

Chapter Fourteen

**INTERSECTION DESIGN
STUDIES**

BUREAU OF DESIGN AND ENVIRONMENT MANUAL

Chapter Fourteen
INTERSECTION DESIGN STUDIES

Table of Contents

<u>Section</u>	<u>Page</u>
14-1 WARRANTS FOR THE PREPARATION OF INTERSECTION DESIGN STUDIES.....	14-1.1
14-2 PREPARATION OF INTERSECTION DESIGN STUDIES	14-2.1
14-3 DATA REQUIRED FOR INTERSECTION DESIGN STUDIES	14-3.1
14-4 INTERSECTION DESIGN STUDY PROCESSING.....	14-4.1

Chapter Fourteen

INTERSECTION DESIGN STUDIES

An Intersection Design Study (IDS) is a graphic representation of a proposed treatment for the development or improvement of an intersection facility. It is based on an analysis of traffic needs and an evaluation of physical and economic elements at the intersection site. Chapter 14 presents the Department's criteria for the preparation of an IDS. Chapter 36 presents the detailed design criteria for intersections.

The primary purpose of an IDS is to provide a review medium for use by the district, BDE, and the general public. The IDS also provides a file reference that documents all pertinent data and information controlling the design of the intersection improvement.

14-1 WARRANTS FOR THE PREPARATION OF INTERSECTION DESIGN STUDIES

Prepare an IDS for intersections if any of the following conditions apply:

- The study location is an intersection of two marked routes.
- The improvement is intersected by either:
 - + a rural highway that has an existing 30th maximum hourly volume greater than 300 vehicles or additional lanes and/or channelization is proposed on one or both routes; or
 - + an urban highway that has an existing 30th maximum hourly volume greater than 400 vehicles or additional lanes and/or channelization is proposed on one or both routes.
- Where complex conditions exist at the intersection (e.g., high crash rate, adverse terrain features, geometric features that will be difficult to correct due to the extent of cultural development).
- Where the proposed improvement will include a roundabout.
- When requested by the district or BDE in accordance with the engineering study and advance engineering data requirements in the ILMUTCD.

14-2 PREPARATION OF INTERSECTION DESIGN STUDIES

Prepare IDS plan sheets on CADD. For guidance on the preparation of plan or profile sheets, see Section 63-4.01. To facilitate uniformity, use the following sheet formats:

1. Sheet No. 1. An example of a Layout Sheet No. 1 is illustrated in Figure 14-2.A. In urban areas, the intersection layout is usually drawn at a scale ratio of 1 in = 50 ft (1:500 metric) and in rural areas 1 in = 100 ft (1:1000 metric) or 1 in = 50 ft (1:500 metric). Sheet No. 1 is the cover sheet and contains the following items:
 - capacity analysis table,
 - turning movement diagram,
 - traffic data table,
 - north arrow,
 - data block for elements controlling design,
 - phasing diagram,
 - location map box,
 - general notes block, and
 - signature and title block in the lower right-hand corner.

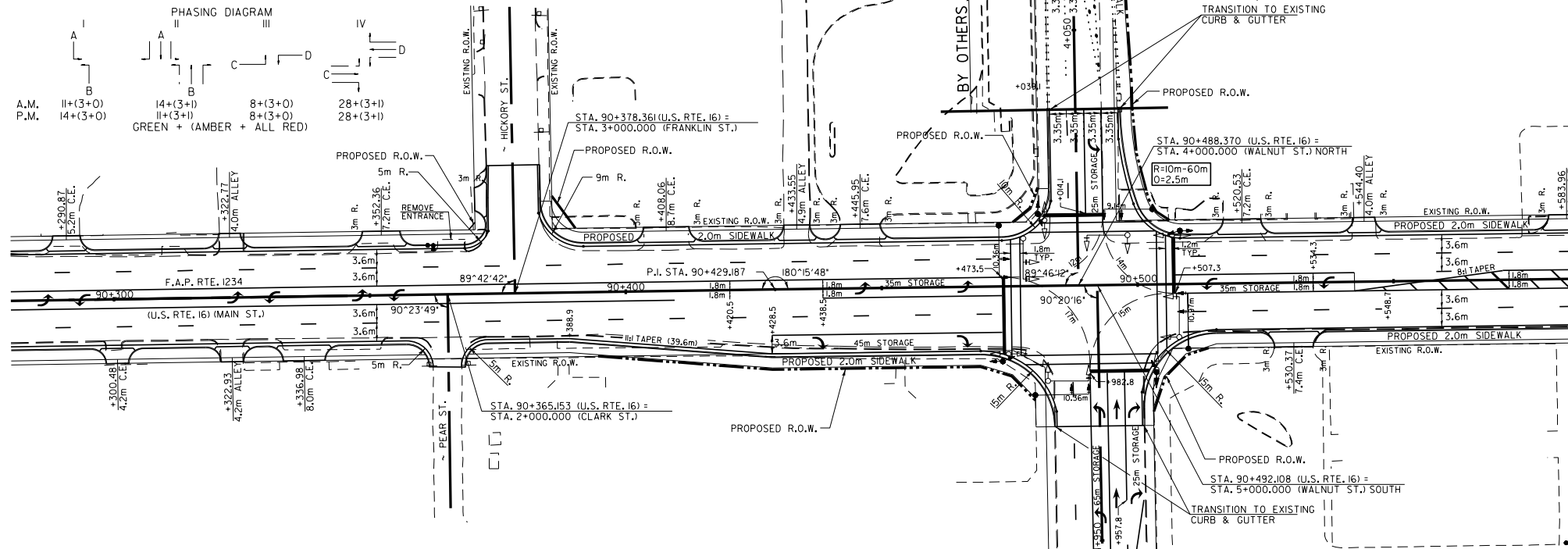
2. Sheet No. 2. Sheet No. 2 is a supplemental sheet for intersection details. Depending on the complexity of the intersection and the need to show special details or cross sections, this sheet may not be required. In urban areas, the scale ratio is usually 1 in = 20 ft (1:250 metric) and in rural areas 1 in = 50 ft (1:500 metric). Also include the following items on the sheet:
 - title block in the lower right-hand corner; and
 - sheet index block in the upper right-hand corner indicating the route, section, county, and sheet numbers.

3. Sheet No. 3. Sheet No. 3 is a typical grid sheet for showing profiles. Use the format illustrated in Figure 14-2.B. Also include the following items on the sheet:
 - title block in the lower right-hand corner; and
 - sheet index block in the upper right-hand corner indicating the route, section, county, and sheet numbers.

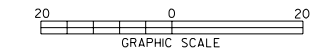
CAPACITY DESIGN ANALYSIS									
4 PHASE 75 SEC. CYCLE SIGNAL TYPE	AREA				OTHER				PEAK HOUR FACTOR 0.95
	AVERAGE INTERSECTION DELAY				PROGRAM USED HCS-VERSION 2.4C				A.M. 13.5 SEC. P.M. 23.1 SEC.
ACTUATED	A		B		C		D		A.M. B P.M. C
APPROACH	A		B		C		D		
BUS STOP CONDITION									
PARKING MANEUVER/HR.									
PEDESTRIANS	50		50		50		50		
ARRIVAL TYPE	3		3		3		3		
LANE UTILIZATION FACTOR	1.00	1.05	1.00	1.00	1.00	1.00	1.05	1.00	1.05
BASE SATURATION FLOW	1900	1900	1900	1900	1900	1900	1900	1900	1900
D - DISTANCE	25m		65m		25m		35m		45m
LANE GROUP	L		TR		L		T		TR
LANE WIDTHS	3.35m		2x3.35m		3.35m		3.35m		3.6m
GREEN TIME (SECONDS)	A.M. 11.0	14.0	11.0	14.0	11.0	14.0	8.0	28.0	28.0
LANE GROUP DELAY (SECONDS)	A.M. 10.4	17.9	16.3	17.6	17.2	7.8	11.5	12.6	6.2
V/C RATIO	A.M. 0.26	0.45	0.73	0.38	0.30	0.41	0.43	0.53	0.20
LEVEL OF SERVICE	A.M. B	C	C	C	C	B	B	B	B
2020 30TH MAX. HOUR TRAFFIC	A.M. 105	255	260	120	80	100	530	290	60
2000 8TH HOURLY TRAFFIC	A.M. 151	370	335	180	75	125	600	260	40
	P.M. 204		253			451			388

ELEMENTS CONTROLLING DESIGN	
1. DESIGN DESIGNATION	F.A.P. RTE. 1234 (U.S. RTE. 16) (MAIN ST.) PRINCIPAL ARTERIAL - 27,000 ADT (2020) WITH (WALNUT ST.) - URBAN COLLECTOR - 12,400 ADT (2020)
2. F.A.P. RTE. 1234 (U.S. RTE. 16) (MAIN ST.)	IS THE PREFERENCE ROUTE
3. ANTICIPATED YEAR OF CONSTRUCTION	2000
4. TRAFFIC CONTROL TO BE	TRAFFIC SIGNALS, EXISTING SIGNALS ARE TO BE MODERNIZED.
5. DESIGN VEHICLE	B-12 NORTH, WB-15 SOUTH
DESIGN SPEED	U.S. RTE. 16 60 km/hr WALNUT ST. 60 km/hr
POSTED SPEED	35 MPH 35 MPH

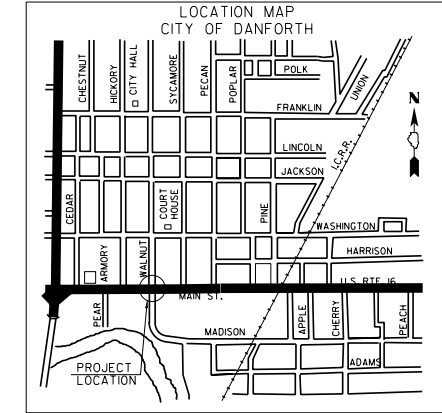
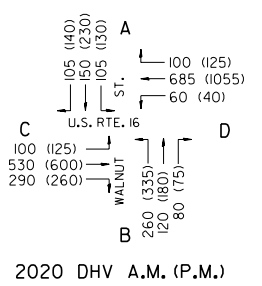
- GENERAL NOTES**
- PROFILES ARE /NOT PROVIDED, SINCE APPROACH GRADES ARE GREATER THAN 1.0 PERCENT ON WALNUT ST.
 - TYPE B-15.60 CURB AND GUTTER TO BE USED ON OUTER EDGES OF PAVEMENT
 - TYPE B-15.60 CURB AND GUTTER TO BE USED ON CHANNELIZING ISLAND
 - ALL DIMENSIONS ARE SHOWN F-F OF CURB PAVEMENT UNLESS OTHERWISE NOTED.
 - ENTRANCES SHALL CONFORM TO THE POLICY ON "ACCESS TO STATE HIGHWAYS".
 - CURBS TO BE DEPRESSED AT CROSSWALKS TO MEET ADA.
 - SIDEWALKS AND R.O.W. ARE SUBJECT TO REVISION DURING PREPARATION OF FINAL PLANS.
 - NON-POLICY ITEMS ADDRESSED IN PROJECT REPORT (LANE LENGTHS, TAPER RATES, ETC.)



IDS Sheet No. 1
Figure 14-2A

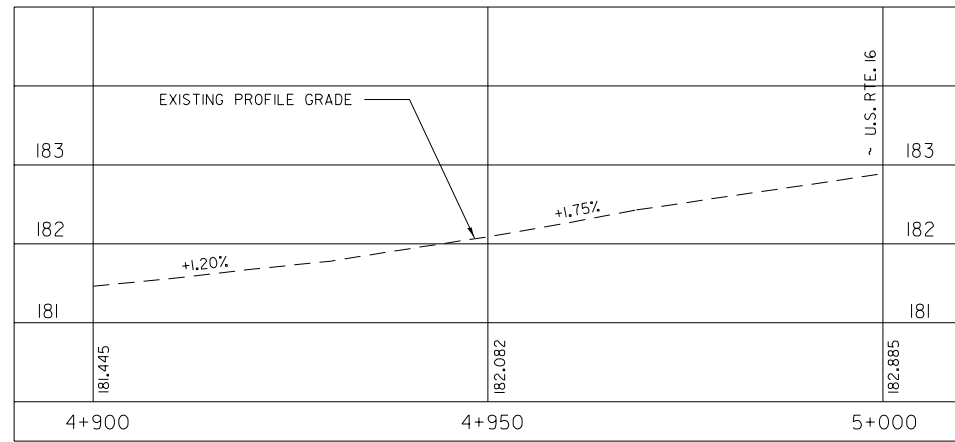


TRAFFIC DATA									
MOVE- MENT	YEAR 2000 30TH MAXIMUM HOURLY TRAFFIC		PERCENT TRUCK TRAFFIC IN 30th MAX HOUR	ESTIMATED PERCENT INCREASE BY	YEAR 2020 30TH MAXIMUM HOURLY TRAFFIC		ESTIMATED PERCENT INCREASE BY	YEAR 2020 30TH MAXIMUM HOURLY TRAFFIC	
	A.M.	P.M.			A.M.	P.M.		A.M.	P.M.
AB	115	165	3					150	230
AD	80	100	3					105	130
AC	80	105	3					105	140
BA	100	150	3					120	180
BC	200	260	3					260	335
BD	60	50	3					80	75
CD	460	520	5.2					530	600
CA	80	100	5.2					100	125
CB	225	200	5.2					290	260
DC	585	900	5.3					685	1055
DB	40	30	5.3					60	40
DA	80	100	5.3					100	125
TOTAL A	535	720						680	930
TOTAL B	740	855						960	1120
TOTAL C	1630	2085						1970	2515
TOTAL D	1305	1700						1560	2025

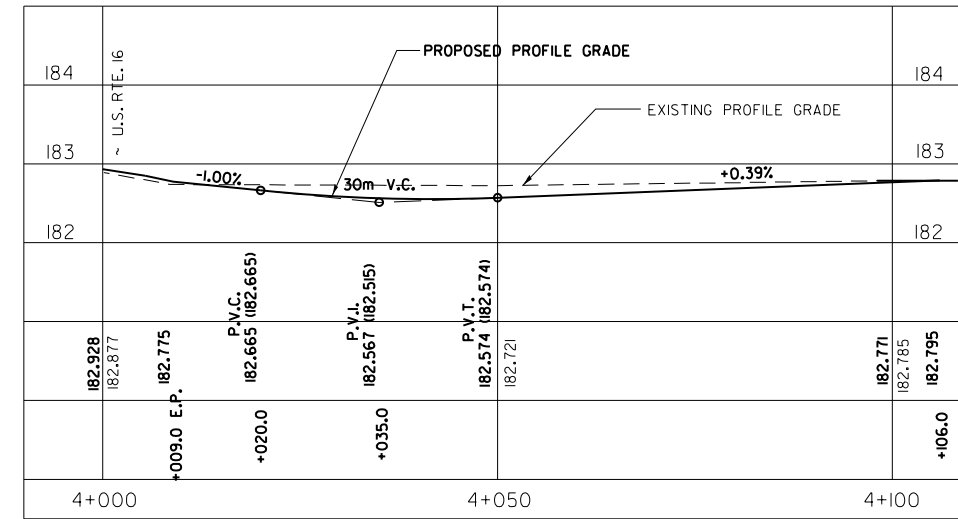


DRAWING NO. _____
INTERSECTION DESIGN STUDY
 F.A.P. ROUTE 1234 (U.S. RTE. 16) (MAIN ST.)
 WITH (WALNUT ST.)
 SEC. NO. (54,43Z-3)(W,RS),(127,19,8,63)(W,RS-1)&35(W,RS-2)
 SCALE 1:500 COUNTY _____ MERIDIAN _____
 SUN : P-90-042-97 REV. NO. 42640
 DESIGNED BY _____ DATE 6/97
 SATISFACTORY _____ DISTRICT GEOMETRICS ENGINEER _____ DATE _____
 SATISFACTORY _____ DISTRICT PROGRAM DEVELOPMENT ENGINEER _____ DATE _____
 SATISFACTORY _____ DISTRICT OPERATIONS ENGINEER _____ DATE _____
 APPROVED _____ DISTRICT ENGINEER _____ DATE _____
 CADD FILE NAME : [] IDS. SHEET 1 OF 2

S. WALNUT ST.



N. WALNUT ST.



IDS Sheet No. 3
Figure 14-2B

DRAWING NO. _____
INTERSECTION DESIGN STUDY
 FAP ROUTE 1234 (U.S. RTE. 16) (MAIN ST.)
 WITH ROUTE _____ (WALNUT ST.)
 SEC. NO. (54,43Z-3)(W,RS)(127,19,8,63)(W,RS-1)&35(W,RS-2)
 SCALE 1/2"=50' VERT. COUNTY MERIDIAN
 1/2"=500' HORIZ.
 SJN : P-90-042-97 PROJ. NO. 42640
 CADD FILE NAME : [] I.D.S. SHEET 2 OF 2

14-3 DATA REQUIRED FOR INTERSECTION DESIGN STUDIES

Document the following data in the IDS:

1. Elements Controlling Design. Chapter 36 presents the design criteria for intersections. On Sheet No. 1, list all pertinent elements affecting the design of the intersection including:
 - the intersection route designation including highway functional classification, SRA Route designation, if appropriate, proposed design speed, and existing and design traffic (ADT and year) for both intersecting routes;
 - the preferential route;
 - the anticipated year of construction;
 - the type of traffic control including:
 - + a statement indicating whether signals will be installed or adjusted;
 - + the warrant, or combination of warrants, from the *ILMUTCD* justifying the use of signal control; and
 - + use of a roundabout;
 - design criteria;
 - design vehicle;
 - truck route designation;
 - existing and proposed posted speeds (mph) on all intersection approaches (proposed posted speeds should be equal to or less than the design speeds); and
 - pedestrian and bicycle usage at intersection.
2. General Notes. Include the following information in the general notes on Sheet No. 1:
 - a. Grades. Where all existing grades to remain are greater than 1% or in all cases with any new or altered grades, include a statement that profiles are shown for both intersecting roads and show them on Sheet No. 3. If existing grades are to remain and are all less than 1%, indicate this fact and state that no profiles are shown.
 - b. Curb and Gutter. Indicate the type of curb and gutter to be used on the outer edges of the traveled way, shoulders, channelizing islands, and corner islands. Only use mountable type curbing on corner islands.

- c. Dimensions. Indicate the type of dimensioning used (e.g., edge-to-edge of pavement, edge-to-edge of traveled way).
 - d. Design Exceptions. List any deviations from design criteria (see Section 31-8) and typical traffic control practice (e.g., large truck turning encroachments, lane widths less than Department criteria, less than desirable level of service, less than desirable storage length for queued vehicles). Include the justification for design exceptions in the Phase I report.
 - e. Access to State Highways. State if the design complies with the criteria in Section 36-7 or list any instances of noncompliance.
 - f. Crashes. Note if the intersection is a Five Percent Report location (FPR) and, if so, what year.
 - g. Terrain. Describe any unusual terrain features that could affect the design.
 - h. Cultural Development. Indicate adjacent cultural development that influences the intersection layout.
 - i. Improvement Type. List the type of improvement (e.g., new construction, reconstruction, 3R, safety).
 - j. Bicycle Route. Note the existence of designated bicycle routes through the intersection.
 - k. Sight Distance. On two-way stop-controlled intersections, note if intersection sight distance is met.
 - l. Verification. Note the method used to verify sufficiency of intersection to accommodate turning movements of the design vehicle.
 - m. Right-of-Way. Indicate if proposed right-of-way limits for the intersection are preliminary.
 - n. Truck Routes. Note the existence of designated truck routes through the intersection.
 - o. Other. Include any additional information not listed elsewhere that will aid in the review of the IDS.
3. Capacity Analysis. Perform and document the capacity analysis of the IDS according to the following guidelines:
- a. Source Document. Use the *Highway Capacity Manual* and the *Highway Capacity Software* (distributed by the McTrans Center for Microcomputers in Transportation) for the capacity analyses. The use of any other capacity techniques and software must be first approved by BDE; see Section 36-1.07.

- b. Signal Phasing. In diagrammatic form, illustrate the proposed signal phasing required to obtain the desired level of service. Orient the signal phasing diagram to be consistent with the plan view of the intersection and any other pertinent diagrams.
 - c. Results. Document the data and results of the capacity analysis on Sheet No. 1 for each leg of the intersection in a table as illustrated in Figure 14-3.A.
4. Traffic Data. Provide the following traffic data on Sheet No 1:
 - a. Traffic Movements. Provide a tabular listing of all movements to and from each leg of the intersection. Use the format illustrated in Figure 14-3.B. Also, prepare a traffic diagram for the design year showing all DHV movements within the intersection. Orient the traffic diagram to be consistent with the plan view of the intersection and any other pertinent diagrams.
 - b. Existing Volumes. Calculate the 8th maximum hourly volume per day from actual traffic counts to determine whether traffic signal warrants are met. See the *ILMUTCD* for additional guidance.
 - c. Proposed Volumes. For new intersections or where proposed intersection improvements for large developments will significantly increase traffic volumes, traffic signals may be justified where the 8th maximum hourly volume three years after construction exceeds the values stated in the warrants. The three years time frame should be increased in the event of staged development. The 8th maximum daily hourly volume may be considered as 55% of the projected 30th maximum hour volume. See the *ILMUTCD* for additional guidance.
 - d. Pedestrians. Where pedestrian control signal heads are proposed, provide a pedestrian count.
5. Intersection Layout and Design. Provide the following intersection layout and design information on Sheets No. 1 and No. 2:
 - a. Centerline. Show the centerline information for all proposed and existing curves within the immediate area of the intersection. Include superelevation rates and transition stations. Label the station equation for all intersecting side roads.
 - b. Angle. Note the angle of intersection between the two roadways.
 - c. Location Map. Provide a small scale location map, covering a sufficient area to properly identify the location of the improvement. It should portray the existing street or local road network and any municipalities adjacent to the improvement. Layout the map with North in the same direction as shown on the intersection layout.
 - d. Auxiliary Lane Lengths. Indicate lengths for all auxiliary lanes.

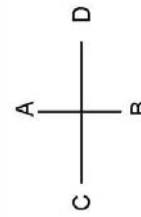
- e. Tapers. Indicate all taper lengths and rates.
 - f. Scales. Provide a bar scale on each sheet.
 - g. Topographic Features. Indicate all limiting topographic features or cultural developments including:
 - existing and proposed access driveways;
 - existing and proposed right-of-way lines and any access control limits;
 - property lines;
 - property owners, business names, land uses, and buildings;
 - sidewalks, curb ramps, and other accessibility requirements, see Chapter 58; and
 - other factors controlling the intersection design (e.g., retaining walls, utilities, gasoline pumps, other appurtenances).
 - h. Signals. Show the proposed signal locations and signal phasing diagram. Prepare these according to the criteria and guidelines presented in Chapter 57. This information is required to ensure compatibility with other design elements, right-of-way, and traffic flow (progression).
 - i. Signs. For complex intersections, show the proper placement of signs and traffic control devices. Because signing distance and legend requirements could influence the design of complex facilities, include a preliminary signing plan with the IDS for all complex intersection designs.
 - j. Striping. Include the proposed striping details on the IDS.
 - k. Control Points. Provide the station and offset of all control points, including all island noses, radius return points of curvature and tangency, and centerline or baseline control points.
6. Title Block. Only the individual personally responsible for the intersection design will occupy the “Designed By” line in the title block.

CAPACITY DESIGN ANALYSIS							
PHASE SEC. CYCLE SIGNAL TYPE	AREA AVERAGE INTERSECTION DELAY PROGRAM USED	B		C		D	
		A.M.	P.M.	A.M.	P.M.	A.M.	P.M.
APPROACH	A	B	C	D	A	B	C
BUS STOP CONDITION							
PARKING MANEUVER/HR.							
PEDESTRIANS							
ARRIVAL TYPE							
THROUGH LANE UTILIZATION FACTOR							
BASE SATURATION FLOW RATE							
D-DISTANCE							
LANE GROUP							
LANE WIDTHS							
GREEN TIME (SECONDS)							
G/C Ratio							
LANE GROUP DELAY (SECONDS)							
V/C							
RATIO							
LEVEL OF SERVICE							
20 TH MAX. A.M.							
8 TH MAX. P.M.							
HOURLY TRAFFIC A.M.							
P.M.							

CAPACITY DESIGN ANALYSIS

Figure 14-3.A

TRAFFIC DATA							
Movement	Year 20 _____ 30th _____		Percent Truck Traffic in 30th Maximum Hour	Estimated Percent Increase by 20 _____		Year 20 _____ 30th _____	
	Maximum Hour Traffic A.M.	Maximum Hour Traffic P.M.		Maximum Hour Traffic A.M.	Maximum Hour Traffic P.M.	Maximum Hour Traffic A.M.	Maximum Hour Traffic P.M.
AB (T)							
AD (L)							
AC (R)							
BA (T)							
BC (L)							
BD (R)							
CD (T)							
CA (L)							
CB (R)							
DC (T)							
DB (L)							
DA (R)							
TOTAL A							
TOTAL B							
TOTAL C							
TOTAL D							



T = Through, L = Left, R = Right

TRAFFIC DATA SUMMARY

Figure 14-3.B

14-4 INTERSECTION DESIGN STUDY PROCESSING

Intersection design studies are normally prepared under the direction of and approved by the District Geometrics Engineer. Upon completion of the IDS, it is approved by the district as illustrated in the signature block in Figure 14-2.A and included in the Phase I report. BDE will review and approve IDSs if requested by the district or if the district does not have a qualified geometrics engineer.

When projects require an IDS, the district should not conduct public involvement activities without an approved IDS. When an IDS is prepared by a qualified Geometrics Engineer, reviewed according to current geometric design policies, and approved by the District Geometrics Engineer, it may be included as part of the Phase I report. Upon approval of the IDS, the district will submit a completed BDE 2602 template to BDE for status information of the IDS.

Final approval of an IDS is given with the design approval of the final Phase I report. This ensures the consideration of social, economic, and environmental factors and public comments that could affect the design elements of an intersection. In addition, a crash analysis and relevant collision diagrams may be reviewed concurrently with the IDS.

If intersection conditions are complex, the district, at its option, may forward the IDS to BDE for early review. In this case, the IDS is reviewed with particular emphasis on compliance with accepted design practices, methods of managing or controlling access, intersection capacity, signal phasing, operational safety, efficiency, and any needed design exceptions. BDE may recommend changes to the IDS. If changes are recommended, the comments are forwarded to the district for revision. After the revised IDS is reviewed and considered satisfactory, it is then approved by the District Geometrics Engineer for inclusion in the Phase I report.

