphpl

FREE-FLOW SPEED

Free-Flow Speed:	Ideal	
FFS or FFSi	70.0	mph
Lane Width	12.0	ft
Lane Width Adjustment, fLW	0.0	mph
Right-Shoulder Lateral Clearance	6.0	ft
Lateral Clearance Adjustment, fLC	0.0	mph
Interchange Density	0.50	interchange/mi
Interchange Density Adjustment, fID	0.0	mph
Number of Lanes, N	2	
Number of Lanes Adjustment, fN	4.5	mph
Adjusted Free-Flow Speed	65.5	mph
	Regular Freeway	

Adjusted free-flow speed cannot be less than 55 mph.

RESULTS

Service Flow Rate, vp	1962	pcphpl
Adjusted Free-Flow Speed, FFS	65.5	mph
Average Passenger-Car Speed, S	62.6	mph
Number of Lanes, N	2	
Density, D	31.4	pc/mi/ln
Level of Service, LOS	D	

HCS: Freeways Release 3.1b

OPERATIONAL ANALYSIS

Highway/Dir. Travel:	Interstate 40
From/To:	U.S. 64 to Canada Road
Agency or Company:	Parsons Transportation Group
Analyst:	KWM
Analysis Time Period:	P.M. Peak Period
Jurisdiction:	Shelby County
Analysis Year:	Year 2024
Date Performed:	6/3/99

VOLUME

Volume, V	2092	vph
Peak-Hour Factor, PHF	0.95	
Peak 15-min Volume, v15	550	v
Number of Lanes, N	2	
Terrain Type	Level	
Grade	0.00	%
Segment Length	0.00	mi
Trucks and Buses	23	%
Trucks and Buses PCE, ET	1.5	
Recreational Vehicles	0	%
Recreational Vehicle PCE, ER	1.2	
Heavy Vehicle Adjustment, fHV	0.90	
Driver Population Adjustment, fP	1.00	
Service Flow Rate, vp	1227	pcphpl

FREE-FLOW SPEED

Free-Flow Speed:	Ideal	
FFS or FFSi	70.0	mph
Lane Width	12.0	ft
Lane Width Adjustment, fLW	0.0	mph
Right-Shoulder Lateral Clearance	6.0	ft
Lateral Clearance Adjustment, fLC	0.0	mph
Interchange Density	0.50	interchange/mi
Interchange Density Adjustment, fID	0.0	mph
Number of Lanes, N	2	
Number of Lanes Adjustment, fN	4.5	mph
Adjusted Free-Flow Speed	65.5	mph
	Regular Freeway	

Adjusted free-flow speed cannot be less than 55 mph.

RESULTS

Service Flow Rate, vp	1227	pcphpl
Adjusted Free-Flow Speed, FFS	65.5	mph
Average Passenger-Car Speed, S	65.5	mph
Number of Lanes, N	2	
Density, D	18.7	pc/mi/ln
Level of Service, LOS	C	

HCS: Freeways Release 3.1b

OPERATIONAL ANALYSIS

Highway/Dir. Travel:	Interstate 40
From/To:	U.S. 64 to Canada Road
Agency or Company:	Parsons Transportation Group
Analyst:	KWM
Analysis Time Period:	P.M. Peak Period
Jurisdiction:	Shelby County
Analysis Year:	Year 2024
Date Performed:	6/3/99

VOLUME

Volume, V	2844	vph
Peak-Hour Factor, PHF	0.95	
Peak 15-min Volume, v15	748	v
Number of Lanes, N	2	
Terrain Type	Level	
Grade	0.00	%
Segment Length	0.00	mi
Trucks and Buses	23	%
Trucks and Buses PCE, ET	1.5	
Recreational Vehicles	0	%
Recreational Vehicle PCE, ER	1.2	
Heavy Vehicle Adjustment, fHV	0.90	
Driver Population Adjustment, fP	1.00	
Service Flow Rate, vp	1667	pcphpl

FREE-FLOW SPEED

Free-Flow Speed:	Ideal	
FFS or FFSi	70.0	mph
Lane Width	12.0	ft
Lane Width Adjustment, fLW	0.0	mph
Right-Shoulder Lateral Clearance	6.0	ft
Lateral Clearance Adjustment, fLC	0.0	mph
Interchange Density	0.50	interchange/mi
Interchange Density Adjustment, fID	0.0	mph
Number of Lanes, N	2	
Number of Lanes Adjustment, fN	4.5	mph
Adjusted Free-Flow Speed	65.5	mph
	Regular Freeway	

Adjusted free-flow speed cannot be less than 55 mph.

RESULTS

Service Flow Rate, vp	1667	pcphpl
Adjusted Free-Flow Speed, FFS	65.5	mph
Average Passenger-Car Speed, S	64.6	mph
Number of Lanes, N	2	
Density, D	25.8	pc/mi/ln
Level of Service, LOS	D	

HCS: Ramps and Ramp Junctions Release 3.1b

MERGE ANALYSIS

Location:	I-40 at Canada Rd. - WB OnRamp
Analyst:	KWM
Analysis Time Period:	Year 2024 (AM Peak)
Date Performed:	6/29/99

FREEWAY-RAMP COMPONENTS AND CHARACTERISTICS

Type of Analysis	Merge	
Freeway Data:		
Number of Lanes in Freeway	2	
Free-Flow Speed on Freeway	70.0	mph
Volume on Freeway	2092	vph
On Ramp Data:		
Side of Freeway	Right	
Number of Lanes in Ramp	1	
Free-Flow Speed on Ramp	60.0	mph
Volume on Ramp	1255	vph
Length of First Accel/Decel Lane	500	ft
Length of Second Accel/Decel Lane		ft
Adjacent Ramp Data if one exists:		
Does adjacent ramp exist?	No	
Volume on Adjacent Ramp		vph
Position of Adjacent Ramp		
Type of Adjacent Ramp		
Distance to Adjacent Ramp		ft

VOLUME ADJUSTMENT

Junction Components	Freeway	Ramp	Adjacent Ramp	
Terrain Type	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Volume, V (vph)	2092	1255		vph
Peak-Hour Factor, PHF	0.90	0.90		
Peak 15-min Volume, v15	581	349		v
Trucks and Buses	23	3		%
Trucks and Buses PCE, ET	1.5	1.5		
Recreational Vehicles	0	0		%
Recreational Vehicle PCE, ER	1.2	1.2		
Heavy Vehicle Adjustment, fHV	0.897	0.985		
Driver Population Adjustment, fP	1.00	1.00		
Service Flow Rate, vp	2591	1417		pcph

ANALYSIS and RESULTS of MERGE AREAS

Estimation of Flow entering Lanes 1 and 2:

Proportion of Freeway Vehicles in Lanes 1 and 2, P_{FM} = 1.000 Using Equation 1

Flow in Lanes 1 and 2, $v_{12} = v_F (P_{FM})$ = 2591 pcph

Capacity Checks:

	Actual	Maximum	LOS F?
v_{FO}	4008	4800	No

v_{R12}	4008	4600	No

Level of Service Operation (if not LOS F):

Density, $D_R = 5.475 + 0.00734\ v_{R12} + 0.0078\ v_{12} - 0.00627\ L_A$ = 33- pc/mi/ln

Level of Service for Ramp-Freeway Junction Areas of Influence D

Speed in Ramp Influence Area, S_R 56.7 mph

HCS: Ramps and Ramp Junctions Release 3.1b

DIVERGE ANALYSIS

Location:	EB I-40 offramp at Canada Rd.
Analyst:	KWM
Analysis Time Period:	Year 2024, P.M. Peak
Date Performed:	6/3/99

FREEWAY-RAMP COMPONENTS AND CHARACTERISTICS

Type of Analysis	Diverge	
Freeway Data:		
Number of Lanes in Freeway	2	
Free-Flow Speed on Freeway	70.0	mph
Volume on Freeway	3347	vph
Off Ramp Data:		
Side of Freeway	Right	
Number of Lanes in Ramp	1	
Free-Flow Speed on Ramp	60.0	mph
Volume on Ramp	1255	vph
Length of First Accel/Decel Lane	500	ft
Length of Second Accel/Decel Lane	500	ft
Adjacent Ramp Data if one exists:		
Does adjacent ramp exist?	No	
Volume on Adjacent Ramp	0	vph
Position of Adjacent Ramp	Upstream	
Type of Adjacent Ramp	On	
Distance to Adjacent Ramp	1000	ft

VOLUME ADJUSTMENT

Junction Components	Freeway	Ramp	Adjacent Ramp	
Terrain Type	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Volume, V (vph)	3347	1255	0	vph
Peak-Hour Factor, PHF	0.90	0.90		
Peak 15-min Volume, v15	930	349		v
Trucks and Buses	23	3	0	%
Trucks and Buses PCE, ET	1.5	1.5	1.5	
Recreational Vehicles	0	0	0	%
Recreational Vehicle PCE, ER	1.2	1.2	1.2	
Heavy Vehicle Adjustment, fHV	0.897	0.985	1.000	
Driver Population Adjustment, fP	1.00	1.00	1.00	
Service Flow Rate, vp	4148	1417		pcph

ANALYSIS and RESULTS of DIVERGE AREAS

Estimation of Flow entering Lanes 1 and 2:

Proportion of Freeway Vehicles in Lanes 1 and 2, P_{FD} = 1.000 Using Equation 6

Flow in Lanes 1 and 2, $v_{12} = v_R + (v_F - v_R) P_{FD}$ = 4148 pcph

Capacity Checks:

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	4148	4800	No

v_{12}	4148	4400	No
$v_{FO} = v_F - v_R$	2731	4800	No
v_R	1417	2200	No

Level of Service Operation (if not LOS F):

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 35+ pc/mi/ln

Level of Service for Ramp-Freeway Junction Areas of Influence E

Speed in Ramp Influence Area, S_R = 64 mph

HCS: Signals Release 3.1b

Inter:
Analyst: KWM
Date: 6/7/99
E/W St: I-40 EASTBOUND RAMPS

City/St: SHELBY
Proj #: ALTERNATE A
Period: YEAR 2004 - AM PEAK
N/S St: CANADA ROAD

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	2	0	1	0	0	0	0	3	1	1	3	0
LGConfig	L		R					T	R	L	T	
Volume	180		174					273	69	34	157	
Lane Width	12.0		12.0					12.0	12.0	12.0	12.0	
RTOR Vol			0						0			

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4	5	6	7	8
EB Left	P				NB Left			
Thru					Thru	P		
Right	P				Right	P		
Peds					Peds			
WB Left					SB Left	P		
Thru					Thru	P		
Right					Right			
Peds					Peds			
NB Right					EB Right			
SB Right					WB Right			
Green		40.0				30.0		
Yellow		3.0				3.0		
All Red		1.0				1.0		

Cycle Length: 78.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capcity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	1796	3502	0.11	0.513	9.9	A	10.5	B
R	828	1615	0.22	0.513	11.1	B		
Westbound								
Northbound								
T	1937	5036	0.15	0.385	15.8	B	15.8	B
R	621	1615	0.12	0.385	15.9	B		
Southbound								
L	416	1081	0.09	0.385	15.7	B		
T	1937	5036	0.09	0.385	15.4	B	15.4	B

Intersection Delay = 13.6 (sec/veh) Intersection LOS = B

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Intersection:	
City/State:	SHELBY
Analyst:	KWM
Project No:	ALTERNATE A
Time Period Analyzed:	YEAR 2004 - AM PEAK
Date:	6/7/99
East/West Street Name:	I-40 EASTBOUND RAMPS
North/South Street Name:	CANADA ROAD

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	180		174					273	69	34	157	
PHF	0.95		0.95					0.95	0.95	0.95	0.95	
PK 15 Vol	47		46					72	18	9	41	
Hi Ln Vol												
% Grade		0						0			0	
Ideal Sat	1900		1900					1900	1900	1900	1900	
ParkExist												
NumPark												
% Heavy Veh	0		0					3	0	0	3	
No. Lanes	2	0	1	0	0	0	0	3	1	1	3	0
LGConfig	L		R					T	R	L	T	
Lane Width	12.0		12.0					12.0	12.0	12.0	12.0	
RTOR Vol			0						0			
Adj Flow	189		183					287	73	36	165	
%InSharedLn												
Prop Turns												
NumPeds			0			0			0			
NumBus	0		0					0	0	0	0	

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet	0.0		0.0					0.0	0.0	0.0	0.0	
Arriv. Type	3		3					3	3	3	3	
Unit Ext.	3.0		3.0					3.0	3.0	3.0	3.0	
I Factor		1.000						1.000			1.000	
Lost Time	2.0		2.0					2.0	2.0	2.0	2.0	
Ext of g	2.0		2.0					2.0	2.0	2.0	2.0	
Ped Min g		0.0						0.0			0.0	

PHASE DATA

Phase Combination	1	2	3	4	5	6	7	8
EB Left	P				NB Left			
Thru					Thru	P		

	Right	P			Right	P	
	Peds				Peds		
WB	Left			SB	Left	P	
	Thru				Thru	P	
	Right				Right		
	Peds				Peds		
NB	Right			EB	Right		
SB	Right			WB	Right		
Green		40.0				30.0	
Yellow		3.0				3.0	
All Red		1.0				1.0	

Cycle Length: 78.0 secs

VOLUME ADJUSTMENT WORKSHEET

Appr./ Movement	Mvt Volume	PHF	Flow Rate	No. Lanes	Lane Group	RTOR	Adjusted Flow Rate In Lane Grp	Prop. Left Turns	Prop. Right Turns
Eastbound									
Left	180	0.95	189	2	L		189		
Thru				0					
Right	174	0.95	183	1	R	0	183		
Westbound									
Left				0					
Thru				0					
Right				0					
Northbound									
Left				0					
Thru	273	0.95	287	3	T		287		
Right	69	0.95	73	1	R	0	73		
Southbound									
Left	34	0.95	36	1	L		36		
Thru	157	0.95	165	3	T		165		
Right				0					

* Value entered by user.

SATURATION FLOW ADJUSTMENT WORKSHEET

Appr/ Lane Group	Ideal Sat Flow	f W	f HV	f G	f P	f BB	f A	f LU	f RT	f LT	Adj Sat Flow
Eastbound							Sec LT Adj/LT Sat:				
L	1900	1.000	1.000	1.000	1.000	1.000	1.00	0.97	----	0.950	3502

R	1900	1.000	1.000	1.000	1.000	1.000	1.00	1.00	0.850	----	1615
Westbound							Sec LT Adj/LT Sat:				

Northbound									Sec LT Adj/LT Sat:		

T	1900	1.000	0.971	1.000	1.000	1.000	1.00	0.91	1.000	1.000	5036
R	1900	1.000	1.000	1.000	1.000	1.000	1.00	1.00	0.850	----	1615
Southbound									Sec LT Adj/LT Sat:		

L	1900	1.000	1.000	1.000	1.000	1.000	1.00	1.00	----	0.569	1081
T	1900	1.000	0.971	1.000	1.000	1.000	1.00	0.91	1.000	1.000	5036

CAPACITY ANALYSIS WORKSHEET

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Pri.							
Sec.							
Left	L	189	3502	0.05	0.513	1796	0.11
Thru							
Right	R	183	1615	# 0.11	0.513	828	0.22
Westbound							
Pri.							
Sec.							
Left							
Thru							
Right							
Northbound							
Pri.							
Sec.							
Left							
Thru	T	287	5036	# 0.06	0.385	1937	0.15
Right	R	73	1615	0.05	0.385	621	0.12
Southbound							
Pri.							
Sec.							
Left	L	36	1081	0.03	0.385	416	0.09
Thru	T	165	5036	0.03	0.385	1937	0.09
Right							

Sum (v/s) critical = 0.17

Lost Time/Cycle, L = 8.00 sec Critical v/c(X) = 0.19

LEVEL OF SERVICE WORKSHEET

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Incremental Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
L	0.11	0.513	9.8	1.000	1796	0.50	0.1	0.0	9.9	A	10.5	B
R	0.22	0.513	10.4	1.000	828	0.50	0.6	0.0	11.1	B		
Westbound												
Northbound												
T	0.15	0.385	15.7	1.000	1937	0.50	0.2	0.0	15.8	B	15.8	B

R	0.12	0.385	15.5	1.000	621	0.50	0.4	0.0	15.9	B	
Southbound											
L	0.09	0.385	15.3	1.000	416	0.50	0.4	0.0	15.7	B	
T	0.09	0.385	15.3	1.000	1937	0.50	0.1	0.0	15.4	B	15.4 B

Intersection Delay = 13.6 (sec/veh) Intersection LOS = B

SUPPLEMENTAL PERMITTED LT WORKSHEET
for exclusive lefts

APPROACH	EB	WB	NB	SB
Cycle Length, C 78.0 sec				30.0
Actual Green Time for Lane Group, G				30.00
Effective Green Time for Lane Group, g				30.0
Opposing Effective Green Time, go				1
Number of Lanes in Lane Group, N				3
Number of Opposing Lanes, No				36
Adjusted Left-Turn Flow Rate, Vlt				0.00
Proportion of Left Turns in Opposing Flow, Plto				287
Adjusted Opposing Flow Rate, Vo				4.00
Lost Time for Lane Group, tl				0.78
Left Turns per Cycle: LTC=VltC/3600				2.28
Opposing Flow per Lane, Per Cycle: Volc=VoC/3600fluo				1.00
Opposing Platoon Ratio, Rpo (Table 9-2 or Eqn 9-7)				0.0
gf=[Gexp(- a * (LTC ** b))]-tl, gf<=g				0.62
Opposing Queue Ratio: qro=1-Rpo(go/C)				0.00
gq=(4.943Volc**0.762)(qro**1.061)-tl, gq<=g				30.00
gu =g-gq if gq>=gf, =g-gf if gq<gf				0.00
n=(gq-gf)/2, n>=0				1.00
Ptho=1-Plto				1.00
Pl*=Plt[1+{(N-1)g/(gf+gu/El1+4.24)))				1.76
El1 (Figure 9-7)				1.00
El2=(1-Ptho**n)/Plto, El2>=1.0				0.13
fmin=2(1+Plt)/g or fmin=2(1+Pl)/g				0.00
gdiff=max(gq-gf,0)				0.57
fm=[gf/g]+[gu/g][1/{1+Pl(El1-1)}], (min=fmin;max=1.00)				
flt=fm=[gf/g]+gdiff[1/{1+Plt(El2-1)}]				
+[gu/g][1/(1+Plt(El1-1)],(min=fmin;max=1.0) or flt=[fm+0.91(N-1)]/N**				
flt				0.569

For special case of single-lane approach opposed by multilane approach, see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PERMITTED LT WORKSHEET
for shared lefts

APPROACH	EB	WB	NB	SB
Cycle Length, C 78.0 sec				
Actual Green Time for Lane Group, G				
Effective Green Time for Lane Group, g				
Opposing Effective Green Time, go				
Number of Lanes in Lane Group, N				

Number of Opposing Lanes, No
Adjusted Left-Turn Flow Rate, Vlt
Proportion of Left Turns in Lane Group, Plt
Proportion of Left Turns in Opposing Flow, Plto
Adjusted Opposing Flow Rate, Vo
Lost Time for Lane Group, tl
Left Turns per Cycle: LTC=VltC/3600
Opposing Flow per Lane, Per Cycle: Volc=VoC/3600fluo
Opposing Platoon Ratio, Rpo (Table 9-2 or Eqn 9-7)
gf=[Gexp(- a * (LTC ** b))]-tl, gf<=g
Opposing Queue Ratio: qro=1-Rpo(go/C)
gq=(4.943Volc**0.762)(qro**1.061)-tl, gq<=g
gu =g-gq if gq>=gf, =g-gf if gq<gf
n=(gq-gf)/2, n>=0
Ptho=1-Plto
Pl*=Plt[1+{(N-1)g/(gf+gu/El1+4.24)))
El1 (Figure 9-7)
El2=(1-Ptho**n)/Plto, El2>=1.0
fmin=2(1+Plt)/g or fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g][1/{1+Pl(El1-1)}], (min=fmin;max=1.00)
flt=fm=[gf/g]+gdiff[1/{1+Plt(El2-1)}]
+[gu/g][1/(1+Plt(El1-1)],(min=fmin;max=1.0) or flt=[fm+0.91(N-1)]/N**
flt Primary

For special case of single-lane approach opposed by multilane approach, see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

	EBLT	WBLT	NBLT	SBLT
Adj. LT Vol from Vol Adjustment Worksheet, v				
v/c ratio from Capacity Worksheet, X				
Primary phase effective green, g				
Secondary phase effective green, gq				
(From Supplemental Permitted LT Worksheet), gu				
Cycle length, C 78.0 Red =(C-g-gq-gu), r				
Arrivals: v/(3600(max(X,1.0))), qa				
Primary ph. departures: s/3600, sp				
Secondary ph. departures: s(gq+gu)/(gu*3600), ss				
XPerm				
XProt				
XCase				
Queue at beginning of green arrow, Qa				
Queue at beginning of unsaturated green, Qu				
Residual queue, Qr				
Uniform Delay, d1				

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay: Unadj. ds	Uniform Delay: Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec

HCS: Signals Release 3.1b

Inter:
Analyst: KWM
Date: 6/7/99
E/W St: I-40 EASTBOUND RAMPS

City/St: SHELBY
Proj #: ALTERNATE A
Period: YEAR 2024 - AM PEAK
N/S St: CANADA ROAD

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	2	0	1	0	0	0	0	3	1	1	3	0
LGConfig	L		R					T	R	L	T	
Volume	436		819					727	654	98	870	
Lane Width	12.0		12.0					12.0	12.0	12.0	12.0	
RTOR Vol			0						0			

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4	5	6	7	8
EB Left	P							
Thru								
Right	P							
Peds								
WB Left								
Thru								
Right								
Peds								
NB Right								
SB Right								
Green	40.0				30.0			
Yellow	3.0				3.0			
All Red	1.0				1.0			

NB Left: Thru P, Right P, Peds
SB Left P, Thru P, Right, Peds
EB Right
WB Right

Cycle Length: 78.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capcity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	1796	3502	0.26	0.513	11.0	B	43.9	D
R	828	1615	1.04	0.513	61.5	E		
Westbound								
Northbound								
T	1937	5036	0.39	0.385	18.0	B	53.7	D
R	621	1615	1.11	0.385	93.4	F		
Southbound								
L	214	557	0.48	0.385	25.7	C	19.6	B
T	1937	5036	0.47	0.385	18.9	B		

Intersection Delay = 41.1 (sec/veh) Intersection LOS = D

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Intersection:
City/State: SHELBY
Analyst: KWM
Project No: ALTERNATE A
Time Period Analyzed: YEAR 2024 - AM PEAK
Date: 6/7/99
East/West Street Name: I-40 EASTBOUND RAMPS
North/South Street Name: CANADA ROAD

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	436		819					727	654	98	870	
PHF	0.95		0.95					0.95	0.95	0.95	0.95	
PK 15 Vol	115		216					191	172	26	229	
Hi Ln Vol												
% Grade		0						0			0	
Ideal Sat	1900		1900					1900	1900	1900	1900	
ParkExist												
NumPark												
% Heavy Veh	0		0					3	0	0	3	
No. Lanes	2	0	1	0	0	0	0	3	1	1	3	0
LGConfig	L		R					T	R	L	T	
Lane Width	12.0		12.0					12.0	12.0	12.0	12.0	
RTOR Vol			0						0			
Adj Flow	459		862					765	688	103	916	
%InSharedLn												
Prop Turns									0			
NumPeds			0			0		0	0	0	0	
NumBus	0		0									

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet	0.0		0.0					0.0	0.0	0.0	0.0	
Arriv. Type	3		3					3	3	3	3	
Unit Ext.	3.0		3.0					3.0	3.0	3.0	3.0	
I Factor		1.000						1.000			1.000	
Lost Time	2.0		2.0					2.0	2.0	2.0	2.0	
Ext of g	2.0		2.0					2.0	2.0	2.0	2.0	
Ped Min g		0.0						0.0			0.0	

PHASE DATA

Phase Combination	1	2	3	4	5	6	7	8
EB Left	P				NB Left			
Thru					Thru	P		

	Right	P			Right	P	
	Peds				Peds		
WB	Left			SB	Left	P	
	Thru				Thru	P	
	Right				Right		
	Peds				Peds		
NB	Right			EB	Right		
SB	Right			WB	Right		
Green		40.0				30.0	
Yellow		3.0				3.0	
All Red		1.0				1.0	

Cycle Length: 78.0 secs

VOLUME ADJUSTMENT WORKSHEET

Appr./ Movement	Mvt Volume	PHF	Flow Rate	No. Lanes	Lane Group	RTOR	Adjusted Flow Rate In Lane Grp	Prop. Left Turns	Prop. Right Turns
Eastbound									
Left	436	0.95	459	2	L		459		
Thru				0					
Right	819	0.95	862	1	R	0	862		
Westbound									
Left				0					
Thru				0					
Right				0					
Northbound									
Left				0					
Thru	727	0.95	765	3	T		765		
Right	654	0.95	688	1	R	0	688		
Southbound									
Left	98	0.95	103	1	L		103		
Thru	870	0.95	916	3	T		916		
Right				0					

* Value entered by user.

SATURATION FLOW ADJUSTMENT WORKSHEET

Appr/ Lane Group	Ideal Sat Flow	f W	f HV	f G	f P	f BB	f A	f LU	f RT	f LT	Adj Sat Flow
							Sec LT	Adj/LT	Sat:		
Eastbound											
L	1900	1.000	1.000	1.000	1.000	1.000	1.00	0.97	----	0.950	3502

R	1900	1.000	1.000	1.000	1.000	1.000	1.00	1.00	0.850	----	1615
							Sec LT	Adj/LT	Sat:		
Westbound									----		

Northbound								Sec LT Adj/LT Sat:			

T	1900	1.000	0.971	1.000	1.000	1.000	1.00	0.91	1.000	1.000	5036
R	1900	1.000	1.000	1.000	1.000	1.000	1.00	1.00	0.850	----	1615
Southbound								Sec LT Adj/LT Sat:			
L	1900	1.000	1.000	1.000	1.000	1.000	1.00	1.00	----	0.293	557
T	1900	1.000	0.971	1.000	1.000	1.000	1.00	0.91	1.000	1.000	5036

CAPACITY ANALYSIS WORKSHEET

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Pri.							
Sec.							
Left	L	459	3502	0.13	0.513	1796	0.26
Thru							
Right	R	862	1615	# 0.53	0.513	828	1.04
Westbound							
Pri.							
Sec.							
Left							
Thru							
Right							
Northbound							
Pri.							
Sec.							
Left							
Thru	T	765	5036	0.15	0.385	1937	0.39
Right	R	688	1615	# 0.43	0.385	621	1.11
Southbound							
Pri.							
Sec.							
Left	L	103	557	0.18	0.385	214	0.48
Thru	T	916	5036	0.18	0.385	1937	0.47
Right							

Sum (v/s) critical = 0.96

Lost Time/Cycle, L = 8.00 sec Critical v/c(X) = 1.07

LEVEL OF SERVICE WORKSHEET

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Incremental Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
L	0.26	0.513	10.7	1.000	1796	0.50	0.3	0.0	11.0	B	43.9	D
R	1.04	0.513	19.0	1.000	828	0.50	42.5	0.0	61.5	E		
Westbound												
Northbound												
T	0.39	0.385	17.4	1.000	1937	0.50	0.6	0.0	18.0	B	53.7	D

R	1.11	0.385	24.0	1.000	621	0.50	69.4	0.0	93.4	F	
Southbound											
L	0.48	0.385	18.1	1.000	214	0.50	7.6	0.0	25.7	C	
T	0.47	0.385	18.1	1.000	1937	0.50	0.8	0.0	18.9	B	19.6 B

Intersection Delay = 41.1 (sec/veh) Intersection LOS = D

SUPPLEMENTAL PERMITTED LT WORKSHEET
for exclusive lefts

APPROACH	EB	WB	NB	SB
Cycle Length, C 78.0 sec				30.0
Actual Green Time for Lane Group, G				30.00
Effective Green Time for Lane Group, g				30.0
Opposing Effective Green Time, go				1
Number of Lanes in Lane Group, N				3
Number of Opposing Lanes, No				103
Adjusted Left-Turn Flow Rate, Vlt				0.00
Proportion of Left Turns in Opposing Flow, Plto				765
Adjusted Opposing Flow Rate, Vo				4.00
Lost Time for Lane Group, tl				2.23
Left Turns per Cycle: LTC=VltC/3600				6.07
Opposing Flow per Lane, Per Cycle: Volc=VoC/3600fluo				1.00
Opposing Platoon Ratio, Rpo (Table 9-2 or Eqn 9-7)				0.0
gf=[Gexp(- a * (LTC ** b))]-tl, gf<=g				0.62
Opposing Queue Ratio: qro=1-Rpo(go/C)				4.85
gq=(4.943Volc**0.762)(qro**1.061)-tl, gq<=g				25.15
gu =g-gq if gq>=gf, =g-gf if gq<gf				2.43
n=(gq-gf)/2, n>=0				1.00
Ptho=1-Plto				1.00
Pl*=Plt[1+{(N-1)g/(gf+gu/El1+4.24))}				2.86
El1 (Figure 9-7)				1.00
El2=(1-Ptho**n)/Plto, El2>=1.0				0.13
fmin=2(1+Plt)/g or fmin=2(1+Pl)/g				0.00
gdiff=max(gq-gf,0)				0.29
fm=[gf/g]+[gu/g][1/{1+Pl(El1-1)}], (min=fmin;max=1.00)				
flt=fm=[gf/g]+gdiff[1/{1+Plt(El2-1)}]				
+[gu/g][1/(1+Plt(El1-1)],(min=fmin;max=1.0) or flt=[fm+0.91(N-1)]/N**				
flt				0.293

For special case of single-lane approach opposed by multilane approach, see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PERMITTED LT WORKSHEET
for shared lefts

APPROACH	EB	WB	NB	SB
Cycle Length, C 78.0 sec				
Actual Green Time for Lane Group, G				
Effective Green Time for Lane Group, g				
Opposing Effective Green Time, go				
Number of Lanes in Lane Group, N				

Number of Opposing Lanes, No
Adjusted Left-Turn Flow Rate, Vlt
Proportion of Left Turns in Lane Group, Plt
Proportion of Left Turns in Opposing Flow, Plto
Adjusted Opposing Flow Rate, Vo
Lost Time for Lane Group, tl
Left Turns per Cycle: LTC=VltC/3600
Opposing Flow per Lane, Per Cycle: Volc=VoC/3600fluo
Opposing Platoon Ratio, Rpo (Table 9-2 or Eqn 9-7)
gf=[Gexp(- a * (LTC ** b))]-tl, gf<=g
Opposing Queue Ratio: qro=1-Rpo(go/C)
gq=(4.943Volc**0.762)(qro**1.061)-tl, gq<=g
gu =g-gq if gq>=gf, =g-gf if gq<gf
n=(gq-gf)/2, n>=0
Ptho=1-Plto
Pl*=Plt[1+{(N-1)g/(gf+gu/El1+4.24)))
El1 (Figure 9-7)
El2=(1-Ptho**n)/Plto, El2>=1.0
fmin=2(1+Plt)/g or fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g][1/{1+Pl(El1-1)}], (min=fmin;max=1.00)
flt=fm=[gf/g]+gdiff[1/{1+Plt(El2-1)}]
+[gu/g][1/(1+Plt(El1-1)],(min=fmin;max=1.0) or flt=[fm+0.91(N-1)]/N**
flt Primary

For special case of single-lane approach opposed by multilane approach, see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

	EBLT	WBLT	NBLT	SBLT
Adj. LT Vol from Vol Adjustment Worksheet, v				
v/c ratio from Capacity Worksheet, X				
Primary phase effective green, g				
Secondary phase effective green, gq				
(From Supplemental Permitted LT Worksheet), gu				
Cycle length, C 78.0 Red =(C-g-gq-gu), r				
Arrivals: v/(3600(max(X,1.0))), qa				
Primary ph. departures: s/3600, sp				
Secondary ph. departures: s(gq+gu)/(gu*3600), ss				
XPerm				
XProt				
XCase				
Queue at beginning of green arrow, Qa				
Queue at beginning of unsaturated green, Qu				
Residual queue, Qr				
Uniform Delay, d1				

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay: Unadj. ds	Uniform Delay: Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec

HCS: Signals Release 3.1b

Inter:
Analyst: KWM
Date: 6/7/99
E/W St: I-40 EASTBOUND RAMPS

City/St: SHELBY
Proj #: ALTERNATE A- INTERIM 5-LANE
Period: YEAR 2024 - AM PEAK
N/S St: CANADA ROAD

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	2	0	1	0	0	0	0	2	1	1	2	0
LGConfig	L		R					T	R	L	T	
Volume	436		819					727	654	98	870	
Lane Width	12.0		12.0					12.0	12.0	12.0	12.0	
RTOR Vol			0						0			

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4	5	6	7	8
EB Left	P							
Thru								
Right	P							
Peds								
WB Left								
Thru								
Right								
Peds								
NB Right								
SB Right								
Green	40.0				30.0			
Yellow	3.0				3.0			
All Red	1.0				1.0			

NB	Left	
	Thru	P
	Right	P
	Peds	
SB	Left	P
	Thru	P
	Right	
	Peds	
EB	Right	
WB	Right	

Cycle Length: 78.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capcity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	1796	3502	0.26	0.513	11.0	B	43.9	D
R	828	1615	1.04	0.513	61.5	E		
Westbound								
Northbound								
T	1348	3505	0.57	0.385	20.6	C	55.1	E
R	621	1615	1.11	0.385	93.4	F		
Southbound								
L	178	462	0.58	0.385	32.0	C	23.7	C
T	1348	3505	0.68	0.385	22.8	C		

Intersection Delay = 42.8 (sec/veh) Intersection LOS = D

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Intersection:
City/State: SHELBY
Analyst: KWM
Project No: ALTERNATE A- INTERIM 5-LANE
Time Period Analyzed: YEAR 2024 - AM PEAK
Date: 6/7/99
East/West Street Name: I-40 EASTBOUND RAMPS
North/South Street Name: CANADA ROAD

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	436		819					727	654	98	870	
PHF	0.95		0.95					0.95	0.95	0.95	0.95	
PK 15 Vol	115		216					191	172	26	229	
Hi Ln Vol												
% Grade		0						0			0	
Ideal Sat	1900		1900					1900	1900	1900	1900	
ParkExist												
NumPark												
% Heavy Veh	0		0					3	0	0	3	
No. Lanes	2	0	1	0	0	0	0	2	1	1	2	0
LGConfig	L		R					T	R	L	T	
Lane Width	12.0		12.0					12.0	12.0	12.0	12.0	
RTOR Vol			0						0			
Adj Flow	459		862					765	688	103	916	
%InSharedLn												
Prop Turns												
NumPeds			0			0			0			
NumBus	0		0					0	0	0	0	

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet	0.0		0.0					0.0	0.0	0.0	0.0	
Arriv. Type	3		3					3	3	3	3	
Unit Ext.	3.0		3.0					3.0	3.0	3.0	3.0	
I Factor		1.000						1.000			1.000	
Lost Time	2.0		2.0					2.0	2.0	2.0	2.0	
Ext of g	2.0		2.0					2.0	2.0	2.0	2.0	
Ped Min g		0.0						0.0			0.0	

PHASE DATA

Phase Combination	1	2	3	4		5	6	7	8
EB Left	P				NB Left				
Thru					Thru	P			

Northbound									Sec	LT Adj/LT	Sat:

T	1900	1.000	0.971	1.000	1.000	1.000	1.00	0.95	1.000	1.000	3505
R	1900	1.000	1.000	1.000	1.000	1.000	1.00	1.00	0.850	----	1615
Southbound									Sec	LT Adj/LT	Sat:
L	1900	1.000	1.000	1.000	1.000	1.000	1.00	1.00	----	0.243	462
T	1900	1.000	0.971	1.000	1.000	1.000	1.00	0.95	1.000	1.000	3505

CAPACITY ANALYSIS WORKSHEET

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Pri.							
Sec.							
Left	L	459	3502	0.13	0.513	1796	0.26
Thru							
Right	R	862	1615	# 0.53	0.513	828	1.04
Westbound							
Pri.							
Sec.							
Left							
Thru							
Right							
Northbound							
Pri.							
Sec.							
Left							
Thru	T	765	3505	0.22	0.385	1348	0.57
Right	R	688	1615	# 0.43	0.385	621	1.11
Southbound							
Pri.							
Sec.							
Left	L	103	462	0.22	0.385	178	0.58
Thru	T	916	3505	0.26	0.385	1348	0.68
Right							

Sum (v/s) critical = 0.96

Lost Time/Cycle, L = 8.00 sec Critical v/c(X) = 1.07

LEVEL OF SERVICE WORKSHEET

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Incremental Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
L	0.26	0.513	10.7	1.000	1796	0.50	0.3	0.0	11.0	B	43.9	D
R	1.04	0.513	19.0	1.000	828	0.50	42.5	0.0	61.5	E		
Westbound												
Northbound												
T	0.57	0.385	18.9	1.000	1348	0.50	1.7	0.0	20.6	C	55.1	E

R	1.11	0.385	24.0	1.000	621	0.50	69.4	0.0	93.4	F	
Southbound											
L	0.58	0.385	19.0	1.000	178	0.50	13.0	0.0	32.0	C	
T	0.68	0.385	20.0	1.000	1348	0.50	2.8	0.0	22.8	C	23.7 C

Intersection Delay = 42.8 (sec/veh) Intersection LOS = D

SUPPLEMENTAL PERMITTED LT WORKSHEET
for exclusive lefts

APPROACH	EB	WB	NB	SB
Cycle Length, C 78.0 sec				30.0
Actual Green Time for Lane Group, G				30.00
Effective Green Time for Lane Group, g				30.0
Opposing Effective Green Time, go				1
Number of Lanes in Lane Group, N				2
Number of Opposing Lanes, No				103
Adjusted Left-Turn Flow Rate, Vlt				0.00
Proportion of Left Turns in Opposing Flow, Plto				765
Adjusted Opposing Flow Rate, Vo				4.00
Lost Time for Lane Group, tl				2.23
Left Turns per Cycle: LTC=VltC/3600				8.72
Opposing Flow per Lane, Per Cycle: Volc=VoC/3600fluo				1.00
Opposing Platoon Ratio, Rpo (Table 9-2 or Eqn 9-7)				0.0
gf=[Gexp(- a * (LTC ** b))]-tl, gf<=g				0.62
Opposing Queue Ratio: qro=1-Rpo(go/C)				9.83
gq=(4.943Volc**0.762)(qro**1.061)-tl, gq<=g				20.17
gu =g-gq if gq>=gf, =g-gf if gq<gf				4.92
n=(gq-gf)/2, n>=0				1.00
Ptho=1-Plto				1.00
Pl*=Plt[1+{(N-1)g/(gf+gu/El1+4.24))}				2.77
El1 (Figure 9-7)				1.00
El2=(1-Ptho**n)/Plto, El2>=1.0				0.13
fmin=2(1+Plt)/g or fmin=2(1+Pl)/g				0.00
gdiff=max(gq-gf,0)				0.24
fm=[gf/g]+[gu/g][1/{1+Pl(El1-1)}], (min=fmin;max=1.00)				
flt=fm=[gf/g]+gdiff[1/{1+Plt(El2-1)}] +[gu/g][1/(1+Plt(El1-1)],(min=fmin;max=1.0) or flt=[fm+0.91(N-1)]/N**				0.243
flt				

For special case of single-lane approach opposed by multilane approach, see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PERMITTED LT WORKSHEET
for shared lefts

APPROACH	EB	WB	NB	SB
Cycle Length, C 78.0 sec				
Actual Green Time for Lane Group, G				
Effective Green Time for Lane Group, g				
Opposing Effective Green Time, go				
Number of Lanes in Lane Group, N				

Number of Opposing Lanes, No
Adjusted Left-Turn Flow Rate, Vlt
Proportion of Left Turns in Lane Group, Plt
Proportion of Left Turns in Opposing Flow, Plto
Adjusted Opposing Flow Rate, Vo
Lost Time for Lane Group, tl
Left Turns per Cycle: LTC=VltC/3600
Opposing Flow per Lane, Per Cycle: Volc=VoC/3600fluo
Opposing Platoon Ratio, Rpo (Table 9-2 or Eqn 9-7)
gf=[Gexp(- a * (LTC ** b))]-tl, gf<=g
Opposing Queue Ratio: qro=1-Rpo(go/C)
gq=(4.943Volc**0.762)(qro**1.061)-tl, gq<=g
gu =g-gq if gq>=gf, =g-gf if gq<gf
n=(gq-gf)/2, n>=0
Ptho=1-Plto
Pl*=Plt[1+{(N-1)g/(gf+gu/El1+4.24)))
El1 (Figure 9-7)
El2=(1-Ptho**n)/Plto, El2>=1.0
fmin=2(1+Plt)/g or fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g][1/{1+Pl(El1-1)}], (min=fmin;max=1.00)
flt=fm=[gf/g]+gdiff[1/{1+Plt(El2-1)}]
+[gu/g][1/(1+Plt(El1-1)],(min=fmin;max=1.0) or flt=[fm+0.91(N-1)]/N**
flt Primary

For special case of single-lane approach opposed by multilane approach, see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm. For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

	EBLT	WBLT	NBLT	SBLT
Adj. LT Vol from Vol Adjustment Worksheet, v				
v/c ratio from Capacity Worksheet, X				
Primary phase effective green, g				
Secondary phase effective green, gq				
(From Supplemental Permitted LT Worksheet), gu				
Cycle length, C 78.0 Red =(C-g-gq-gu), r				
Arrivals: v/(3600(max(X,1.0))), qa				
Primary ph. departures: s/3600, sp				
Secondary ph. departures: s(gq+gu)/(gu*3600), ss				
XPerm				
XProt				
XCase				
Queue at beginning of green arrow, Qa				
Queue at beginning of unsaturated green, Qu				
Residual queue, Qr				
Uniform Delay, d1				

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay: Unadj. ds	Uniform Delay: Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec

HCS: Signals Release 3.1b

Inter:
Analyst: KWM
Date: 6/7/99
E/W St: I-40 WESTBOUND RAMPS

City/St: SHELBY
Proj #: ALTERNATE A
Period: YEAR 2024 - AM PEAK
N/S St: CANADA ROAD

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	0	0	2	0	1	2	3	0	0	3	0
LGConfig				L		R	L	T			TR	
Volume				69		34	261	156			150	180
Lane Width				12.0		12.0	12.0	12.0			12.0	
RTOR Vol						0						0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination		1	2	3	4	5	6	7	8
EB	Left					NB Left	P		
	Thru					Thru	P	P	
	Right					Right			
	Peds					Peds			
WB	Left		P			SB Left			
	Thru					Thru		P	
	Right		P			Right		P	
	Peds					Peds			
NB	Right					EB Right			
SB	Right					WB Right			
Green			30.0				28.0	20.0	
Yellow			3.0				3.0	3.0	
All Red			1.0				1.0	1.0	

Cycle Length: 90.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capcity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
Westbound								
L	1133	3400	0.06	0.333	20.5	C	20.6	C
R	523	1568	0.07	0.333	20.7	C		
Northbound								
L	1058	3400	0.26	0.311	23.8	C		
T	2910	5036	0.06	0.578	8.3	A	18.0	B
Southbound								
TR	1028	4624	0.34	0.222	30.3	C	30.3	C

Intersection Delay = 23.1 (sec/veh) Intersection LOS = C

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Intersection:	SHELBY
City/State:	KWM
Analyst:	ALTERNATE A
Project No:	YEAR 2024 - AM PEAK
Time Period Analyzed:	6/7/99
Date:	I-40 WESTBOUND RAMPS
East/West Street Name:	CANADA ROAD
North/South Street Name:	

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume				69		34	261	156			150	180
PHF				0.95		0.95	0.95	0.95			0.95	0.95
PK 15 Vol				18		9	69	41			39	47
Hi Ln Vol												
% Grade					0			0			0	
Ideal Sat				1900		1900	1900	1900			1900	
ParkExist												
NumPark											3	0
% Heavy Veh				3		3	3	3		0	3	0
No. Lanes	0	0	0	2	0	1	2	3	0	0	3	0
LGConfig				L		R	L	T			TR	
Lane Width				12.0		12.0	12.0	12.0			12.0	
RTOR Vol						0						0
Adj Flow				73		36	275	164			347	
%InSharedLn												0.54
Prop Turns												0
NumPeds			0			0					0	
NumBus				0		0	0	0				

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet				0.0		0.0	0.0	0.0			0.0	
Arriv. Type				3		3	3	3			3	
Unit Ext.				3.0		3.0	3.0	3.0			3.0	
I Factor					1.000			1.000			1.000	
Lost Time				2.0		2.0	2.0	2.0			2.0	
Ext of g				2.0		2.0	2.0	2.0			2.0	
Ped Min g					0.0			0.0			0.0	

PHASE DATA

Phase Combination	1	2	3	4		5	6	7	8
EB Left					NB Left	P			
Thru					Thru	P	P		

	Right					Right	
	Peds					Peds	
WB	Left	P			SB	Left	
	Thru					Thru	P
	Right	P				Right	P
	Peds					Peds	
NB	Right				EB	Right	
SB	Right				WB	Right	
Green		30.0				28.0	20.0
Yellow		3.0				3.0	3.0
All Red		1.0				1.0	1.0

Cycle Length: 90.0 secs

VOLUME ADJUSTMENT WORKSHEET

Appr./ Movement	Mvt Volume	PHF	Flow Rate	No. Lanes	Lane Group	RTOR	Adjusted Flow Rate In Lane Grp	Prop. Left Turns	Prop. Right Turns
Eastbound				0					
Left				0					
Thru				0					
Right									
Westbound							73		
Left	69	0.95	73	2	L				
Thru				0					
Right	34	0.95	36	1	R	0	36		
Northbound							275		
Left	261	0.95	275	2	L				
Thru	156	0.95	164	3	T		164		
Right				0					
Southbound				0					
Left				3	TR		347		0.54
Thru	150	0.95	158	0		0			
Right	180	0.95	189						

* Value entered by user.

SATURATION FLOW ADJUSTMENT WORKSHEET

Appr/ Lane Group	Ideal Sat Flow	f W	f HV	f G	f P	f BB	f A	f LU	f RT	f LT	Adj Sat Flow
							Sec LT Adj/LT Sat:		----		
Eastbound					---					----	
							Sec LT Adj/LT Sat:				
Westbound											
L	1900	1.000	0.971	1.000	1.000	1.000	1.00	0.97	----	0.950	3400

R	1900	1.000	0.971	1.000	1.000	1.000	1.00	1.00	0.850	---- 1568
							Sec LT Adj/LT Sat:			
Northbound										
L	1900	1.000	0.971	1.000	1.000	1.000	1.00	0.97	----	0.950 3400
T	1900	1.000	0.971	1.000	1.000	1.000	1.00	0.91	1.000	1.000 5036

							Sec LT Adj/LT Sat:			

Southbound										
TR	1900	1.000	0.971	1.000	1.000	1.000	1.00	0.91	0.918	1.000 4624

CAPACITY ANALYSIS WORKSHEET

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Pri.							
Sec.							
Left							
Thru							
Right							
Westbound							
Pri.							
Sec.							
Left	L	73	3400	0.02	0.333	1133	0.06
Thru							
Right	R	36	1568	# 0.02	0.333	523	0.07
Northbound							
Pri.							
Sec.							
Left	L	275	3400	# 0.08	0.311	1058	0.26
Thru	T	164	5036	0.03	0.578	2910	0.06
Right							
Southbound							
Pri.							
Sec.							
Left							
Thru	TR	347	4624	# 0.08	0.222	1028	0.34
Right							

Lost Time/Cycle, L = 12.00 sec Sum (v/s) critical = 0.18
Critical v/c(X) = 0.21

LEVEL OF SERVICE WORKSHEET

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Incremental Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
Westbound												
L	0.06	0.333	20.4	1.000	1133	0.50	0.1	0.0	20.5	C	20.6	C
R	0.07	0.333	20.5	1.000	523	0.50	0.3	0.0	20.7	C		
Northbound												
L	0.26	0.311	23.2	1.000	1058	0.50	0.6	0.0	23.8	C	18.0	B
T	0.06	0.578	8.3	1.000	2910	0.50	0.0	0.0	8.3	A		

Southbound

TR 0.34 0.222 29.4 1.000 1028 0.50 0.9 0.0 30.3 C 30.3 C

Intersection Delay = 23.1 (sec/veh) Intersection LOS = C

SUPPLEMENTAL PERMITTED LT WORKSHEET
for exclusive lefts

	EB	WB	NB	SB
APPROACH				
Cycle Length, C 90.0 sec				
Actual Green Time for Lane Group, G				
Effective Green Time for Lane Group, g				
Opposing Effective Green Time, go				
Number of Lanes in Lane Group, N				
Number of Opposing Lanes, No				
Adjusted Left-Turn Flow Rate, Vlt				
Proportion of Left Turns in Opposing Flow, Plto				
Adjusted Opposing Flow Rate, Vo				
Lost Time for Lane Group, tl				
Left Turns per Cycle: LTC=VltC/3600				
Opposing Flow per Lane, Per Cycle: Volc=VoC/3600fluo				
Opposing Platoon Ratio, Rpo (Table 9-2 or Eqn 9-7)				
gf=[Gexp(- a * (LTC ** b))]-tl, gf<=g				
Opposing Queue Ratio: qro=1-Rpo(go/C)				
gq=(4.943Volc**0.762)(qro**1.061)-tl, gq<=g				
gu =g-gq if gq>=gf, =g-gf if gq<gf				
n=(gq-gf)/2, n>=0				
Ptho=1-Plto				
Pl*=Plt[1+{(N-1)g/(gf+gu/El1+4.24)))				
El1 (Figure 9-7)				
El2=(1-Ptho**n)/Plto, El2>=1.0				
fmin=2(1+Plt)/g or fmin=2(1+Pl)/g				
gdiff=max(gq-gf,0)				
fm=[gf/g]+[gu/g][1/{1+Pl(El1-1)}], (min=fmin;max=1.00)				
flt=fm=[gf/g]+gdiff[1/{1+Plt(El2-1)}] +[gu/g][1/(1+Plt(El1-1)], (min=fmin;max=1.0) or flt=[fm+0.91(N-1)]/N**				
flt				

For special case of single-lane approach opposed by multilane approach, see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm. For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PERMITTED LT WORKSHEET
for shared lefts

	EB	WB	NB	SB
APPROACH				
Cycle Length, C 90.0 sec				
Actual Green Time for Lane Group, G				
Effective Green Time for Lane Group, g				
Opposing Effective Green Time, go				
Number of Lanes in Lane Group, N				

Number of Opposing Lanes, No
Adjusted Left-Turn Flow Rate, Vlt
Proportion of Left Turns in Lane Group, Plt
Proportion of Left Turns in Opposing Flow, Plto
Adjusted Opposing Flow Rate, Vo
Lost Time for Lane Group, tl
Left Turns per Cycle: LTC=VltC/3600
Opposing Flow per Lane, Per Cycle: Volc=VoC/3600fluo
Opposing Platoon Ratio, Rpo (Table 9-2 or Eqn 9-7)
gf=[Gexp(- a * (LTC ** b))]-tl, gf<=g
Opposing Queue Ratio: qro=1-Rpo(go/C)
gq=(4.943Volc**0.762)(qro**1.061)-tl, gq<=g
gu =g-gq if gq>=gf, =g-gf if gq<gf
n=(gq-gf)/2, n>=0
Ptho=1-Plto
Pl*=Plt[1+{(N-1)g/(gf+gu/El1+4.24)))
El1 (Figure 9-7)
El2=(1-Ptho**n)/Plto, El2>=1.0
fmin=2(1+Plt)/g or fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g][1/{1+Pl(El1-1)}], (min=fmin;max=1.00)
flt=fm=[gf/g]+gdiff[1/{1+Plt(El2-1)}]
+[gu/g][1/(1+Plt(El1-1)],(min=fmin;max=1.0) or flt=[fm+0.91(N-1)]/N**
flt Primary

For special case of single-lane approach opposed by multilane approach, see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

	EBLT	WBLT	NBLT	SBLT
Adj. LT Vol from Vol Adjustment Worksheet, v				
v/c ratio from Capacity Worksheet, X				
Primary phase effective green, g				
Secondary phase effective green, gq				
(From Supplemental Permitted LT Worksheet), gu				
Cycle length, C 90.0 Red =(C-g-gq-gu), r				
Arrivals: v/(3600(max(X,1.0))), qa				
Primary ph. departures: s/3600, sp				
Secondary ph. departures: s(gq+gu)/(gu*3600), ss				
XPerm				
XProt				
XCase				
Queue at beginning of green arrow, Qa				
Queue at beginning of unsaturated green, Qu				
Residual queue, Qr				
Uniform Delay, d1				

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec

HCS: Signals Release 3.1b

Inter:
Analyst: KWM
Date: 6/7/99
E/W St: I-40 WESTBOUND RAMPS

City/St: SHELBY
Proj #: ALTERNATE A
Period: YEAR 2024 - AM PEAK
N/S St: CANADA ROAD

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	0	0	2	0	1	2	3	0	0	3	0
LGConfig				L		R	L	T			TR	
Volume				654		98	819	543			328	436
Lane Width				12.0		12.0	12.0	12.0			12.0	
RTOR Vol						0						0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4	5	6	7	8
EB Left					NB Left	P		
Thru					Thru	P	P	
Right					Right			
Peds					Peds			
WB Left		P			SB Left			
Thru					Thru		P	
Right		P			Right		P	
Peds					Peds			
NB Right					EB Right			
SB Right					WB Right			
Green		30.0				28.0	20.0	
Yellow		3.0				3.0	3.0	
All Red		1.0				1.0	1.0	

Cycle Length: 90.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capcity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
Westbound								
L	1133	3400	0.61	0.333	27.5	C	26.8	C
R	523	1568	0.20	0.333	22.2	C		
Northbound								
L	1058	3400	0.81	0.311	35.5	D	25.0	C
T	2910	5036	0.20	0.578	9.2	A		
Southbound								
TR	1023	4605	0.79	0.222	39.1	D	39.1	D

Intersection Delay = 29.2 (sec/veh) Intersection LOS = C

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Intersection:	SHELBY
City/State:	KWM
Analyst:	ALTERNATE A
Project No:	YEAR 2024 - AM PEAK
Time Period Analyzed:	6/7/99
Date:	I-40 WESTBOUND RAMPS
East/West Street Name:	CANADA ROAD
North/South Street Name:	

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume				654		98	819	543			328	436
PHF				0.95		0.95	0.95	0.95			0.95	0.95
PK 15 Vol				172		26	216	143			86	115
Hi Ln Vol					0			0			0	
% Grade				1900		1900	1900	1900			1900	
Ideal Sat												
ParkExist											3	0
NumPark				3		3	3	3		0	3	0
% Heavy Veh				2	0	1	2	3	0		TR	
No. Lanes	0	0	0	L		R	L	T			12.0	
LGConfig				12.0		12.0	12.0	12.0				0
Lane Width						0					804	
RTOR Vol				688		103	862	572				0.57
Adj Flow												0
%InSharedLn												
Prop Turns						0					0	
NumPeds			0			0	0	0				
NumBus				0								

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet				0.0		0.0	0.0	0.0			0.0	
Arriv. Type				3		3	3	3			3	
Unit Ext.				3.0		3.0	3.0	3.0			3.0	
I Factor					1.000			1.000			1.000	
Lost Time				2.0		2.0	2.0	2.0			2.0	
Ext of g				2.0		2.0	2.0	2.0			2.0	
Ped Min g					0.0			0.0			0.0	

PHASE DATA

Phase Combination	1	2	3	4	5	6	7	8
EB Left					NB Left	P		
Thru					Thru	P	P	

	Right Peds				Right Peds	
WB	Left	P		SB	Left	
	Thru				Thru	P
	Right	P			Right	P
	Peds				Peds	
NB	Right			EB	Right	
SB	Right			WB	Right	
Green		30.0			28.0	20.0
Yellow		3.0			3.0	3.0
All Red		1.0			1.0	1.0

Cycle Length: 90.0 secs

VOLUME ADJUSTMENT WORKSHEET

Appr./ Movement	Mvt Volume	PHF	Flow Rate	No. Lanes	Lane Group	RTOR	Adjusted Flow Rate In Lane Grp	Prop. Left Turns	Prop. Right Turns
Eastbound				0					
Left				0					
Thru				0					
Right									
Westbound									
Left	654	0.95	688	2	L		688		
Thru				0					
Right	98	0.95	103	1	R	0	103		
Northbound									
Left	819	0.95	862	2	L		862		
Thru	543	0.95	572	3	T		572		
Right				0					
Southbound				0					
Left				3	TR		804		0.57
Thru	328	0.95	345	0		0			
Right	436	0.95	459						

* Value entered by user.

SATURATION FLOW ADJUSTMENT WORKSHEET

Appr/ Lane Group	Ideal Sat Flow	f W	f HV	f G	f P	f BB	f A	f LU	f RT	f LT	Adj Sat Flow
							Sec LT	Adj/LT	Sat:		
Eastbound									----		
					---					----	
							Sec LT	Adj/LT	Sat:		
Westbound											
L	1900	1.000	0.971	1.000	1.000	1.000	1.00	0.97	----	0.950	3400

R	1900	1.000	0.971	1.000	1.000	1.000	1.00	1.00	0.850	----	1568
							Sec LT Adj/LT Sat:				
Northbound										0.950	3400
L	1900	1.000	0.971	1.000	1.000	1.000	1.00	0.97	----	1.000	5036
T	1900	1.000	0.971	1.000	1.000	1.000	1.00	0.91	1.000	----	
							Sec LT Adj/LT Sat:		----		
Southbound										1.000	4605
TR	1900	1.000	0.971	1.000	1.000	1.000	1.00	0.91	0.914	----	

CAPACITY ANALYSIS WORKSHEET

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Pri.							
Sec.							
Left							
Thru							
Right							
Westbound							
Pri.							
Sec.							
Left	L	688	3400	# 0.20	0.333	1133	0.61
Thru							
Right	R	103	1568	0.07	0.333	523	0.20
Northbound							
Pri.							
Sec.							
Left	L	862	3400	# 0.25	0.311	1058	0.81
Thru	T	572	5036	0.11	0.578	2910	0.20
Right							
Southbound							
Pri.							
Sec.							
Left							
Thru	TR	804	4605	# 0.17	0.222	1023	0.79
Right							

Lost Time/Cycle, L = 12.00 sec

Sum (v/s) critical = 0.63
Critical v/c(X) = 0.73

LEVEL OF SERVICE WORKSHEET

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Incremental Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
Westbound												
L	0.61	0.333	25.1	1.000	1133	0.50	2.4	0.0	27.5	C	26.8	C
R	0.20	0.333	21.4	1.000	523	0.50	0.8	0.0	22.2	C		
Northbound												
L	0.81	0.311	28.6	1.000	1058	0.50	6.9	0.0	35.5	D		
T	0.20	0.578	9.1	1.000	2910	0.50	0.2	0.0	9.2	A	25.0	C

Southbound

TR 0.79 0.222 33.0 1.000 1023 0.50 6.1 0.0 39.1 D 39.1 D

Intersection Delay = 29.2 (sec/veh) Intersection LOS = C

SUPPLEMENTAL PERMITTED LT WORKSHEET
for exclusive lefts

	EB	WB	NB	SB
APPROACH				
Cycle Length, C 90.0 sec				
Actual Green Time for Lane Group, G				
Effective Green Time for Lane Group, g				
Opposing Effective Green Time, go				
Number of Lanes in Lane Group, N				
Number of Opposing Lanes, No				
Adjusted Left-Turn Flow Rate, Vlt				
Proportion of Left Turns in Opposing Flow, Plto				
Adjusted Opposing Flow Rate, Vo				
Lost Time for Lane Group, tl				
Left Turns per Cycle: LTC=VltC/3600				
Opposing Flow per Lane, Per Cycle: Volc=VoC/3600fluo				
Opposing Platoon Ratio, Rpo (Table 9-2 or Eqn 9-7)				
gf=[Gexp(- a * (LTC ** b))]-tl, gf<=g				
Opposing Queue Ratio: qro=1-Rpo(go/C)				
gq=(4.943Volc**0.762)(qro**1.061)-tl, gq<=g				
gu =g-gq if gq>=gf, =g-gf if gq<gf				
n=(gq-gf)/2, n>=0				
Ptho=1-Plto				
Pl*=Plt[1+{(N-1)g/(gf+gu/El1+4.24)))				
El1 (Figure 9-7)				
El2=(1-Ptho**n)/Plto, El2>=1.0				
fmin=2(1+Plt)/g or fmin=2(1+Pl)/g				
gdiff=max(gq-gf,0)				
fm=[gf/g]+[gu/g][1/{1+Pl(El1-1)}], (min=fmin;max=1.00)				
flt=fm=[gf/g]+gdiff[1/{1+Plt(El2-1)}]				
+[gu/g][1/(1+Plt(El1-1)], (min=fmin;max=1.0) or flt=[fm+0.91(N-1)]/N**				
flt				

For special case of single-lane approach opposed by multilane approach, see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm. For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PERMITTED LT WORKSHEET
for shared lefts

	EB	WB	NB	SB
APPROACH				
Cycle Length, C 90.0 sec				
Actual Green Time for Lane Group, G				
Effective Green Time for Lane Group, g				
Opposing Effective Green Time, go				
Number of Lanes in Lane Group, N				

Number of Opposing Lanes, No
Adjusted Left-Turn Flow Rate, Vlt
Proportion of Left Turns in Lane Group, Plt
Proportion of Left Turns in Opposing Flow, Plto
Adjusted Opposing Flow Rate, Vo
Lost Time for Lane Group, tl
Left Turns per Cycle: LTC=VltC/3600
Opposing Flow per Lane, Per Cycle: Volc=VoC/3600fluo
Opposing Platoon Ratio, Rpo (Table 9-2 or Eqn 9-7)
gf=[Gexp(- a * (LTC ** b))]-tl, gf<=g
Opposing Queue Ratio: qro=1-Rpo(go/C)
gq=(4.943Volc**0.762)(qro**1.061)-tl, gq<=g
gu =g-gq if gq>=gf, =g-gf if gq<gf
n=(gq-gf)/2, n>=0
Ptho=1-Plto
Pl*=Plt[1+{(N-1)g/(gf+gu/El1+4.24)))
El1 (Figure 9-7)
El2=(1-Ptho**n)/Plto, El2>=1.0
fmin=2(1+Plt)/g or fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g][1/{1+Pl(El1-1)}], (min=fmin;max=1.00)
flt=fm=[gf/g]+gdiff[1/{1+Plt(El2-1)}]
+[gu/g][1/(1+Plt(El1-1)],(min=fmin;max=1.0) or flt=[fm+0.91(N-1)]/N**
flt Primary

For special case of single-lane approach opposed by multilane approach, see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

	EBLT	WBLT	NBLT	SBLT
Adj. LT Vol from Vol Adjustment Worksheet, v				
v/c ratio from Capacity Worksheet, X				
Primary phase effective green, g				
Secondary phase effective green, gq				
(From Supplemental Permitted LT Worksheet), gu				
Cycle length, C 90.0 Red =(C-g-gq-gu), r				
Arrivals: v/(3600(max(X,1.0))), qa				
Primary ph. departures: s/3600, sp				
Secondary ph. departures: s(gq+gu)/(gu*3600), ss				
XPerm				
XProt				
XCase				
Queue at beginning of green arrow, Qa				
Queue at beginning of unsaturated green, Qu				
Residual queue, Qr				
Uniform Delay, d1				

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec

HCS: Signals Release 3.1b

Inter:
Analyst: KWM
Date: 6/7/99
E/W St: I-40 WESTBOUND RAMPS

City/St: SHELBY
Proj #: ALTERNATE A
Period: YEAR 2024 - AM PEAK
N/S St: CANADA ROAD

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	0	0	2	0	1	0	3	0	0	3	0
LGConfig				L		R		T			TR	
Volume				654		98		543			328	436
Lane Width				12.0		12.0		12.0			12.0	
RTOR Vol						0						0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4	5	6	7	8
EB Left					NB Left			
Thru					Thru	P		
Right					Right			
Peds					Peds			
WB Left		P			SB Left			
Thru					Thru	P		
Right		P			Right	P		
Peds					Peds			
NB Right					EB Right			
SB Right					WB Right			
Green		41.0				41.0		
Yellow		3.0				3.0		
All Red		1.0				1.0		

Cycle Length: 90.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capcity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
Westbound								
L	1549	3400	0.44	0.456	17.6	B	17.3	B
R	714	1568	0.14	0.456	14.7	B		
Northbound								
T	2294	5036	0.25	0.456	15.3	B	15.3	B
Southbound								
TR	2098	4605	0.38	0.456	16.7	B	16.7	B

Intersection Delay = 16.5 (sec/veh) Intersection LOS = B

Phone:
E-Mail:

Fax:

OPERATIONAL ANALYSIS

Intersection:	SHELBY
City/State:	KWM
Analyst:	ALTERNATE A
Project No:	YEAR 2024 - AM PEAK
Time Period Analyzed:	6/7/99
Date:	I-40 WESTBOUND RAMPS
East/West Street Name:	CANADA ROAD
North/South Street Name:	

VOLUME DATA

	Eastbound			Westbound		Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume				654		98		543			328	436
PHF				0.95		0.95		0.95			0.95	0.95
PK 15 Vol				172		26		143			86	115
Hi Ln Vol					0							
% Grade				1900		1900		1900			1900	
Ideal Sat												
ParkExist												
NumPark				3		3		3			3	0
% Heavy Veh					2	0	1	0	3	0	0	3	0
No. Lanes	0	0	0		L		R		T			TR	
LGConfig				12.0		12.0		12.0			12.0		
Lane Width						0						0	
RTOR Vol				688		103		572			804		
Adj Flow													0.57
%InSharedLn													0
Prop Turns						0							
NumPeds			0			0		0			0		
NumBus				0									

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound			Westbound		Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet				0.0		0.0		0.0			0.0	
Arriv. Type				3		3		3			3	
Unit Ext.				3.0		3.0		3.0			3.0	
I Factor					1.000			1.000			1.000	
Lost Time				2.0		2.0		2.0			2.0	
Ext of g				2.0		2.0		2.0			2.0	
Ped Min g					0.0			0.0			0.0	

PHASE DATA

Phase Combination	1	2	3	4	5	6	7	8
EB Left					NB Left			
Thru					Thru	P		

	Right					Right	
	Peds					Peds	
WB	Left	P			SB	Left	
	Thru					Thru	P
	Right	P				Right	P
	Peds					Peds	
NB	Right				EB	Right	
SB	Right				WB	Right	
Green		41.0					41.0
Yellow		3.0					3.0
All Red		1.0					1.0

Cycle Length: 90.0 secs

VOLUME ADJUSTMENT WORKSHEET

Appr./ Movement	Mvt Volume	PHF	Flow Rate	No. Lanes	Lane Group	RTOR	Adjusted Flow Rate In Lane Grp	Prop. Left Turns	Prop. Right Turns
Eastbound				0					
Left				0					
Thru				0					
Right									
Westbound									
Left	654	0.95	688	2	L		688		
Thru				0					
Right	98	0.95	103	1	R	0	103		
Northbound									
Left				0					
Thru	543	0.95	572	3	T		572		
Right				0					
Southbound				0					
Left									
Thru	328	0.95	345	3	TR		804		0.57
Right	436	0.95	459	0		0			

* Value entered by user.

SATURATION FLOW ADJUSTMENT WORKSHEET

Appr/ Lane Group	Ideal Sat Flow	f W	f HV	f G	f P	f BB	f A	f LU	f RT	f LT	Adj Sat Flow
							Sec LT Adj/LT Sat:		----		
Eastbound					---					----	
							Sec LT Adj/LT Sat:				
Westbound											
L	1900	1.000	0.971	1.000	1.000	1.000	1.00	0.97	----	0.950	3400

R	1900	1.000	0.971	1.000	1.000	1.000	1.00	1.00	0.850	---- 1568
Northbound									Sec LT Adj/LT Sat: ----	
T	1900	1.000	0.971	1.000	1.000	1.000	1.00	0.91	1.000	1.000 ---- 5036
Southbound									Sec LT Adj/LT Sat: ----	
TR	1900	1.000	0.971	1.000	1.000	1.000	1.00	0.91	0.914	1.000 ---- 4605

CAPACITY ANALYSIS WORKSHEET

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Pri.							
Sec.							
Left							
Thru							
Right							
Westbound							
Pri.							
Sec.							
Left	L	688	3400	# 0.20	0.456	1549	0.44
Thru							
Right	R	103	1568	0.07	0.456	714	0.14
Northbound							
Pri.							
Sec.							
Left							
Thru	T	572	5036	0.11	0.456	2294	0.25
Right							
Southbound							
Pri.							
Sec.							
Left							
Thru	TR	804	4605	# 0.17	0.456	2098	0.38
Right							

Sum (v/s) critical = 0.38

Lost Time/Cycle, L = 8.00 sec Critical v/c(X) = 0.41

LEVEL OF SERVICE WORKSHEET

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Incremental Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
Westbound												
L	0.44	0.456	16.7	1.000	1549	0.50	0.9	0.0	17.6	B	17.3	B
R	0.14	0.456	14.3	1.000	714	0.50	0.4	0.0	14.7	B		
Northbound												
T	0.25	0.456	15.0	1.000	2294	0.50	0.3	0.0	15.3	B	15.3	B

Southbound

TR 0.38 0.456 16.2 1.000 2098 0.50 0.5 0.0 16.7 B 16.7 B

Intersection Delay = 16.5 (sec/veh) Intersection LOS = B

SUPPLEMENTAL PERMITTED LT WORKSHEET
for exclusive lefts

	EB	WB	NB	SB
APPROACH				
Cycle Length, C 90.0 sec				
Actual Green Time for Lane Group, G				
Effective Green Time for Lane Group, g				
Opposing Effective Green Time, go				
Number of Lanes in Lane Group, N				
Number of Opposing Lanes, No				
Adjusted Left-Turn Flow Rate, Vlt				
Proportion of Left Turns in Opposing Flow, Plto				
Adjusted Opposing Flow Rate, Vo				
Lost Time for Lane Group, tl				
Left Turns per Cycle: LTC=VltC/3600				
Opposing Flow per Lane, Per Cycle: Volc=VoC/3600fluo				
Opposing Platoon Ratio, Rpo (Table 9-2 or Eqn 9-7)				
gf=[Gexp(- a * (LTC ** b))]-tl, gf<=g				
Opposing Queue Ratio: qro=1-Rpo(go/C)				
gq=(4.943Volc**0.762)(qro**1.061)-tl, gq<=g				
gu =g-gq if gq>=gf, =g-gf if gq<gf				
n=(gq-gf)/2, n>=0				
Ptho=1-Plto				
Pl*=Plt[1+{(N-1)g/(gf+gu/El1+4.24)))				
El1 (Figure 9-7)				
El2=(1-Ptho**n)/Plto, El2>=1.0				
fmin=2(1+Plt)/g or fmin=2(1+Pl)/g				
gdiff=max(gq-gf,0)				
fm=[gf/g]+[gu/g][1/{1+Pl(El1-1)}], (min=fmin;max=1.00)				
flt=fm=[gf/g]+gdiff[1/{1+Plt(El2-1)}]				
+[gu/g][1/(1+Plt(El1-1))],(min=fmin;max=1.0) or flt=[fm+0.91(N-1)]/N**				
flt				

For special case of single-lane approach opposed by multilane approach, see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm. For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PERMITTED LT WORKSHEET
for shared lefts

	EB	WB	NB	SB
APPROACH				
Cycle Length, C 90.0 sec				
Actual Green Time for Lane Group, G				
Effective Green Time for Lane Group, g				
Opposing Effective Green Time, go				
Number of Lanes in Lane Group, N				

Number of Opposing Lanes, No
Adjusted Left-Turn Flow Rate, Vlt
Proportion of Left Turns in Lane Group, Plt
Proportion of Left Turns in Opposing Flow, Plto
Adjusted Opposing Flow Rate, Vo
Lost Time for Lane Group, tl
Left Turns per Cycle: LTC=VltC/3600
Opposing Flow per Lane, Per Cycle: Volc=VoC/3600fluo
Opposing Platoon Ratio, Rpo (Table 9-2 or Eqn 9-7)
gf=[Gexp(- a * (LTC ** b))]-tl, gf<=g
Opposing Queue Ratio: qro=1-Rpo(go/C)
gq=(4.943Volc**0.762)(qro**1.061)-tl, gq<=g
gu =g-gq if gq>=gf, =g-gf if gq<gf
n=(gq-gf)/2, n>=0
Ptho=1-Plto
Pl*=Plt[1+{(N-1)g/(gf+gu/El1+4.24)))
El1 (Figure 9-7)
El2=(1-Ptho**n)/Plto, El2>=1.0
fmin=2(1+Plt)/g or fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g][1/{1+Pl(El1-1)}], (min=fmin;max=1.00)
flt=fm=[gf/g]+gdiff[1/{1+Plt(El2-1)}]
+[gu/g][1/(1+Plt(El1-1)],(min=fmin;max=1.0) or flt=[fm+0.91(N-1)]/N**
flt Primary

For special case of single-lane approach opposed by multilane approach, see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm. For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

	EBLT	WBLT	NBLT	SBLT
Adj. LT Vol from Vol Adjustment Worksheet, v				
v/c ratio from Capacity Worksheet, X				
Primary phase effective green, g				
Secondary phase effective green, gq				
(From Supplemental Permitted LT Worksheet), gu				
Cycle length, C 90.0 Red =(C-g-gq-gu), r				
Arrivals: v/(3600(max(X,1.0))), qa				
Primary ph. departures: s/3600, sp				
Secondary ph. departures: s(gq+gu)/(gu*3600), ss				
XPerm				
XProt				
XCase				
Queue at beginning of green arrow, Qa				
Queue at beginning of unsaturated green, Qu				
Residual queue, Qr				
Uniform Delay, d1				

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay: Unadj. ds	Uniform Delay: Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec

HCS: Signals Release 3.1b

Inter:
Analyst: KWM
Date: 6/7/99
E/W St: I-40 WESTBOUND RAMPS

City/St: SHELBY
Proj #: ALTERNATE A - INTERIM 5-LANE
Period: YEAR 2024 - AM PEAK
N/S St: CANADA ROAD

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	0	0	2	0	1	2	2	0	0	2	0
LGConfig				L		R	L	T			TR	
Volume				654		98	819	543			328	436
Lane Width				12.0		12.0	12.0	12.0			12.0	
RTOR Vol						0						0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4	5	6	7	8
EB Left					NB Left	P		
Thru					Thru	P	P	
Right					Right			
Peds					Peds			
WB Left		P			SB Left			
Thru					Thru		P	
Right		P			Right		P	
Peds					Peds			
NB Right					EB Right			
SB Right					WB Right			
Green		24.0				28.0	26.0	
Yellow		3.0				3.0	3.0	
All Red		1.0				1.0	1.0	

Cycle Length: 90.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capcity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
Westbound								
L	907	3400	0.76	0.267	36.2	D	35.1	D
R	418	1568	0.25	0.267	27.3	C		
Northbound								
L	1058	3400	0.81	0.311	35.5	D	24.2	C
T	2259	3505	0.25	0.644	7.1	A		
Southbound								
TR	926	3205	0.87	0.289	41.2	D	41.2	D

Intersection Delay = 31.5 (sec/veh) Intersection LOS = C

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Intersection:	SHELBY
City/State:	KWM
Analyst:	ALTERNATE A - INTERIM 5-LANE
Project No:	YEAR 2024 - AM PEAK
Time Period Analyzed:	6/7/99
Date:	I-40 WESTBOUND RAMPS
East/West Street Name:	CANADA ROAD
North/South Street Name:	

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume				654		98	819	543			328	436
PHF				0.95		0.95	0.95	0.95			0.95	0.95
PK 15 Vol				172		26	216	143			86	115
Hi Ln Vol					0			0			0	
% Grade				1900		1900	1900	1900			1900	
Ideal Sat												
ParkExist											3	0
NumPark				3		3	3	3		0	2	0
% Heavy Veh				2	0	1	2	2	0		TR	
No. Lanes	0	0	0	L		R	L	T			12.0	
LGConfig				12.0		12.0	12.0	12.0			0	
Lane Width						0					804	
RTOR Vol				688		103	862	572				0.57
Adj Flow												0
%InSharedLn												
Prop Turns						0					0	
NumPeds			0			0	0	0				
NumBus				0								

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet				0.0		0.0	0.0	0.0			0.0	
Arriv. Type				3		3	3	3			3	
Unit Ext.				3.0		3.0	3.0	3.0			3.0	
I Factor					1.000			1.000			1.000	
Lost Time				2.0		2.0	2.0	2.0			2.0	
Ext of g				2.0		2.0	2.0	2.0			2.0	
Ped Min g					0.0			0.0			0.0	

PHASE DATA

Phase Combination	1	2	3	4		5	6	7	8
					NB Left	P			
EB Left					Thru	P	P		
Thru									

	Right			Right	
	Peds			Peds	
WB	Left	P	SB	Left	
	Thru			Thru	P
	Right	P		Right	P
	Peds			Peds	
NB	Right		EB	Right	
SB	Right		WB	Right	
Green		24.0		28.0	26.0
Yellow		3.0		3.0	3.0
All Red		1.0		1.0	1.0

Cycle Length: 90.0 secs

VOLUME ADJUSTMENT WORKSHEET

Appr./ Movement	Mvt Volume	PHF	Flow Rate	No. Lanes	Lane Group	RTOR	Adjusted Flow Rate In Lane Grp	Prop. Left Turns	Prop. Right Turns
Eastbound				0					
Left				0					
Thru				0					
Right									
Westbound									
Left	654	0.95	688	2	L		688		
Thru				0					
Right	98	0.95	103	1	R	0	103		
Northbound									
Left	819	0.95	862	2	L		862		
Thru	543	0.95	572	2	T		572		
Right				0					
Southbound				0					
Left				2	TR		804		0.57
Thru	328	0.95	345	0		0			
Right	436	0.95	459						

* Value entered by user.

SATURATION FLOW ADJUSTMENT WORKSHEET

Appr/ Lane Group	Ideal Sat Flow	f W	f HV	f G	f P	f BB	f A	f LU	f RT	f LT	Adj Sat Flow
							Sec LT Adj/LT Sat:		----		
Eastbound					---					----	
							Sec LT Adj/LT Sat:				
Westbound											
L	1900	1.000	0.971	1.000	1.000	1.000	1.00	0.97	----	0.950	3400

R	1900	1.000	0.971	1.000	1.000	1.000	1.00	1.00	0.850	---- 1568
							Sec	LT Adj/LT	Sat:	
Northbound										
L	1900	1.000	0.971	1.000	1.000	1.000	1.00	0.97	----	0.950 3400
T	1900	1.000	0.971	1.000	1.000	1.000	1.00	0.95	1.000	1.000 3505

							Sec	LT Adj/LT	Sat:	
Southbound									----	
TR	1900	1.000	0.971	1.000	1.000	1.000	1.00	0.95	0.914	1.000 3205

CAPACITY ANALYSIS WORKSHEET

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Pri.							
Sec.							
Left							
Thru							
Right							
Westbound							
Pri.							
Sec.							
Left	L	688	3400	# 0.20	0.267	907	0.76
Thru							
Right	R	103	1568	0.07	0.267	418	0.25
Northbound							
Pri.							
Sec.							
Left	L	862	3400	# 0.25	0.311	1058	0.81
Thru	T	572	3505	0.16	0.644	2259	0.25
Right							
Southbound							
Pri.							
Sec.							
Left							
Thru	TR	804	3205	# 0.25	0.289	926	0.87
Right							

Sum (v/s) critical = 0.71

Lost Time/Cycle, L = 12.00 sec Critical v/c(X) = 0.82

LEVEL OF SERVICE WORKSHEET

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor Del k	Incremental Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
Westbound												
L	0.76	0.267	30.3	1.000	907	0.50	5.9	0.0	36.2	D	35.1	D
R	0.25	0.267	25.9	1.000	418	0.50	1.4	0.0	27.3	C		
Northbound												
L	0.81	0.311	28.6	1.000	1058	0.50	6.9	0.0	35.5	D	24.2	C
T	0.25	0.644	6.8	1.000	2259	0.50	0.3	0.0	7.1	A		

Southbound

TR 0.87 0.289 30.4 1.000 926 0.50 10.8 0.0 41.2 D 41.2 D

Intersection Delay = 31.5 (sec/veh) Intersection LOS = C

SUPPLEMENTAL PERMITTED LT WORKSHEET
for exclusive lefts

	EB	WB	NB	SB
APPROACH				
Cycle Length, C 90.0 sec				
Actual Green Time for Lane Group, G				
Effective Green Time for Lane Group, g				
Opposing Effective Green Time, go				
Number of Lanes in Lane Group, N				
Number of Opposing Lanes, No				
Adjusted Left-Turn Flow Rate, Vlt				
Proportion of Left Turns in Opposing Flow, Plto				
Adjusted Opposing Flow Rate, Vo				
Lost Time for Lane Group, tl				
Left Turns per Cycle: LTC=VltC/3600				
Opposing Flow per Lane, Per Cycle: Volc=VoC/3600fluo				
Opposing Platoon Ratio, Rpo (Table 9-2 or Eqn 9-7)				
gf=[Gexp(- a * (LTC ** b))]-tl, gf<=g				
Opposing Queue Ratio: qro=1-Rpo(go/C)				
gq=(4.943Volc**0.762)(qro**1.061)-tl, gq<=g				
gu =g-gq if gq>=gf, =g-gf if gq<gf				
n=(gq-gf)/2, n>=0				
Ptho=1-Plto				
Pl*=Plt[1+{(N-1)g/(gf+gu/El1+4.24)))				
El1 (Figure 9-7)				
El2=(1-Ptho**n)/Plto, El2>=1.0				
fmin=2(1+Plt)/g or fmin=2(1+Pl)/g				
gdiff=max(gq-gf,0)				
fm=[gf/g]+[gu/g][1/{1+Pl(El1-1)}], (min=fmin;max=1.00)				
flt=fm=[gf/g]+gdiff[1/{1+Plt(El2-1)}] +[gu/g][1/(1+Plt(El1-1)],(min=fmin;max=1.0) or flt=[fm+0.91(N-1)]/N**				
flt				

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm. For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PERMITTED LT WORKSHEET
for shared lefts

	EB	WB	NB	SB
APPROACH				
Cycle Length, C 90.0 sec				
Actual Green Time for Lane Group, G				
Effective Green Time for Lane Group, g				
Opposing Effective Green Time, go				
Number of Lanes in Lane Group, N				

Number of Opposing Lanes, No
Adjusted Left-Turn Flow Rate, Vlt
Proportion of Left Turns in Lane Group, Plt
Proportion of Left Turns in Opposing Flow, Plto
Adjusted Opposing Flow Rate, Vo
Lost Time for Lane Group, tl
Left Turns per Cycle: LTC=VltC/3600
Opposing Flow per Lane, Per Cycle: Volc=VoC/3600fluo
Opposing Platoon Ratio, Rpo (Table 9-2 or Eqn 9-7)
gf=[Gexp(- a * (LTC ** b))]-tl, gf<=g
Opposing Queue Ratio: qro=1-Rpo(go/C)
gq=(4.943Volc**0.762)(qro**1.061)-tl, gq<=g
gu =g-gq if gq>=gf, =g-gf if gq<gf
n=(gq-gf)/2, n>=0
Ptho=1-Plto
Pl*=Plt[1+{(N-1)g/(gf+gu/El1+4.24)})
El1 (Figure 9-7)
El2=(1-Ptho**n)/Plto, El2>=1.0
fmin=2(1+Plt)/g or fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g][1/{1+Pl(El1-1)}], (min=fmin;max=1.00)
flt=fm=[gf/g]+gdiff[1/{1+Plt(El2-1)}]
+[gu/g][1/(1+Plt(El1-1)],(min=fmin;max=1.0) or flt=[fm+0.91(N-1)]/N**
flt Primary

For special case of single-lane approach opposed by multilane approach, see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm. For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

	EBLT	WBLT	NBLT	SBLT
Adj. LT Vol from Vol Adjustment Worksheet, v				
v/c ratio from Capacity Worksheet, X				
Primary phase effective green, g				
Secondary phase effective green, gq				
(From Supplemental Permitted LT Worksheet), gu				
Cycle length, C 90.0 Red =(C-g-gq-gu), r				
Arrivals: v/(3600(max(X,1.0))), qa				
Primary ph. departures: s/3600, sp				
Secondary ph. departures: s(gq+gu)/(gu*3600), ss				
XPerm				
XProt				
XCase				
Queue at beginning of green arrow, Qa				
Queue at beginning of unsaturated green, Qu				
Residual queue, Qr				
Uniform Delay, d1				

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec

JBK P+D
4353
Respond
cc Hon.
am

City of Lakeland

October 05, 1998

TDOT

The Honorable Don Sundquist
State Capital Building
Nashville, Tennessee 37243-5081

Dear Governor Sundquist:

As Mayor of the City of Lakeland, I am asking you as our Honorable Governor to inquire about what action you and the State of Tennessee Department of Transportation may have planned to make improvements to the Canada Road/I-40 interchange.

It has been numerous business owners and Lakeland Citizens concerned about the safety at Canada Road and I-40 due to the tremendous traffic flow in this area. Plans were announced just recently to develop a one million square foot shopping mall at Canada and I-40 on a 121 acre tract on the North/West of the interchange.

In the past twelve (12) months, there has been tremendous interest to develop Residential lots. Research by my Planning Staff indicates that west of Chambers Chapel Road and south of Memphis-Arlington Road and north of I-40 will result in approximately 2,188 lots and at present the Municipal Planning Commission has approved 853 lots that will develop within the next several months. Lakeland is in the geographic path of progress and the growth potential is great in the near future. The traffic in Lakeland is increasing and getting to the point of congestion at peak hours with tractor trailers having problems entering and exiting the narrow inadequate ramps and overpass due to the increased population in the last couple of years. On Numerous occasions there have been traffic accidents and the guard rails have been destroyed at I-40 and Canada Road by the numerous tractor trailer who use this exit daily. Lakeland's population at this time is approximate 6,000 and growing and I feel this interchange will be more inadequate and close to impassable very soon.

As Mayor of Lakeland, I respectfully request that you consider taking action soon to resolve this problem and make I-40 and Canada Road a safe interchange to accommodate present and future growth and development.

As you know, the State some time in the past acquired the additional right of way needed for widening I-40 and Canada Road. Now with progress and the recent

10001 U.S. Highway 70 • Lakeland, TN 38002 • (901) 867-2717 Phone • (901) 867-2063 Fax
email: LAKELAND7@aol.com.

improvements to I-40 and U.S. Highway 64 and I-40 and Paul Barrett Parkway and with the City of Lakeland's tremendous growth present and in the near future the traffic is beginning to increase quickly due to Houston Levee/U.S. Highway 64 recent widening. Traffic signals are needed to allow better traffic flow and I am asking you and the State of Tennessee to seriously consider these necessary safety improvements which will address the concerns of Lakeland Citizens, tourist, motorist and businesses using this interchange at I-40 and Canada Road. Also Canada Road from U.S. Highway 64 North to I-40 needs widening to properly handle the traffic flow in this area.

I appreciate your consideration and hope you can make the City of Lakeland, Tennessee, a safer City to live in and conduct business. Lakeland's future depends on your help.

If you have any questions please give me a call.

Respectfully,

Jim Bomprezzi

Jim Bomprezzzi
Mayor
City of Lakeland, Tennessee

cc:

Mayor Jim Rout
Senator Tom Leatherwood
State Representative's
Ed Haley
Bubba Pleasant
Curry Todd
DOT Commissioner Saltsman
County Commissioner's
Clair Vander Schaaf
Tommy Hart
Mark Norris
Municipal planning Commision
Chairman Richard Hazlett

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
SUITE 700, JAMES K. POLK BUILDING
NASHVILLE, TENNESSEE 37243-0349

DON SUNDQUIST
GOVERNOR

J. BRUCE SALTSMAN, SR.
COMMISSIONER

October 27, 1998

Honorable Jim Bomprezzi
Mayor, City of Lakeland
10001 Highway 70
Lakeland, Tennessee 38002

SUBJECT: Canada Road / I-40 Interchange
in Lakeland, Shelby County

Dear Mayor Bomprezzi:

In response to your letter, I would like to thank you for sharing your concerns as they relate to traffic flow on the Canada Road / I-40 Interchange and motorist safety in your area.

Your request is being forwarded to the Planning Division for integration into their work program. A study will be initiated to ascertain the needs in this interchange area. The estimated time frame for this to be accomplished is between ten and twelve months.

In the event you have more information or questions regarding this issue, please call Mr. Jerry Moorhead at (615) 741-3629.

Sincerely,

J. Bruce Saltsman, Sr.
Commissioner

JBS/JCM/gm

Copy: Governor Don Sundquist

Blind Copy: Commissioner Saltsman
Bill Moore
William C. Wallace
Glenn A. Beckwith
Jerry C. Moorhead

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
SUITE 700, JAMES K. POLK BUILDING
NASHVILLE, TENNESSEE 37243-0349

DON SUNDQUIST
GOVERNOR

J. BRUCE SALTSMAN, SR.
COMMISSIONER

August 16, 1999

The Honorable Curtis Person, Jr.
State Senator
Suite 308, War Memorial Building
Nashville, Tennessee 37243-0031

Dear Senator Person:

This responds to your recent letter submitting correspondence from Mayor James Bomprezzi of Lakeland. In his letter, Mayor Bomprezzi expressed strong support for needed improvements at the Interstate 40 and Canada Road interchange.

The determination of improvements to existing highway facilities, as well as the need for new facilities, grows out of a cooperative and comprehensive transportation planning process that is undertaken by the Memphis Metropolitan Planning Organization or MPO. That organization is an umbrella planning agency for the Memphis Urban Area consisting of the City of Memphis, Shelby County, western portion of Fayette County and northern portion of Desoto County, Mississippi. The State of Tennessee, as a member of the MPO Executive Board, is directly involved in the development and adoption of the long-range transportation plan.

We have determined from our inspection of the *Memphis MPO Transportation Plan 2020*, Canada Road is a local road proposed to be widened to a seven-lane roadway between US-64 (Stage Road) and US-70 (Summer Avenue), including interchange improvements at Interstate 40. The project is shown as a priority one in the long-range transportation plan. However, no implementation schedules have been established to date and no funds have been budgeted for the project.

It should be noted the Department is preparing a study to determine the improvements needed, including the possibility of traffic signals, at the Interstate 40 and Canada Road interchange. The study should be completed early next year, and we would be pleased to share this information with you.

I appreciate your interest and concern for the safety of the transportation system in the Memphis area and invite you to call upon me if I may be of further assistance.

Sincerely,

J. Bruce Saltsman, Sr.
Commissioner

JBS:RK:rk

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
PLANNING DIVISION
SUITE 900, JAMES K. POLK BLDG.
505 DEADERICK STREET
NASHVILLE, TENNESSEE 37243-0334

February 9, 1999

Mr. Charles Graves, Manager 1
Functional Design Office
Suite 1000, James K. Polk Building
Nashville, Tennessee 37243

Subject: *Advance Planning Report, Interchange Modification I-40 with Canada Rd. Shelby County.*

Dear Mr. Graves:

The Memphis MPO Major Road Plan, which was amended May, 1995, shows Canada Road, as a Priority 1 (next 10 years) south of I-40 and as a Priority 2 (next 10-20 years) north of I-40.

The Proposed typical section on Canada Road is shown as a 6 lane undivided, with a center turn lane on 108' of Right-Of Way, an 88'/108' section.

If you have any questions, please contact me.

Sincerely,

Harold Clawson

for Bill Jacobs,
Manager 1
Transportation Planning Office

Copies: *Mr. Glenn Beckwith*
Mr. Jerry Moorhead
Mr. Harold Clawson

MEMORANDUM

To: Distribution

From: Ed Cain

Date: June 10, 1999

Subject: Field Review, I-40/Canada Road Interchange Modification Study

A field review was conducted for the subject IMS on June 9, 1999. The following were in attendance:

Elizabeth Smith	TDOT, Planning Division
Charlie Graves	TDOT, Functional Design Office
Joe Warren	TDOT, Region IV Traffic
Ed Cain	Parsons Transportation Group
Kenneth Monroe	Parsons Transportation Group

The following items were reviewed/discussed:

1. An information packet containing traffic data and other project information was distributed. The existing interchange configuration is a compressed (urban) diamond with Canada Road over I-40. Existing Canada Road is a two-lane section through the interchange area with no left-turn lanes or signals at the ramp terminals. Existing I-40 has four lanes through the interchange area, and the taper lengths of the exit and entrance terminals are not to current standards. The functional drawings for the modification plan developed by TDOT were reviewed and discussed. This plan consists of widening Canada Road to the west to provide a nine-lane section within the interchange area, providing double left-turn lanes for northbound Canada Road to westbound I-40 traffic. This would entail replacing the existing structure over I-40. A single left-turn lane would be provided for the southbound Canada Road to eastbound I-40 move. Both off-ramps will be widened to provide three lanes at Canada Road, double left-turn lanes and a right-turn lane. The westbound on-ramp will be widened to provide two lanes at Canada Road. No widening is proposed for the eastbound on-ramp. All exit and entrance terminals will be reconstructed to current standards, but will remain single-lane terminals. Traffic signals will be provided at the ramp terminals on Canada Road.

2. Capacity analyses, based on the Highway Capacity Manual (HCM), showed that the existing interchange would operate at Level-of-Service (LOS) C in Year 2004, and LOS F in the design year (2024) if no improvements are made to the interchange. With the improvements described above, the interchange would operate at LOS C in Year 2004, and LOS D in Year 2024. It was also noted that the west oriented I-40 terminals would operate at a low LOS in

the design year, without the construction of additional traffic lanes on I-40. Elizabeth Smith will check on the programming for adding the additional lanes on I-40.

3. It was noted that the capacity analyses considered each of the signalized terminals separately and not as a related system. With this approach the required storage for the left turns from Canada Road onto the entrance ramps was not addressed. It was agreed that further analyses should be made that would consider the two signals as an integrated system, and would determine the required storage length for the aforementioned left turns.

4. The proximity (300' +/-) of the intersection of Canada Road and Huff'n Puff Road to the north interchange terminal was discussed. Huff'n Puff Road acts as a frontage road running along the north side of I-40 east of Canada Road. It presently serves recent development in the northeast quadrant of the interchange, including a Days Inn Motel and a Super 8 Motel. Traffic projections were not available for Huff'n Puff Road. It was suggested that this intersection should be relocated to the north approximately 800', opposite the intersection of Davies Plantation Road East and Canada Road. It was agreed that this relocation should be shown on the functional plans as a desirable design alternative, and should be costed separately.

5. The Memphis-Shelby County Major Road Plan calls for Canada Road to be improved to a six-lane urban section with a continuous left-turn lane (88'/108' section). It appears that the remainder of the 108' of right-of-way has been dedicated along recent development on the west side of Canada Road in the vicinity of the interchange.

6. At present, control of access does not extend to the required 100' along Canada Road from the ramp ER's. It was agreed that as part of this improvement, additional A/C should be acquired along Canada Road to achieve the 100' requirement. This will impact existing access to developments that abut the existing ramps.

7. It was noted that impacts to existing developments along Canada Road in the vicinity of the interchange would be substantial due the widening of Canada Road and the acquiring of additional access control. It was suggested that the cost of acquiring some of these properties in total could cost relatively little more than paying for the damages resulting from the widening and acquiring of additional A/C. Purchasing the properties in total would perhaps allow for more substantial improvements to the interchange that would provide for more efficient operation.

8. An alternative prepared by PTG in single-line sketch format was reviewed. This plan proposed a loop in the northeast quadrant to serve the northbound Canada Road to westbound I-40 move. This alternative would result in major right-of-way impacts to adjoining development, and a slightly improved LOS compared to the previously discussed improvement. It was agreed that this alternative should be developed to include preparation of cost estimates so that comparisons can be made to the plan proposed by TDOT. PTG will prepare a single-line sketch and, as previously agreed, TDOT will prepare functional drawings and cost estimates for the alternative. It was suggested that the alternative would

entail closely spaced successive entrance terminals on I-40, and the capacity of the terminals should be checked. Also a C-D road might be required for acceptable operation of this configuration.

9. An interim alternative was also investigated. This would entail phased construction of the improvement proposed by TDOT so that initially, less than the nine-lane section would be constructed in the interchange area. Capacity analyses showed that a seven-lane section would provide acceptable levels-of-service for the design year. However, it was noted that this analysis did not consider required storage lengths for the left turns, and that overall, an interim phase may not be cost effective because of reconstruction required for the second phase. An advantage of the interim phase is that the more narrow section would be more compatible with existing Canada Road and more compatible with five-lane interim construction on Canada Road. It was agreed that PTG will prepare a single-line sketch of the interim alternative, and TDOT will prepare cost estimates and functional drawings as required.

(1)

Sept 27, 1999

Memorandum

TO: Jerry C. Moorhead Manager
Transportation Planning Office

From Charles T. Graves Manager
Functional Planning Office

Subject: Advance Planning Report
Interchange Modification Pla
I-40 at Canada Road
Shelby County

Please refer to our April 15, 19
Memorandum in regard to the Subject
Report. We conducted a functional
plan that would improve Canada
Road to a basic seven (7) lan
section with additional accelera
lanes to facilitate turning vehic
The diamond ramps were modified
to accodate additional turning
lanes. Cost estimates and a
D-5-1 form also were attached
to this correandance.

Since that date, we have been
requested to provide an additio

(2)

plan that would add a loop ramp in the northeast quadra
We also prepared a study to
relocate Huff-N-Puff Road. The
relocation will be necessary with
the loop plan but optional with
the modified diamond plan.

Our estimated costs for the loo
plans and the relocation of
Huff-N-Puff Road are as follow

Loop Plan

5,610,000
510,000
1,530,000
1,200,000
15,865,000

	Construction Cost	$ 4,940,0
	Preliminary Eng Cost	$ 450,0
	Right-of-Way Cost	$ 8,545,0
(local)	Utility Adjustment Cost	$ 55,0
(state)	Utility Adjustment Cost	$ 65,0
	Total Cost	$ 14,055,0

Relocation Huff-N-Puff Road

	Construction Cost	$ 595,00
	Preliminary Eng Cost	$ 55,00
	Right-of-Way Cost	$ 1,875,00
(local)	Utility Adjustment Cost	$ 5,00
(state)	Utility Adjustment Cost	$ 5,00
	Total Cost	$ 2,535,0

(3)

We are providing you with the original footing plans for the plan along with copies of the D.S.I forms and cost break downs. The proposed typical sanitary for Canada Road (60SC) is the same for each plan with the exception of turn lanes and manhole locations. If you have any questions or require additional information, please feel free to call one us.

CTG
attachments
CC
Marston
Langley
Comer
Jones
Bisson
Wasserman
Tidwell
Jim Watts
file

TENNESSEE DEPARTMENT OF TRANSPORTATION

DESIGN CRITERIA FOR LOCATION AND DESIGN PHASE

ROUTE Huff-N. Duff Road ALTERNATE _____ SECTION _____

REGION 4 COUNTY Shelby PROJECT _____

LOCATION: FROM Canada Road

TO 0.35± mile east

19___ ADT	
_____ ADT	
PERCENT TRUCKS	
DHV	
FUNCTIONAL CLASSIFICATION	local
MINIMUM DESIGN SPEED	40 mph
ACCESS CONTROL	N/A
MAXIMUM CURVE	(possible future urban section) 10°-00' (SE:0.04)
MAXIMUM GRADE	7%
MINIMUM STOPPING SIGHT DISTANCE	275'-325'
SURFACE WIDTH	2@12'
NUMBER OF LANES	2
USEABLE SHOULDER WIDTH	2@8'
MEDIAN WIDTH	N/A
MINIMUM RIGHT-OF-WAY	* 100
SIGNALIZATION	Canada Road

REMARKS See attached letter and functional plans for additional information. Actual right-of-way to be determined by slope limits. The right-of-way width will allow for a future five (5) lane urban section if traffic warrants

9-27-99

Route: ~~Canada Road~~ I-40
Description: ~~From~~ Interchange Modification at Canada Road (Diamond with loop
~~To~~
County: Shelby
~~Length~~:
Date: 9-27-99

CLEAR AND GRUBBING	$ 20,000
EARTHWORK	$ 320,000
PAVEMENT REMOVAL	$ 55,000
DRAINAGE	$ 195,000
STRUCTURES	$ 2,345,000
RAILROAD CROSSING OR SEPARATION	$ N/A
PAVING	$ 1,050,000
RETAINING WALLS	$ 75,000
MAINTENANCE OF TRAFFIC	$ 110,000
TOPSOIL	$ 12,000
SEEDING	$ 8,000
SODDING	$ 25,000
SIGNING	$ 100,000
LIGHTING	$ N/A
SIGNALIZATION	$ 100,000
FENCE	$ 20,000
GUARDRAIL	$ 40,000
RIP RAP OR SLOPE PROTECTION	$ 15,000
OTHER CONST. ITEMS (8.5%)	$ 400,000
MOBILIZATION	$ 210,000
CONSTRUCTION COST	$ 5,100,000
10% ENG. & CONT.	$ 510,000
TOTAL CONSTRUCTION COST	$ 5,610,000
10% PRELIMINARY ENGINEERING	$ 510,000
TOTAL COST	$ 6,120,000

50
~~4,490~~
~~4,700~~
5,100

Prepared by Special Design & Estimates Office

Route: Relocated Huff-N-Puff Road
Description: From: Canada Road
TO: 0.35 ± mile east
County: Shelby
Length: 0.35 ± miles
Date: 9.27.99

CLEAR AND GRUBBING	$ 5,000
EARTHWORK	$ 125,000
PAVEMENT REMOVAL	$ 5,000
DRAINAGE	$ 125,000
STRUCTURES	$ N/A
RAILROAD CROSSING OR SEPARATION	$ N/A
PAVING	$ 155,000
RETAINING WALLS	$ N/A
MAINTENANCE OF TRAFFIC	$ 5,000
TOPSOIL	$ 3,000
SEEDING	$ 2,000
SODDING	$ 5,000
SIGNING	$ 5,000
LIGHTING	$ N/A
SIGNALIZATION 475 ~~800~~	$ 40,000
FENCE	$ N/A
GUARDRAIL	$ N/A
RIP RAP OR SLOPE PROTECTION	$ N/A
OTHER CONST. ITEMS (8.5%)	$ ~~40~~ 40,000
MOBILIZATION	$ 25,000
CONSTRUCTION COST	$ 540,000
10% ENG. & CONT.	$ 55,000
TOTAL CONSTRUCTION COST	$ 595,000
10% PRELIMINARY ENGINEERING	$ 55,000
TOTAL COST	$ 650,000

Prepared by Special Design & Estimates Office

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
NASHVILLE, TENNESSEE 37243-0337

August 20, 1999

Mr. Charles Graves
Transportation Manager I
Suite 1000, James K. Polk Bldg.
Nashville, TN 37243

RE: Right-of-Way and Utility
Relocation Cost Estimates
Interchange Modifications I-40 with
Canada Road and Relocated Huff-N-Puff
Road
Shelby County

Dear Mr. Graves:

Please find enclosed the Right-of-Way and Utility Relocation Cost Estimates, which your office requested for the above referenced project.

There are relocations required for this project, therefore marked up plans were returned.

Sincerely,

Jeffery D. Hoge
Transportation Manager I
Central Right-of-Way Office

JDH:nj1

Enclosure

TENNDOT

REVISED ESTIMATE

DT-0172

ROW FORM 44-A

RIGHT-OF-WAY REPORT FOR LOCATION STUDY

STATE PROJ. 99101-5226-04 COUNTY SHELBY

FEDERAL PROJ. N/A PROJ. DESC. Interchange Modification at I-40 and Canada Road

ESTIMATED RIGHT-OF-WAY COSTS

COST ITEMS	SEC I EST.COST	SEC II EST.COST	SEC EST.COST	SEC EST.COST	SEC. EST.COST
LAND REQUIRED	$1,717,415.00	$5,044,230.00	$	$	$
ACRES	4.77 acres	14.01 acres			
IMPROVEMENTS	$ 21,602.00	$ 3,204,400.00	$	$	$
NUMBER	Asphalt and Landscaping	4 businesses			
DAMAGES	$ 100,813.00	$180,022.00	$	$	$
INCIDENTALS	$ 34,020.00 6 tracts	$ 68,040.00 12 tracts	$	$	$
RESIDENTIAL RELOC.	$N/A	$ N/A	$	$	$
NUMBER	N/A	N/A			
BUSINESS & FARM RELOC.	$ N/A	$45,360.00	$	$	$
NUMBER	N/A	4			
TOTAL EST. COST OF ROW	$1,873,850.00	$8,542,052.00	$	$	$

REMARKS: This estimate was prepared from aerial photographs with acquisition areas calculated on plans. The land value was estimated at $250,000.00 per acre or $5.75 per sq.ft. due to the Interstate Influence. There are three gas stations located on the project area within the acquisition area with underground tanks. The gas stations are located on plans.

PREPARED BY

NAME

August 4, 1999

DATE

RECOMMENDED

Bobby Jonson

NAME

August 4, 1999

DATE

APPROVED

NAME

August 4, 1999

DATE

May 17, 1982

STATE OF TENNESSEE – DEPARTMENT OF HIGHWAYS

UTILITY REPORT FOR LOCATION STUDY

ROUTE I-40 ALTERNATE

PROJECT NO. INTERCHANGE MODIFICATION COUNTY SHELBY

FROM I-40 WITH CANADA ROAD

TO

UTILITY	TOTAL COST OF ADJUSTMENTS	REIMBURSABLE BY STATE
CITY OF LAKE LAKELAND (SEWER)	$ 22000	$ 19800
MEMPHIS LIGHT, GAS + WATER DIV. (GAS)	$ 21600	$ 10800
" " " " " (WATER)	$ 33000	$ 16500
" " " " " (ELECT.)	$ 22500	$ 12000
BELLSOUTH (TEL.)	$ 16200	$ 1200
TIME WARNER COMM. (TV)	$ 6000	$ 2000
	$	$
	$	$
	$	$
	$	$
	$	$
TOTAL	$ 121300	$ 62300

REMARKS: THE PROPOSED RIGHT-OF-WAY FOR INTERCHANGE MODIFICATION I-40 @ CANADA ROAD 14.01± ACRES

PREPARED BY: John Barker 8/12/99
ENGINEER – UTILITIES DATE

RAILROAD INVOLVED YES (NO)

May 17, 1982

STATE OF TENNESSEE – DEPARTMENT OF HIGHWAYS

UTILITY REPORT FOR LOCATION STUDY

ROUTE I-40 ALTERNATE

PROJECT NO. INTERCHANGE MODIFICATION COUNTY SHELBY

FROM RELOCATED HUFF-N-PUFF ROAD

TO

UTILITY	TOTAL COST OF ADJUSTMENTS	REIMBURSABLE BY STATE
CITY OF LAKELAND (SEWER)	$ 2200	$ 2200
MEMPHIS LIGHT, GAS + WATER DIV. (WATER)	$ 1000	$ 000
" " " " " (ELECT.)	$ 000	$ 000
BELLSOUTH, (TEL.)	$ 7200	$ 000
	$	$
	$	$
	$	$
	$	$
	$	$
	$	$
	$	$
TOTAL	$ 10400	$ 2200

REMARKS: THE PROPOSED RIGHT-OF-WAY FOR RELOCATED HUFF-N-PUFF ROAD 4.77 ± ACRES

PREPARED BY: John Barker 8/12/82
ENGINEER – UTILITIES DATE

RAILROAD INVOLVED YES (NO)

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
Functional Design Office
SUITE 1000, JAMES K. POLK BUILDING
NASHVILLE, TENNESSEE 37243-0350

Phone: (615) 741-0978

Fax: (615) 532-0353

MEMORANDUM

TO: Jerry C. Moorhead, Transportation Manager II
Transportation Planning Office

FROM: Charles T. Graves, Transportation Manager I
Functional Design Office

DATE: April 15, 1999

SUBJECT: Advance Planning Report
Interchange Modification Plan
I-40 at Canada Road
Shelby County

At your request, this office has developed functional plans and cost estimates on the subject project. The major route plan on Canada Road calls for six (6) traffic lanes, turn lanes and curbs and gutters within an 108' right-of-way. I-40 is four (4) lanes with 60' median. The interstate will probably be widened to six-eight lanes in the future.

It is proposed to replace the bridge over I-40 with a nine (9) lane structure with curbs and gutters and sidewalks. The typical section will provide three (3) traffic lanes in each direction, double left-turn lane southbound and single turn lane northbound. This section will taper to the standard seven (7) lane section north and south of the ramp terminals. TDOT's participation will end at the north and south limits of the interchange on Canada road. Most of the widening will take place on the west side of Canada Road. This will facilitate the maintenance of traffic when the existing bridge is removed.

It is proposed to signalize the ramp terminals with the signals coordinated together to provide optimum operation capacity. All the ramps will be modified in order to provide for double left turns with the exception of the eastbound on-ramp. The acceleration and deceleration ramps will be re-constructed in order to provide standard tapers.

Our estimated costs to construct the proposed improvements are:

Construction Cost	$ 4,940,000
Preliminary Engineering Cost	$ 450,000
Right-of-Way Cost	$ 1,245,000
(local) Utility Adjustment Cost	$ 20,000
(state) Utility Adjustment Cost	$ 40,000
Total Cost	**6,695,000**

We are providing you with the original functional plans and copies of the D.-S. 1 form and cost breakdowns. If you have any questions or require additional assistance, please feel free to call on us.

CTG/jf

Attachments

Cc: Mr. Bill Wallace
Mr. Harris Scott
Mr. Jim Zeigler
Mr. Glenn Beckwith
Mr. Ray Brisson
Mr. John Tidwell
Mr. Ed Wasserman
File

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
NASHVILLE, TENNESSEE 37243-0337

March 31, 1999

Mr. Charles Graves
Roadway Supervisor Specialist II
Suite 1000, James K. Polk Bldg.
Nashville, TN 37243

RE: Right-of-Way and Utility
Adjustment Cost Estimates
Interchange Modification I-40
with Canada Road
Shelby County

Dear Mr. Graves:

Attached are the Right-of-Way and Utility Adjustment Cost Estimates Reports for the Location Study, which you office requested for the above referenced project.

There are no relocations required for this project, therefore no marked up plans were returned.

Sincerely,

Jeffery D. Hoge
Transportation Manager I
Central Right-of-Way Office

JDH:nj1

Attachments

TENNDOT

ROW FORM 44-A

REVISED ESTIMATE

DT-0172

RIGHT-OF-WAY REPORT FOR LOCATION STUDY

STATE PROJ. 99101-5226-04 COUNTY SHELBY

FEDERAL PROJ. N/A PROJ. DESC. Interchange Modification at I-40 and Canada Road

ESTIMATED RIGHT-OF-WAY COSTS

COST ITEMS	SEC EST.COST	SEC EST.COST	SEC EST.COST	SEC EST.COST	SEC. EST.COST
LAND REQUIRED	$1,008,126.00	$	$	$	$
ACRES	2.80 acres				
IMPROVEMENTS	$ 22,322.00	$	$	$	$
NUMBER	7 Business Lights,& 1 business sign				
DAMAGES	$ 187,223.00	$	$	$	$
INCIDENTALS	$ 28,350.00 9 tracts	$	$	$	$
RESIDENTIAL RELOC.	$N/A	$	$	$	$
NUMBER	N/A				
BUSINESS & FARM RELOC.	$ N/A	$	$	$	$
NUMBER	N/A				
TOTAL EST. COST OF ROW	$1,246,000.00®	$	$	$	$

REMARKS: This revised estimate was due to a mathematical error which land value was supposed to be value at $250,000.00 per acre not $25,000.00 per acre or $5.75 per sq.ft. due to Interstate Influence. There are four gas stations located on the project area with underground tanks. It appears after a field inspection of the project that the North-West quadrant of project has been dedicated as right-of-way from appearance only of tracts involved. The estimate was prepared from aerial phothographs with acquisition areas calculated on plans.

PREPARED BY

NAME

4-15-99
DATE

RECOMMENDED

NAME

4-15-99
DATE

APPROVED

NAME

4-15-99
DATE

FORM LS-5

May 17, 1982

STATE OF TENNESSEE - DEPARTMENT OF HIGHWAYS

UTILITY REPORT FOR LOCATION STUDY

ROUTE _____ ALTERNATE _____

PROJECT NO. INTERCHANGE MODIFICATION COUNTY SHELBY

~~FROM~~ I-40 WITH CANADA ROAD

~~TO~~ _____

UTILITY		TOTAL COST OF ADJUSTMENTS	REIMBURSABLE BY STATE
CITY OF LAKELAND	(SEWER)	$ 6000	$ 3000
MEMPHIS LIGHT, GAS + WATER DIV.	(GAS)	$ 18000	$ 12000
" " " " "	(WATER)	$ 11300	$ 4500
" " " " "	(ELECT.)	$ 5000	$ 5000
BELLSOUTH	(TEL.)	$ 18000	$ 12000
TIME WARNER COMM.	(TV.)	$ 2500	$ 2500
		$	$
		$	$
		$	$
		$	$
		$	$
TOTAL		$ 60800	$ 39000

REMARKS: _____

PREPARED BY: John Barker 3/24/99
ENGINEER - UTILITIES DATE

RAILROAD INVOLVED YES (NO)

Route: I-40
Description: Interchange Modification at Canada Road
County: Shelby
Date: April 15, 1999

CLEAR AND GRUBBING	$ 10,000
EARTHWORK	$ 230,000
PAVEMENT REMOVAL	$ 50,000
DRAINAGE	$ 175,000
STRUCTURES	$ 2,140,00
RAILROAD CROSSING OR SEPARATION	$ N/A
PAVING	$ 975,000
RETAINING WALLS	$ 50,000
MAINTENANCE OF TRAFFIC	$ 100,000
TOPSOIL	$ 10,000
SEEDING	$ 5,000
SODDING	$ 20,000
SIGNING	$ 50,000
LIGHTING	$ N/A
SIGNALIZATION	$ 100,000
FENCE	$ 15,000
GUARDRAIL	$ 30,000
RIP RAP OR SLOPE PROTECTION	$ 10,000
OTHER CONST. ITEMS (8.5%)	$ 350,000
MOBILIZATION	$ 170,000
CONSTRUCTION COST	$ 4,490,000
10% ENG. & CONT.	$ 450,000
TOTAL CONSTRUCTION COST	$ 4,940,000
10% PRELIMINARY ENGINEERING	$ 450,000
TOTAL COST	$ 5,390,000

Prepared by Functional Design Office

TENNESSEE DEPARTMENT OF TRANSPORTATION

DESIGN CRITERIA FOR LOCATION AND DESIGN PHASE

ROUTE I-40 ALTERNATE _____ SECTION _____

REGION 4 COUNTY Shelby PROJECT _____

LOCATION: FROM: Interchange Modification at Canada Road

19___ ADT..... _____

_____ ADT..... _____

PERCENT TRUCKS..... _____

DHV..... _____

FUNCTIONAL CLASSIFICATION..... _____

MINIMUM DESIGN SPEED..... 40 mph

ACCESS CONTROL..... Existing

MAXIMUM CURVE..... Existing

MAXIMUM GRADE..... Existing

MINIMUM STOPPING SIGHT DISTANCE..... Existing

SURFACE WIDTH..... 2@ 36'

NUMBER OF LANES..... 6

USEABLE SHOULDER WIDTH..... curbs & gutters

MEDIAN WIDTH..... *12' Turn Lane

MINIMUM RIGHT-OF-WAY..... ** 108'

SIGNALIZATION..... Ramp Terminals

REMARKS * double left turn lane southbound-single turn lane northbound across I-40 Structure. ** Easements will be necessary outside the right-of-way limits.

Prepared by Functional Design Office 4-15-99

dex of Sheets

	DESCRIPTION
	TITLE SHEET
	PROPOSED TYPICAL SECTION
	PRESENT AND PROPOSED LAYOUTS

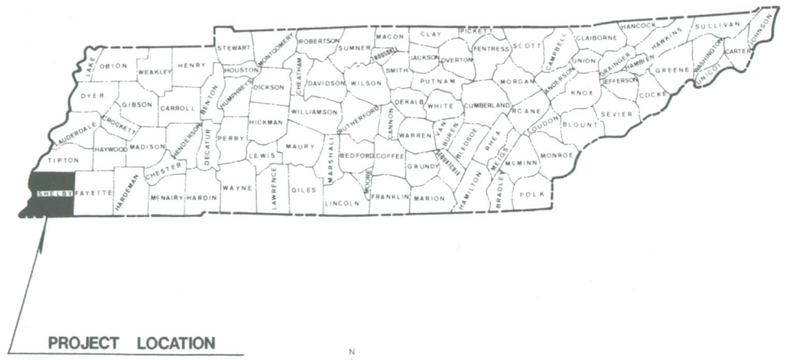
TENN.	YEAR	SHEET NO.
	1999	1
FED. AID PROJ. NO.		
STATE PROJ. NO.		

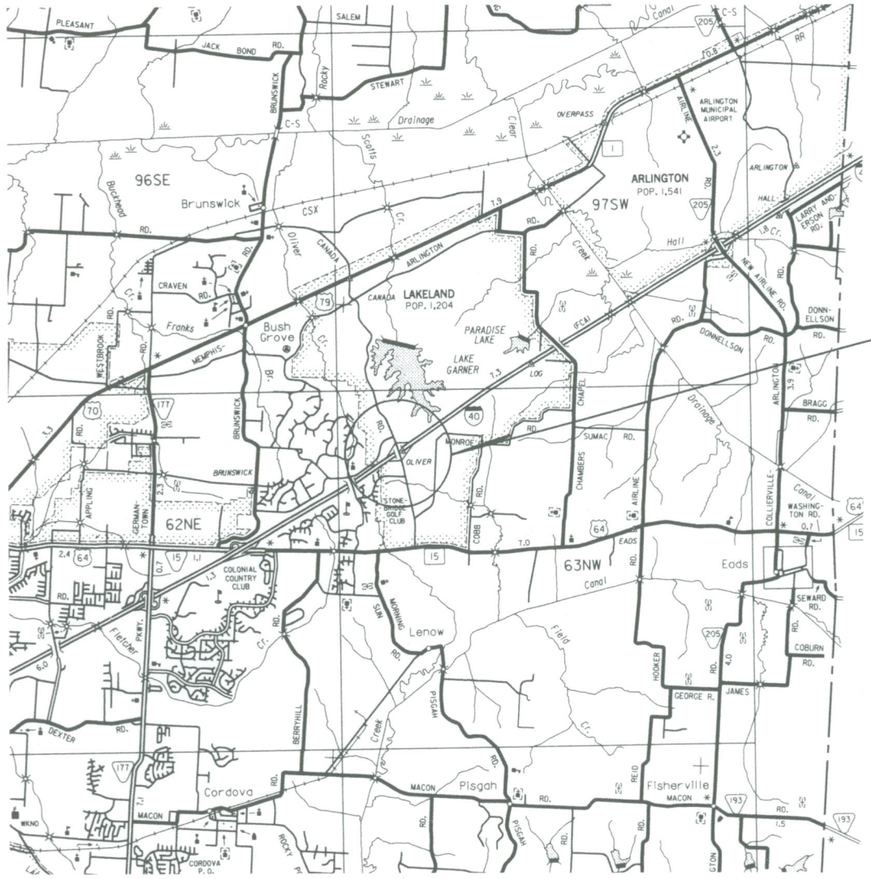
STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
BUREAU OF PLANNING AND DEVELOPMENT

SHELBY COUNTY

INTERCHANGE MODIFICATION
I - 40 @ CANADA ROAD

STATE HIGHWAY NO. F.A.H.S. NO.





PROPOSED PROJECT

N

SCALE
0 1 2 3 4 MILES

SPECIAL NOTES

Y BE REJECTED BY THE COMMISSIONER IF ANY OF THE UNIT PRICES EREIN ARE OBVIOUSLY UNBALANCED, EITHER EXCESSIVE OR BELOW LE COST ANALYSIS VALUE.

TO BE CONSTRUCTED UNDER THE STANDARD SPECIFICATIONS OF THE PARTMENT OF TRANSPORTATION DATED MARCH 1, AND ADDITIONAL S AND SPECIAL PROVISIONS CONTAINED IN THE PLANS AND IN CONTRACT.

IGN & ESTIMATES
FRANK FULGHUM DRAFTSMAN JOAN HAYNES
JON HOPKINS

APPROVED:
DIRECTOR, DESIGN DIVISION
DATE
APPROVED:
COMMISSIONER

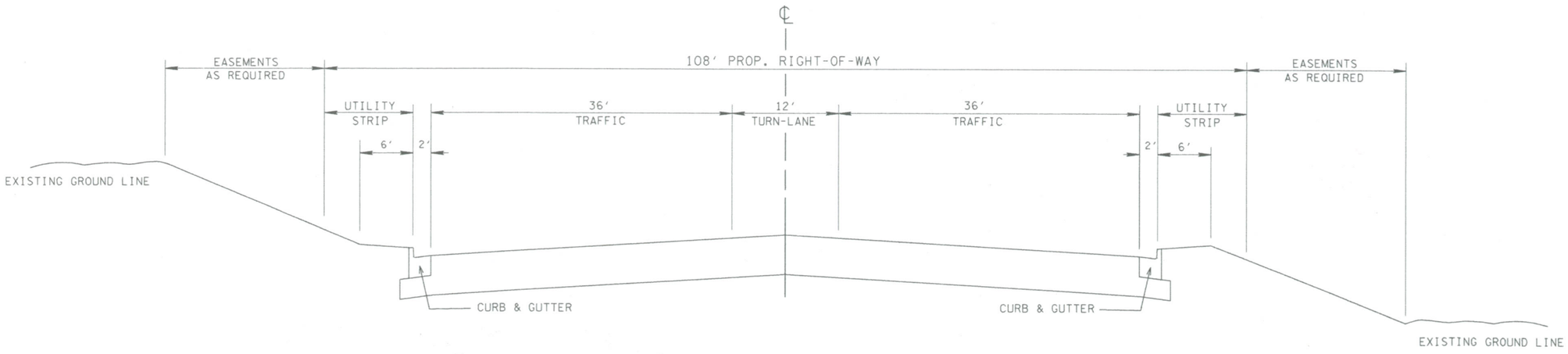
TRAFFIC DATA
ADT
ADT
DHV
D
T
V

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

APPROVED:
DIVISION ADMINISTRATOR DATE

Revised 8-10-99

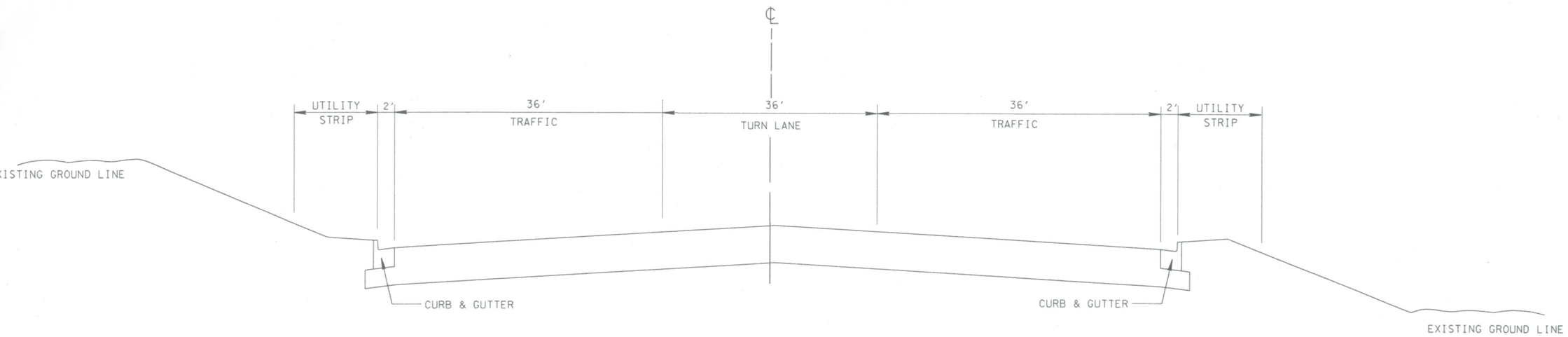
TYPE	YEAR	PROJECT NO.	SHEET NO.
			2



PROPOSED TYPICAL SECTION

CANADA ROAD
ALTERNATE B
(OUTSIDE OF INTERCHANGE AREA) *
ALTERNATE A

* NOTE: SEE PLANS FOR LOCATIONS



PROPOSED TYPICAL SECTION

CANADA ROAD
(WITHIN INTERCHANGE AREA)*
ALTERNATE A

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
BUREAU OF PLANNING & DEVELOPMENT

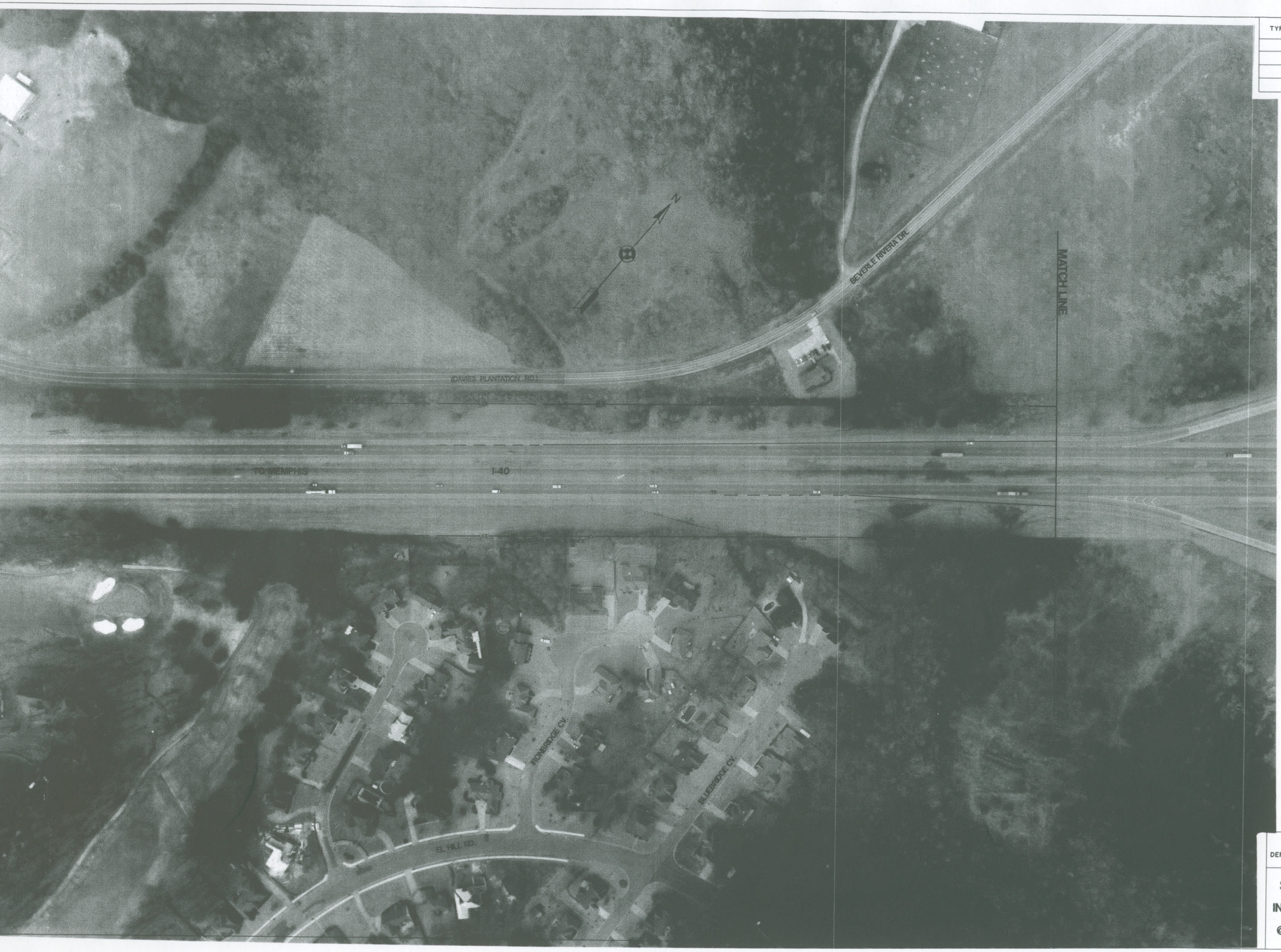
SHELBY COUNTY

INTERCHANGE I-40
@ CANADA ROAD

NOT TO SCALE

REVISION 8-10-99

TYPE	YEAR	PROJECT NO.	SHT. NO.
			3



ALTERNATE A

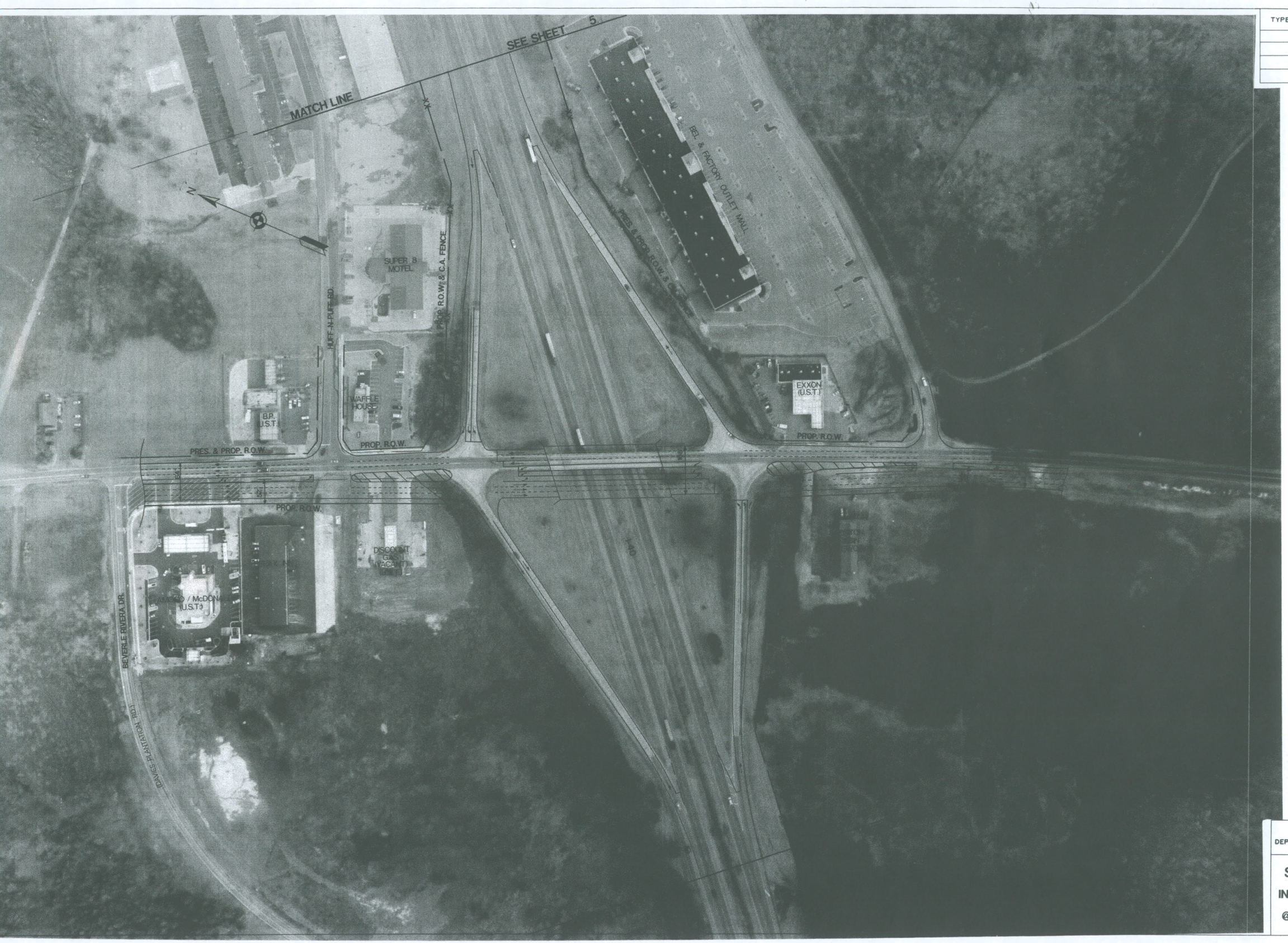
0 100' 200'
SCALE

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION

SHELBY COUNTY
INTERCHANGE I - 40
@ CANADA ROAD

3/11/99

TYPE	YEAR	PROJECT NO.	SHT. NO.
			4



ALTERNATE A

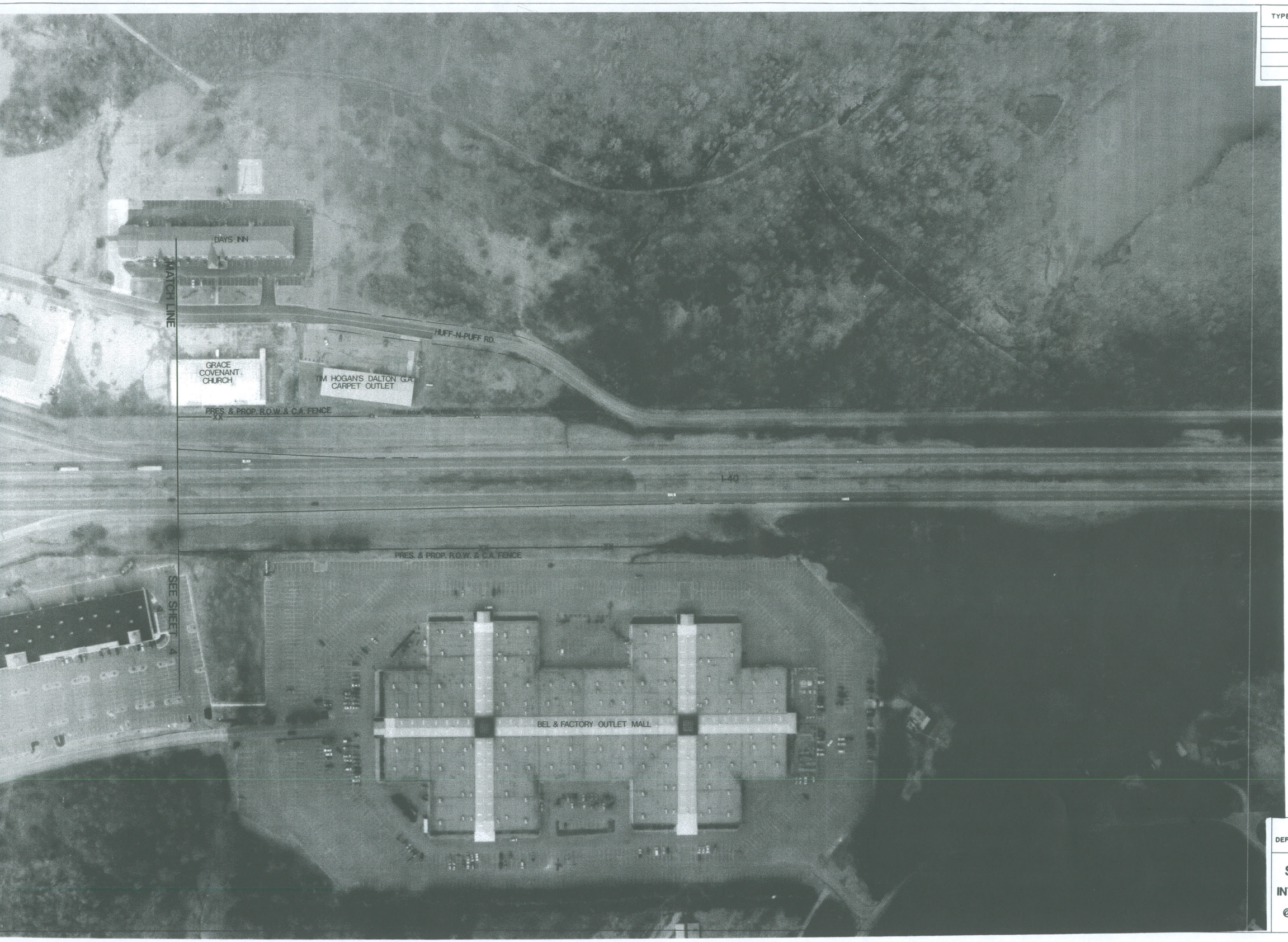
0 100' 200'
SCALE

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION

SHELBY COUNTY
INTERCHANGE I - 40
@ CANADA ROAD

3/11/99

TYPE	YEAR	PROJECT NO.	SHT. NO.
			5



ALTERNATE A

0 100' 200'
SCALE

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION

SHELBY COUNTY
INTERCHANGE I - 40
@ CANADA ROAD

3/11/99

TYPE	Y

ALT

0

STATE
DEPARTMENT

SHELB
INTERCH
@ CAN

8-10-99

TYPE

MATCH LINE

SEE SHEET

PROP. R.O.W. & C.A. FENCE

PROP. R.O.W.

EXIST. R.O.W.

50'

B.P. (U.S.T.)

OFFICE HOUSE

XXXX

EXXON (U.S.T.)

CANADA RD.

PROP. R.O.W.

BEVERLEE RIVERA DR. (ABANDONED)

AMOCO / McDONALD'S (U.S.T.)

BARRIER WALL

I-40

COTTON PLAIN WORKS

ALT

0

STATE
DEPARTMENT

SHELBY
INTERCHA
@ CANA

8-10-99

TYPE	YEA

SEE SHEET 7

DAYS INN

PROP. R.O.W.

EXIST. R.O.W.

GRACE COVENANT CHURCH

EXIST. R.O.W.

XXXX
PRES. & PROP. R.O.W.

M HOGAN'S DALTON GA. CARPET OUTLET

XX
PRES. & PROP. R.O.W. & C.A. FENCE
XX

HUFF-N-PUFF RD.

MATCH LINE

I-40

TO ARLINGTON

XX
PRES. & PROP. R.O.W. & C.A. FENCE

BEL & FACTORY OUTLET MALL

AL

0

STAT
DEPARTMEN

SHEL
INTERC
@ CA

8-10-99