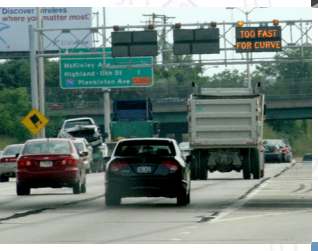

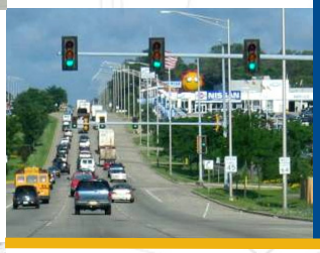

Traffic Impact Analysis Guidelines

Updated: January 2014

BUREAU OF TRAFFIC OPERATIONS

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PDF Navigation Guidelines

If you are viewing this document as a PDF file, you can navigate through the document via internal links as well as to external websites. Please note the following.

- By clicking on the Chapter Information in the Table of Contents, you will be taken directly to the beginning of that chapter.
- By clicking on the Chapter Titles in the List of Required Exhibits, you will be taken directly to the beginning of that chapter.
- No matter where you are in the document, if you click on the Wisconsin Button on the top of each page, you will be taken back to the Table of Contents.
- By clicking on the URL information within the document's text, you will be taken to the related website.

Traffic impacts, and how to mitigate them, are an important consideration for any community when a significant development is proposed. Public policy makers, citizens and developers all have a stake in understanding and responding to additional demands on the transportation system. All share the common interest of a safe and efficient transportation network. A properly developed traffic impact analysis study can provide the factual basis for good decision making and facilitate the timely implementation of effective mitigation measures.

A traffic impact analysis (TIA) is a specialized engineering study that determines the potential traffic impacts of a proposed traffic generator and *should* answer the following fundamental questions:

- What are the existing traffic conditions, the expected future traffic conditions without the development, and the expected future traffic conditions with the development in place?
- Can the existing and planned transportation system accommodate the additional traffic generated by the planned development?
- Are roadway system improvements needed to maintain an acceptable level of service (LOS) beyond those already programmed or included in the local transportation plan?
- What are the recommended roadway improvements that may be necessary to accommodate the expected development traffic?

A TIA must be completed prior to finalizing the development design, while there is still flexibility in the development's site design. The TIA must be completed and accepted by WisDOT prior to obtaining any permits.

PURPOSE

The purpose of this document is to establish uniform guidelines for conducting TIA's for proposed new developments, the expansion of existing developments and requests for new or modified access (direct or indirect) to the State Trunk Highway System. The guidelines aim to ensure all studies contain the necessary information in a uniform format, providing the opportunity for an efficient review of the proposal's affect on the state highway.

WisDOT is charged with operating a safe and efficient state highway system. Proactive access management is vital in maintaining the overall safety and efficiency of this system. Access to the state highway system is managed through statutes 86.07, 84.09 and 84.25, and Administrative Rules Trans. 231 and Trans. 233.

As part of the Wisconsin Department of Transportation's Access Permitting Procedure or the Trans. 233 review process, the Region may require a TIA of proposed land divisions or proposed access requests. Facilities Development Manual (FDM) procedure 7-35-10 states, *"A TIA should be considered whenever traffic generated by the proposed development is expected to exceed 100 vehicles in the peak hour. Greater consideration*

The acceptance of a TIA is not an approval of proposed recommendations.

should be given to requiring a TIA on an already congested or unsafe highway than on one with lower traffic volumes and crash rates. Whenever WisDOT determines a TIA is necessary, the developer is required to provide it."

Note that the acceptance of the TIA is not an approval of proposed recommendations outlined in the study, but an acknowledgment that the TIA was submitted in a format that was acceptable for the Department to review. Typically, the Regional Traffic Contact will provide a summary of the Department's position and issues that need to be addressed on the proposed recommendations outlined in the submitted TIA prior to moving forward with the permitting process.

TIA STUDY TIMEFRAME

A development expected to generate between 100 and 500 trips may only require an abbreviated TIA.

If a development is expected to generate between 100 and 500 driveway trips in the peak hour, WisDOT has the option to require an abbreviated TIA instead of a full TIA. An abbreviated TIA focuses only on the base year traffic conditions with and without the development whereas a full TIA analyzes both base and horizon year traffic conditions with and without the development. A full TIA is generally more suitable for larger developments (greater than 500 peak hour vehicles), and requires involvement from the WisDOT central office forecasting team for horizon year traffic projections. A letter sent by the Region will define the parameters of the study and identify the need for an abbreviated or full TIA, including the proposed study years.

INITIAL REVIEW

Prior to preparing a TIA, please contact the WisDOT Regional Office and request an initial review of the proposed development.

Prior to the submission of a full or abbreviated TIA, WisDOT may require preliminary traffic information to be used in developing the TIA parameters through the initial review process. Typically, the preparer will be informed of the need to complete an initial review during or shortly after preliminary development review meetings with WisDOT's planning and operations staff. The initial review document **shall**, at a minimum, provide an overview of the proposed development plan, outline the existing transportation system, and highlight existing ADT volumes and expected development peak hour trip generation. For additional information on the initial review process, please contact the appropriate WisDOT Regional TIA representative.

IMPLEMENTATION OF TIA-REQUIRED IMPROVEMENTS

The required development-driven improvements will be identified by correspondence in response to the findings of the TIA.

Improvements that are required to mitigate traffic impacts caused by development are based on, but not limited to, the recommendations section of a TIA. The required development-driven improvements will be identified by letter, memorandum or email correspondence by WisDOT in response to the findings of the TIA. These requirements are subject to WisDOT's authority and jurisdiction over any given highway. The mechanism for requiring TIA-related improvements is generally the permitting process (e.g. work on highway right-of-way, access, utility, etc.) overseen by the Regional Maintenance Units. Cited improvements and the methods for implementing them will become a condition of the permit. All improvements **shall** comply with current Facilities Development Manual (FDM) standards.

Design plan sets of required improvements based on a TIA *should* typically include: project overview, typical sections, construction details, right-of-way plats, erosion control, pavement details, structural details, intersection layouts, storm sewer, plan/profile, traffic control design (e.g. traffic signal plans), lighting design, signing & marking, work zone traffic control, standard detail drawings, standard sign plates, cross-sections, specifications, and project cost estimates. This information **shall** be made available in hardcopy and CAD format (e.g. DGN). Coordination and plan review meetings between the developer, developer's agents, as well as appropriate municipal and WisDOT staff are encouraged.

QUALIFICATIONS OF THE PREPARER

A Traffic Impact Analysis *should* be prepared by a transportation professional with training and experience in traffic engineering and transportation planning. It **shall** be prepared by, or under the supervision of, a professional engineer that is registered in Wisconsin and has experience in traffic engineering operations. The study **shall** be signed, sealed and contain the following statement of certification:

> *"I certify that this Traffic Impact Analysis has been prepared by me or under my immediate supervision and that I have experience and training in the field of traffic and transportation engineering."*
>
> (Signature)
> John Q. Smith, P.E.
> Wisconsin Registration #12345
> Consulting Firm, Inc.

QUALIFICATIONS OF THE REVIEWER

The TIA **shall** be reviewed by one or more of WisDOT's professional staff, along with that of any other participating agency (regional planning agency, county, city, village, or town) who collectively have training and experience in traffic impact study methodology, land use planning and traffic engineering, including traffic safety and operations.

ETHICS AND OBJECTIVITY

Although TIA preparers and reviewers might have different objectives and perspectives, they *should* adhere to the established engineering ethics (similar to the Canon of Engineering Ethics) and *should* conduct all analyses and reviews objectively and professionally.

ORGANIZATION / FORMAT

The WisDOT Traffic Impact Analysis Guidelines highlight the information to be included within the TIA and the format for presenting the study findings in a manner consistent with the reviewer's expectation. The TIA report organizational structure **shall** follow the format outlined in this guideline. All TIA's are to include:

- Formatting that matches the order, labeling, and numbering system presented in the attached outline.
- Pages must be dated with the current document submittal date.
- Table of contents.
- Tabs or dividers to assist in identifying each chapter and appendices of the TIA

One ring-bound hard copy of the full TIA report and analysis output (SE Region requires 2 hard copies) as well as one copy of the electronic files used in the study (compact disc or other media storage) **shall** be submitted to WisDOT. Electronic files **shall** include, but are not limited to, a portable document format (PDF) of the report plus appendices and the capacity analysis files in their software file format (e.g. SYN, XRA).

The WisDOT Traffic Impact Analysis Guidelines Manual was originally released January 1, 2004. When periodic changes are made, the manual is re-released. For prior editions to this manual, please contact the WisDOT Bureau of Traffic Operations (BTO) office.

TIA Scoping Checklist

The following checklist was developed to aid TIA preparers & reviewers in appropriately determining the scope of a development-related traffic study. This list may not include all aspects that need to be addressed by every TIA. Therefore, careful consideration *should* be given to issues that may be unique to a specific study and the scope *should* be reasonably adjusted, if necessary.

- ☐ Determine study objectives & purpose.
- ☐ Verify development land use. Make reasonable assumptions, if unknown.
- ☐ Identify off-site development(s).
- ☐ Review site plan, if available.
- ☐ Verify development staging.
- ☐ Determine build-out, interim, & study horizon year(s).
- ☐ Based on land use trip generation, identify peak periods for analysis.
- ☐ Determine area of significant traffic impact & identify specific study area intersections.
- ☐ Determine appropriate site access.
- ☐ Determine target level of service (LOS).
- ☐ Identify any alternative analyses that need to be considered within the study (typically this will be based on various geometric conditions/configurations).
- ☐ Identify planning studies or programmed roadway improvement projects that may require coordination.
- ☐ Check to see if recent field data is available for: intersection turning movement counts, spot-speed or specialized studies (saturation flow, delay, etc.). If none is available, arrange for information to be collected.
- ☐ Assess need to consider other transportation modes (e.g. cycling, walking, public transport, etc.) within the study area.

- Determine appropriate source for trip generation information (typically ITE Trip Generation: An ITE Informational Report).
- Estimate pass-by & linked-trips.
- Determine development trip distribution.
- Arrange for a Central Office traffic forecast based on the analysis years.
- Identify traffic analysis software that will be used to evaluate each alternative.
- Assess the need to develop a micro-simulation model.
- Determine specific requirements to be used for analysis. This may relate to analysis software inputs such as: PHF, saturation flow, RTOR volumes, ped/truck volume considerations, etc.
- Identify any special considerations that will need to be addressed within the study

Prior to preparing a TIA, please contact the WisDOT Regional Office and request an Initial Review of your proposed development.

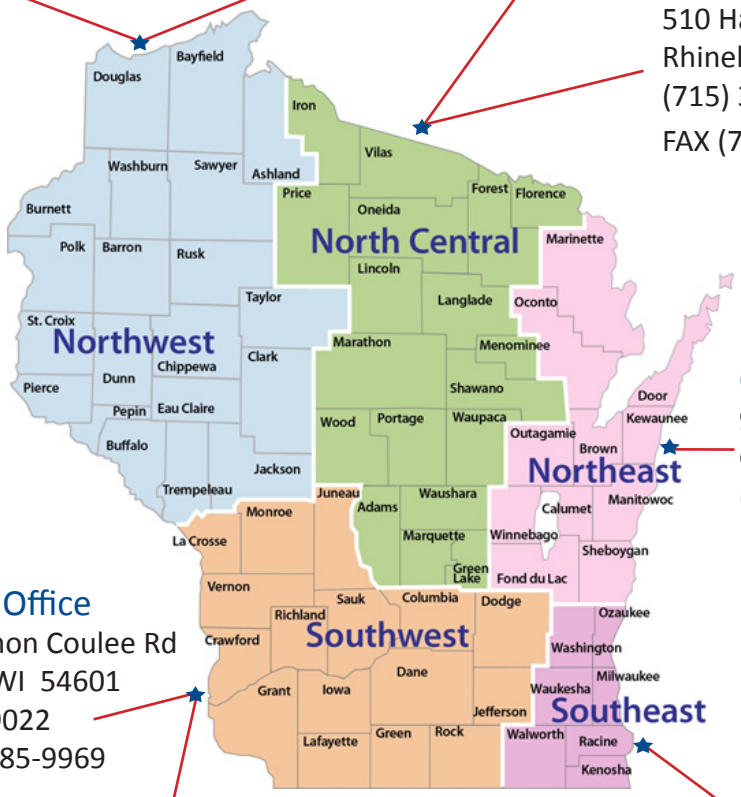
IMPORTANT NOTICE

Superior Office
1701 N. 4th St
Superior, WI 54880
(715) 392-7925
FAX (715) 392-7863

Eau Claire Office
718 Clairemont Ave
Eau Claire, WI 54701
(715) 836-2891
FAX (715) 836-2807

Wisconsin Rapids Office
1681 2nd Ave South
Wisconsin Rapids, WI 54495
(715) 421-8300
FAX (715) 423-0334

Rhinelander Office
510 Hanson Lake Road
Rhinelander, WI 54501
(715) 365-3490
FAX (715) 365-5780



Green Bay Office
944 Vanderperren Way
Green Bay, WI 54304
(920) 492-5643
FAX (920) 492-5640

La Crosse Office
3550 Mormon Coulee Rd
La Crosse, WI 54601
(608) 785-9022
FAX (608) 785-9969

Madison Office
2101 Wright St
Madison, WI 53704
(608) 246-3800
FAX (608) 246-7996

Waukesha Office
141 N.W. Barstow St
Waukesha, WI 53187
(262) 548-5682
FAX (262) 548-8836

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- A. Purpose of Report and Study Objectives
- B. Executive Summary
- C. Chapter 1 Exhibits

Chapter 2 Proposed Development
- A. On-Site Development
  1. Development Descriptions and Site Location
  2. Land Use and Intensity
  3. Site Plan
  4. Development Phasing and Timing
- B. Study Area
  1. Influence Area
  2. Area of Significant Traffic Impact
- C. Off-Site Land Use and Development
- D. Site Accessibility
- E. Chapter 2 Exhibits

Chapter 3 Analysis of Existing Conditions
- A. Physical Characteristics
- B. Traffic Volumes
- C. Capacity/Level of Service
- D. Sources of Data
- E. Chapter 3 Exhibits

Chapter 4 Projected Traffic
- A. Background Traffic Forecasting
- B. On-Site and Off-Site Development Traffic Forecasting
  1. Trip Generation
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  4. Trip Distribution
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- A. Site Access
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- C. Queuing Analysis
- D. Pedestrian, Bicycle, and Multi-Use Trail Considerations
- E. Speed Considerations/Sight Distance
- F. Traffic Control Needs

Chapter 6 Conclusions and Recommendations
- A. Conclusions
- B. Recommendations
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Glossary

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Planned Transportation System (If known project in study area). 3-1B
Existing Traffic Volumes 3-2A
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Base Year Background Traffic Capacity/LOS Analysis, Existing/Planned Transportation System 3-3

Chapter 4

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Horizon Year Background Traffic Volumes 4-2
Trip Generation Table 4-3
Trip Distribution 4-4

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- New Trips 4-5A
- Multi-Linked Trips 4-5B
- Pass-by Trips. 4-5C
- Driveway Trips 4-5D

Interim Year On-site Development Traffic Assignment

- New Trips 4-6A
- Multi-Linked Trips 4-6B
- Pass-by Trips. 4-6C
- Driveway Trips 4-6D

Horizon Year On-site Development Traffic Assignment

- New Trips 4-7A
- Multi-Linked Trips 4-7B
- Pass-by Trips. 4-7C
- Driveway Trips 4-7D

Exhibit **Number**

Base Year Off-site Development Traffic Assignment
New Trips 4-8A
Multi-Linked Trips 4-8B
Pass-by Trips. 4-8C
Driveway Trips 4-8D
Interim Year Off-site Development Traffic Assignment
New Trips 4-9A
Multi-Linked Trips 4-9B
Pass-by Trips. 4-9C
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Base Year Total Development Traffic Volumes 4-14
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Interim Year Total Traffic. 5-25
Horizon Year Total Traffic 5-26
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Chapter 6
Intersection Conceptual Drawing 6-1

Notes:

- *Multiple interim years* **shall** *be labeled sequentially (e.g. Exhibit 4-5E)*
- *Exclude exhibits not required for the specific TIA, but maintain required numbering as shown above. It is not necessary to include a page in the TIA report indicating the exhibit is not attached or needed.*

A
APENDICIES

Appendix A – Traffic
- Summary of PHF and Percent Heavy Vehicles
- Existing Traffic Counts
- Future Traffic Projections
- Intersection sight distances at intersection locations immediately adjacent to the proposed development
- Existing signal phasing and timing
- Roadway horizontal and vertical alignment (as-builts)

Appendix B – Existing Transportation System with Background Traffic Operational Analysis
- Capacity Analysis Inputs/Outputs

Appendix C – Existing Transportation System with Build Traffic Operational Analysis
- Capacity Analysis Inputs/Outputs

Appendix D – Existing Transportation System with Total Traffic Operational Analysis
- Capacity Analysis Inputs/Outputs

Appendix E – Transportation System Improvements with Background Traffic Operational Analysis
- Capacity Analysis Input/Outputs for each Alternative

(Label I, II, III, Etc.)

Appendix F – Transportation System Improvements with Build Traffic Operational Analysis
- Capacity Analysis Input/Outputs for each Alternative

(Label I, II, III, Etc.)

Appendix G – Transportation System Improvements with Total Traffic Operational Analysis
- Capacity Analysis Input/Outputs for each Alternative

(Label I, II, III, Etc.)

Appendix H – Justification for a Regulatory Speed Limit Change
- Speed Study

Appendix I – Warrant Analysis for Intersection Traffic Control
- Signal warrants
- Warrants for other types of control

1 CHAPTER

A brief introduction and summary *should* be provided at the beginning of the TIA report.

PART A — PURPOSE OF REPORT AND STUDY OBJECTIVES

The purpose of the report, highlighting who conducted the analysis and why, **shall** be clearly identified. Discussion of the study objectives, focusing on the specific issues addressed, is also helpful in establishing the background for review of the report.

PART B — EXECUTIVE SUMMARY

The summary should typically be a maximum of five pages in length.

An Executive Summary **shall** be provided at the beginning of the report to provide a short synopsis of the important findings and conclusions. The summary would normally be a maximum of five pages in length and *should* be understandable as a stand-alone document. It **shall** contain, at a minimum, the following information:

- Location of the study site with respect to the area roadway network.
- Description of the proposed development including the types and sizes of all land uses, construction phasing (if applicable), and proposed access scheme.
- Discussion of the principal findings of the analysis: existing traffic conditions, programmed roadway improvements (if applicable), amount of site-generated traffic, and projected background traffic volumes.
- Summary of the study conclusions: future levels of service with and without the proposed development.
- Identification of all mitigation measures recommended to achieve an acceptable LOS on the area roadway network, including a discussion of when they *should* be implemented.

2
CHAPTER

Narratives and figures provide the reviewer with a complete description of the proposed development. Descriptions must explain the time-frame(s) and stages/phases for the development, location of the site, planned land use, and intensity of the development. If the development will not take place at once, the development stages including areas for each phase and year of build-out must be identified and shown on the site plan.

The description of the proposed development **shall** include the following:

- On-site development
- Study area
- Off-site land use and development
- Site accessibility

PART A — ON-SITE DEVELOPMENT

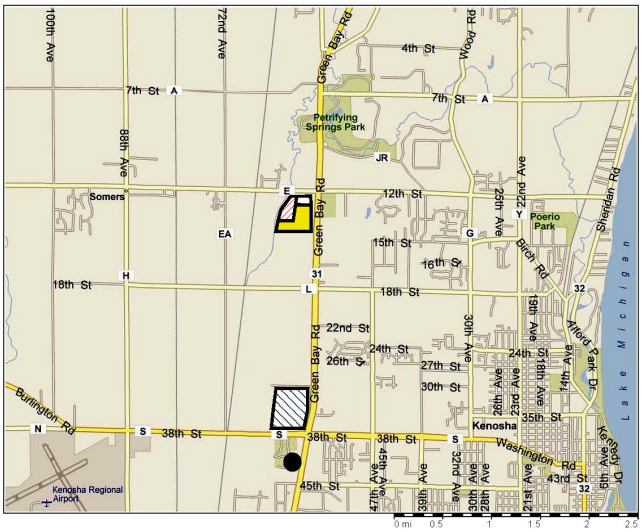
The description of the proposed development **shall** include the following exhibits:

Exhibit 2-1 . . . . . Site Location Map
Exhibit 2-2 . . . . . Site Plan
Exhibit 2-3 . . . . . Development Staging Detail

1. Development Description and Site Location

Identify the name of the proposed development and describe its general intended use. A legible map showing the study site in relation to the surrounding roadway network **shall** be provided in the report. The size of the site in acres and the amount of frontage available on all adjacent streets **shall** be noted on the map or in the accompanying text. Exhibit 2-1 is a sample of a site location map.

EXHIBIT 2-1



PROPOSED ROLLING WILLOW CENTER
ON-SITE DEVELOPMENT

WILLOW CREEK CONDOS
OFF-SITE DEVELOPMENT

CONNOLLY SUBDIVISION
OFF-SITE DEVELOPMENT

SAVANNAH AND AVALON PARC
OFF-SITE DEVELOPMENT

PARCEL A
OFF-SITE DEVELOPMENT

2. Land Use and Intensity

The project description *should* provide as much detail as possible for all land uses being proposed for the site along with the local zoning designation. If specific tenants are known (e.g. Wal-Mart, Walgreens, Menards) or if the developer expects to attract certain types of uses (e.g. branch bank, medical offices, fast-food restaurant, convenience store, gas station), these *should* be noted. The use of generalized land-use categories (i.e. "commercial/retail") *should* be avoided whenever possible.

The size of each land use component within the development **shall** be given in terms of square feet of gross building area (for retail, office, and

*The size of each land use component **shall** be given.*

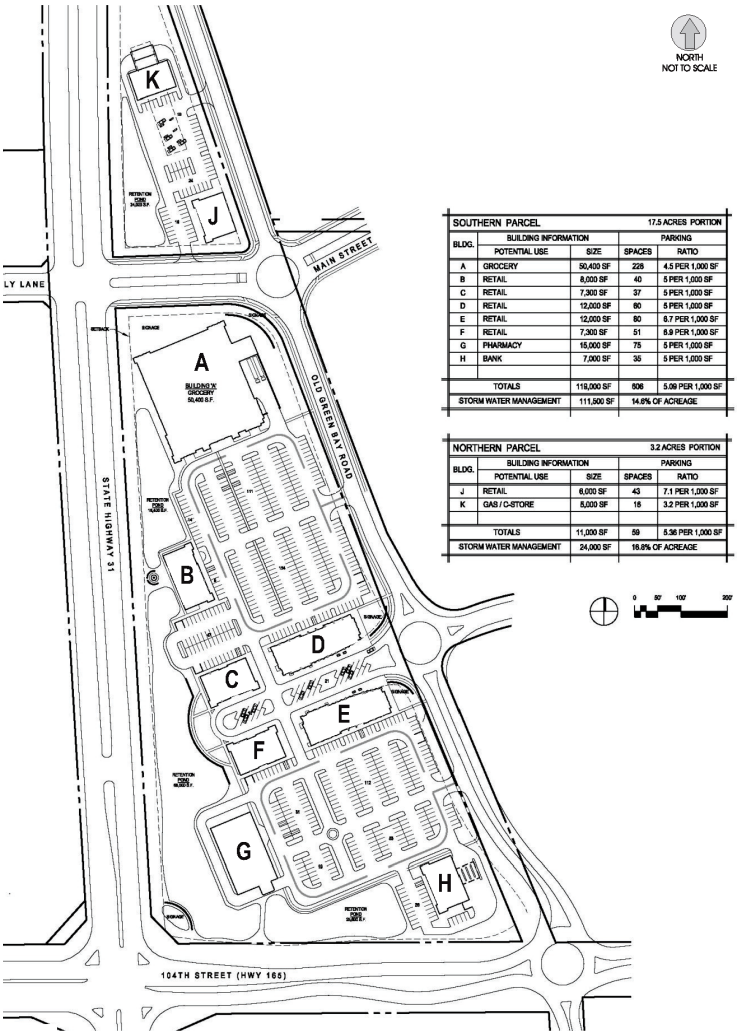
industrial uses), dwelling units (for residential components), or other unit appropriate for that particular land use type in accordance with the latest version of the ITE Trip Generation Manual.

3. Proposed Site Plan

A scaled drawing of the proposed development plan **shall** be provided. A brief narrative **shall** also be included in the report to help identify key features on the drawing. The following information **shall** be clearly identified:

- North Arrow
- Dimensions of the site
- Site boundaries and adjacent streets
- Location of existing driveways and/or street intersections in close proximity to the site (scalable or include dimensions)
- Existing rights-of-way with the location, lane configurations and widths of pavement, sidewalks, or multi-use trails on all adjacent streets
- Location and size of all land uses within the project
- Building configurations (if known) and pedestrian access including sidewalks
- Location and design of all proposed driveways and/or street intersections in close proximity to the site (scalable or include dimensions)
- Parking layout, internal circulation, and location of bike racks
- Any deed restrictions or access control
- Medians
- Median Openings

EXHIBIT 2-2



SOUTHERN PARCEL				17.5 ACRES PORTION
BLDG.	BUILDING INFORMATION		PARKING	
	POTENTIAL USE	SIZE	SPACES	RATIO
A	GROCERY	50,400 SF	226	4.5 PER 1,000 SF
B	RETAIL	8,000 SF	40	5 PER 1,000 SF
C	RETAIL	7,300 SF	37	5 PER 1,000 SF
D	RETAIL	12,000 SF	60	5 PER 1,000 SF
E	RETAIL	12,000 SF	80	6.7 PER 1,000 SF
F	RETAIL	7,300 SF	51	6.9 PER 1,000 SF
G	PHARMACY	15,000 SF	75	5 PER 1,000 SF
H	BANK	7,000 SF	35	5 PER 1,000 SF
TOTALS		119,000 SF	606	5.09 PER 1,000 SF
STORM WATER MANAGEMENT		111,500 SF	14.6% OF ACREAGE	

NORTHERN PARCEL				3.2 ACRES PORTION
BLDG.	BUILDING INFORMATION		PARKING	
	POTENTIAL USE	SIZE	SPACES	RATIO
J	RETAIL	6,000 SF	43	7.1 PER 1,000 SF
K	GAS / C-STORE	5,000 SF	16	3.2 PER 1,000 SF
TOTALS		11,000 SF	59	5.36 PER 1,000 SF
STORM WATER MANAGEMENT		24,000 SF	16.6% OF ACREAGE	

Exhibit 2-2 illustrates an example site plan that shows the driveways and the relationship of the driveways to the street system.

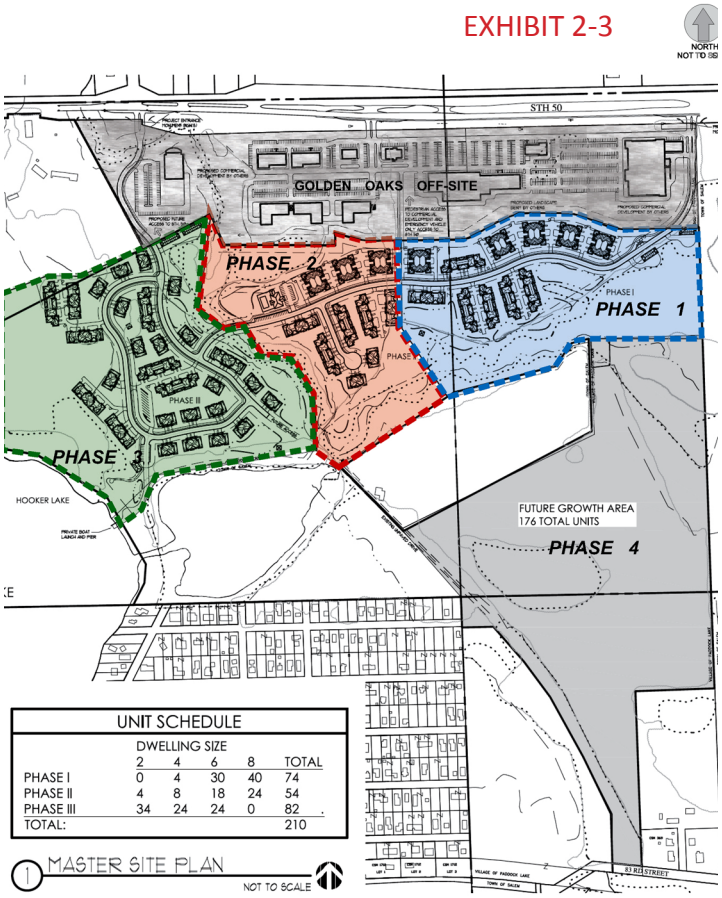
4. Development Phasing and Timing

The anticipated opening date for the proposed development **shall** be identified. If the developer plans to build a large project over a period of five years or more, the expected phasing schedule **shall** be provided; it *should* indicate what specific construction (land-use, size and type)

would be undertaken and the projected completion date for each phase. There may be various improvement needs necessary for the entire project, which are not warranted for the initial stage. A drawing of the site that highlights each of the various stages of development *should* be provided.

Exhibit 2-3 is an illustration of a development phasing detail.

EXHIBIT 2-3



PART B — STUDY AREA

The purpose of this section is to describe the area impacted by, or influencing traffic to and from the proposed development. Typically this area depends upon the type, size, and location of the proposed development and the prevailing traffic conditions on the surrounding roadway network. The study area *should* be determined based on the projects influence area and its area of significant traffic impact.

1. Influence Area

The influence area is typically used as the basis for estimating the distribution of trips to the site.

The proposed development's influence area is the geographical area surrounding the site from which the project is likely to draw a high percentage of its trips. The influence area is typically used as the basis for estimating the distribution of vehicle trips to the site. Describe the influence area for this project and identify the method used to establish it.

2. Area of Significant Traffic Impact

The study area will be confirmed by WisDOT's Regional Office during the initial review process.

The area of significant traffic impact is the geographical area that includes the facilities significantly impacted by the site traffic. The traffic generated by larger developments is likely to affect traffic conditions over a wider area than smaller projects. Therefore, it is appropriate to require a larger study area in the analysis of larger projects. The study area will be confirmed by WisDOT's Regional Office during the initial review process.

A description of the anticipated roadway system to be studied *should* be presented in this section.

PART C — OFF-SITE LAND USE AND DEVELOPMENT

Planned projects that may have a significant impact on future travel conditions should be noted.

Understanding the existing and future developments within the study area is essential to evaluating the impacts of the new site, determining the appropriate access points, and selecting improvements. The TIA report *should* provide the reader a full understanding of the area, so potential conflicts, impacts, or the opportunity for incorporating improvements as part of the proposed development project can be realized.

A brief description of current land uses and anticipated future development in the vicinity of the site *should* be provided. Any available information on planned projects that, due to their size and/or location, would have a significant impact on future travel conditions in the study area *should* be noted.

EXHIBIT 2-4

The local entities within the study area *should* be consulted to determine what other developments are being proposed for the area. Discuss the Regional Planning Commission's latest land use plan and the local government's short term (within 5 years) plans for the area. Contact information for all regional planning commission's can be found at this website (http://www.dot.wisconsin.gov/projects/planorg/rpc-contacts.htm) A local entity's master plan for the area **shall** be shown, if complete.

Exhibit 2-4 illustrates a map of a study area showing existing and proposed land uses.

PART D — SITE ACCESSIBILITY

A description of the existing roadway system should be provided.

The purpose of this section is to present the existing and future area roadway system servicing the proposed development. This information *should* be presented in a narrative form and shown on the Site Location Map and/or Site Plan.

A description of the existing roadway system *should* be provided in this section of the report with particular emphasis on the major travel routes to and from the site. The narrative *should* include such items as existing roadways, adjacent driveways, frontage road/interconnections, private roads, and sidewalks within the study area. The existing traffic control at each intersection (e.g. signalized, four way stop) **shall** be identified. Any travel restrictions such as one-way streets or left-turn prohibitions **shall** be discussed.

The local entities within the study area must be consulted to determine what, if any, roadway projects are planned for the area. These might include construction of new roadways, widening or extension of existing facilities, or installation of new traffic signals. The scheduled completion date for such improvements *should* be provided.

A discussion of all alternative modes of transportation that may service the development must be included. These modes include, but are not limited to: transit, car pools, vanpools, bicycles, and walking. In addition, alternative work hours *should* be discussed if appropriate. For further information, see Chapter 4 – Part B.

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CHAPTER

The analysis of existing conditions provides a base against which the incremental traffic impacts of the proposed development can be measured. The following topics **shall** be addressed:

- Physical characteristics
- Traffic volumes
- Capacity/Level of Service
- Sources of data

PART A — PHYSICAL CHARACTERISTICS

Detailed information regarding the physical characteristics of the existing transportation system **shall** be provided for the study area. Indicate any currently planned roadway or traffic control changes (state year improvement is planned and initiating agency). This topic *should* be discussed in project narrative. A general discussion regarding the characteristics **shall** be included in the report along with a detailed exhibit. Exhibit 3-1A Existing Transportation System and Exhibit 3-1B Planned Transportation System *should* include the following items:

a. North Arrow
b. Labeled major highways and streets
c. For the roadway system:
   - » Indicate if roadways are divided or undivided
     - ▪ Identify median openings
   - » Show distances between major roadways and proposed site
   - » Identify the location of driveways within the immediate area
   - » Show the lane configuration at each intersection to be analyzed
     - ▪ Can be shown as arrows
   - » Identify the location and type of traffic control devices (e.g. stop signs, traffic signals, etc.)
   - » Indicate the posted speed limits
   - » Identify pedestrian, bicycle, and multi-use trails
   - » Highlight available transit service and bus stops
   - » Identify restrictions such as one-way streets or left-turn prohibitions

Note: A scaled exhibit is not required, however, distances to major roadways, driveways, access points, median openings and so on **shall** be shown in order to easily identify access spacing issues which may arise during the review.

PART B — TRAFFIC VOLUMES

The report *should* contain information on existing 24-hour traffic volumes for the highways and streets in the study area as well as peak-hour turning movements at all major intersections to be analyzed.

At a minimum, the traffic volumes *should* include AADT or AAWDT and critical hours of ingress or egress of the proposed development. The critical hours **shall** be determined as any timeframe that will have the greatest impact to the highway system and

highest traffic to/from the development. Time frames may vary depending on the type of development and the traffic volumes generated, but typically *should* be:

Morning peak:	6 A.M.	to	9 A.M.
Afternoon peak:	3 P.M.	to	6 P.M.
Weekend peak:	11 A.M.	to	2 P.M.

Other peak periods may be specified in addition to, or in place of the weekday morning and afternoon typical peak hours in the following situations:

- Peak traffic in the study area is known to occur at a different time of day (e.g. noon or weekends only).
- The proposed project is expected to generate little or no traffic during the AM or PM peak periods.
- The proposed land use has unusual peaking characteristics (e.g. a church or theater).

*Improvements to meet the highest traffic volumes for a particular movement **shall** be proposed.*

Show the current turning movements at the existing controlled intersections that are expected to be impacted by the proposed development. For the major intersections, both the AM and PM peak volumes **shall** be shown. The highest traffic volumes for a given maneuver at a major intersection may be higher during a period which is not a critical time for the development. In this case, volumes not identified as the critical hours for development generated traffic would dictate storage lengths or lane needs. The traffic volumes at the intersection's peak hours must be evaluated to ensure the improvements are appropriate to handle the system's traffic. The non-critical hours for the development do not need to be shown for the private access points. However, improvements to meet the highest traffic volume **shall** be proposed and discussed in the conclusions and recommendations.

WisDOT collects traffic volume data at nearly 30,000 sites on streets and highways around the state. Sites that are counted include freeways, major and minor arterials, and collector streets in all 72 Wisconsin counties. Summaries of the Annual Average Daily Traffic (AADT) have been published in map format by the department for many years and are available at www.dot.state.wi.us/travel/counts. TIA preparers benefit from information about how traffic volumes vary at different times of the day (e.g. rush hour vs. off-peak) or by travel direction. The Wisconsin Traffic Operations and Safety (TOPS) Laboratory has created a website with the continuous and coverage count data collected by WisDOT to provide more convenient data access to hourly and directional traffic volume information. The website can be accessed through this link - http://transportal.cee.wisc.edu/products/hourly-traffic-data/. Some regions also perform manual turning movement counts at certain intersections. These counts are typically repeated every three years. The coverage count data includes AADT, raw data, and hourly volumes. Traffic volume data might also be available from the local municipality. This information *should* be used as the primary source of existing traffic volumes rather than conducting new counting efforts. WisDOT does not typically conduct counts for private entrances; this information will need to be collected by the

*Traffic volume data used **shall** be at most three years old.*

consultant preparing the report. If independent data gathering is conducted, methods and sources **shall** be documented. Traffic volume data used **shall** be at most three years old. Traffic volume data for multiple intersections in the same corridor **shall** be within the same year. Contact the WisDOT Regional Office with requests for existing traffic volume information that is not available in the links provided.

The WisDOT Regional Office **shall** be consulted before a traffic count is performed to help identify the time periods to be counted.

If the development will not be completed within two years of the oldest count in the study area, base year traffic **shall** be established. **Base year** traffic refers to the year the development is anticipated to open. A forecast request for the base year traffic **shall** be submitted to the WisDOT Regional Traffic Forecasting Contact

Exhibit 3-2A Existing Traffic Volumes **shall** illustrate the existing AADT/AAWDT for all highway segments within the study area, and all peak hour movements for the critical hours of ingress or egress. Exhibit 3-2B Base Year Background Traffic Volumes **shall** illustrate the base year AADT/AAWDT for all highway segments within the study area, and all peak hour movements for the critical hours of ingress and egress. Exhibit 3-2B is necessary if the development is not building in the existing year. Exhibits 3-2A and 3-2B **shall** include the following items:

- North Arrow
- Label all major highways, streets, and access points
- Provide a legend indicating the peak hour movements by time. To differentiate between each hour, denote the time as follows:
  - » AM
  - » (PM)
  - » [Other Critical Hours]

Appendix A Traffic – Existing Traffic Counts **shall** include any raw data used to create Exhibits 3-2A & B.

PART C — CAPACITY / LEVEL OF SERVICE

The purpose of the Capacity/Level of Service analysis is to show the relationship between traffic operations and roadway geometrics, identify needs, and to identify alternatives for further consideration. The analysis of traffic volumes, facility capacity, and level of service (LOS) must be performed for each roadway segment, intersection, and driveway in the immediate area of the development within the study area.

*Roadway and intersection capacity analysis **shall** be based on the methods of the latest HCM.*

Roadway and intersection capacity analysis **shall** be based on the procedures, methods, and techniques recommended in the latest edition of the Highway Capacity Manual. The most current version of accepted software's that support the HCM methodology **shall** be used. Acceptable software programs for each type of facility are listed in WisDOT's Facilities Development Manual (FDM) Procedure 11-5-3.7. For studies which require a

traffic signal system analysis, the Region office will determine the appropriate software program. For all analyses, both the input and output data must be clearly labeled and included in Appendix B Existing Transportation System Conditions Capacity/LOS Analysis.

When using Synchro to perform the analysis, the following reports shall be included within the appendix:

Signalized Intersections:

Contact the Regional Office for current signal timings and sequence of operations.

- Intersection report with the following data:
  - » Lane Inputs
  - » Volume Inputs
  - » Timing Inputs
  - » Actuated Inputs
  - » Queues
  - » Actuated Inputs
- HCM 2010 Signalized "Summary" report*

Unsignalized Intersections:

- Intersection report with the following data:
  - » Lane Inputs
  - » Volume Inputs
- HCM 2010 AWSC or TWSC report*

'Skip Unused Items' should not be selected when creating the reports.

* *To present the 95th percentile queue within the HCM 2010 Signalized report, the Queue Length Percentile must be changed to '95' under Synchro's HCM 2010 tab.*

For **signalized intersections**, LOS is based on roadway system characteristics that include traffic volume, lane geometry, percentage of trucks, peak-hour factor, saturation flow, number of lanes, signal progression, ratio of signal green time to cycle time, roadway grades, parking conditions and pedestrian flows. For the analysis of an existing signalized intersection, contact the Regional Office for the current signal timings and sequence of operations. This information will dictate the time for minimum green, maximum green, pedestrian walk, pedestrian clearance, and vehicular clearance intervals. For signalized intersections within a system, the existing timing will also provide cycle lengths, splits, and offsets. For an isolated actuated signalized intersection, a field study to determine the average green time for each movement *should* be conducted.

The percent heavy vehicles **shall** be calculated for each approach based on the most recent manual traffic count class distribution. Geometric information such as the number of lanes, lane widths, approach grades, and lane usage **shall** be gathered from either as-built plans or field observations. Transit information including route locations,

stop locations, and frequency of buses **shall** be obtained from the appropriate transit agency.

The peak hour factor (PHF) **shall** be calculated per intersection based on the most recent manual traffic count. In those cases where trip generators have peaking characteristics such as churches, movie theaters and factories, a PHF may be applied per movement to perform the analysis.

A v/c ratio of 1.0 or more represents failure from a capacity perspective.

Right turns on red can only be considered if an exclusive right turn lane is provided. Contact the Regional Engineer for guidance on the method to be used to calculate RTOR.

At **unsignalized intersections** LOS analysis for both two-way stop controlled (TWSC) and all-way stop control (AWSC) depends upon a clear understanding of the interaction of drivers on the controlled approaches with drivers on the uncontrolled approaches (if any). Both gap acceptance and empirical models have been developed to describe this interaction. Level of service for TWSC and AWSC intersections is determined by computing or measuring control delay. Unsignalized intersection analysis **shall** follow current HCM procedures. A gap study can be presented as additional information, however, there are two main issues related to gap studies, which do not allow this study to be used as a replacement of the HCM procedures.

Base roadway conditions include the existing roadway and intersection conditions plus any programmed improvement.

1. The gap study only considers the existing available gaps; the gap reduction due to increased traffic along the main highway cannot be evaluated.

2. The gap study must look at the total gaps available for all conflicting maneuvers within the intersection. A left turn exiting may turn directly after an entering left turn if no other vehicles are queued waiting to enter the side road or access point. However, the exiting vehicle may not proceed into the intersection if other main highway traffic is waiting to turn left. Since exiting traffic must yield to all other traffic maneuvers, it is important to ensure they can turn without excessive delay or blocking of a median opening to complete the turn.

As discussed in the HCM, LOS can be characterized for a whole intersection, each intersection approach, and each lane group. Control delay is used to characterize LOS for the entire signalized or unsignalized intersection or an approach. In contrast, control delay and volume to capacity ratio (v/c) are used to characterize LOS for a lane group at an intersection. A lane group can have a delay less than the threshold for LOS D, E or F when the v/c ratio exceeds 1.0. A v/c ratio of 1.0 or more indicates that cycle capacity is fully utilized at a signalized intersection or that the gap sizes are not enough for the minor-street demand volume to safely cross at a stop controlled intersection and represents failure from a capacity perspective; just as LOS F represents significant failure from a delay perspective. A critical v/c ratio greater than 1.0 indicates that the overall signal, stop control and or lane configuration provides inadequate capacity for the given flows.

Using the information provided in Parts A and B above, conduct the analysis for the existing (i.e. base) roadway and traffic conditions with non-site traffic (i.e. without the proposed development). Base roadway conditions include the existing roadway and intersection conditions plus any programmed improvements that will be in place prior to the development being completed. This serves as the baseline for determining the current operation or LOS of the existing transportation system. Identify the existing capacity, delay, LOS, geometric and operational deficiencies, and the methods used to calculate them. Exhibit 3-3 Base Year Background Capacity/LOS Analysis **shall** illustrate in a table and/or graphic format the LOS, delay, volume to capacity (v/c) ratio and 95th percentile queues for each movement and the intersection as a whole. Consult with the Region for their format preference. Electronic files used for the analysis **shall** be provided and clearly labeled as a digital submission (e.g. xra, syn).

PART D — SOURCES OF DATA

In this section, list the type, year and source of all traffic data including but not limited to: turning movement counts, average daily traffic, traffic forecasts, existing signal timings, crash data and programmed improvements plans/analysis files (if available). WisDOT provides data on the State Trunk Highway and Connecting Highway systems.

Additional sources of data include:

- Regional Planning Commissions
- Municipal Traffic Departments
- County Traffic Departments
- Other recent traffic studies
- Highway design data for recent projects
- Traffic Operations and Safety (TOPS) Laboratory

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Future traffic volumes in the vicinity of the site **shall** consist of background traffic plus development traffic plus the additional off-site development traffic generated. Because the accuracy of the traffic analysis is dependent upon the accuracy of the traffic projections, it is very important that all assumptions and the methodology used in preparing the estimates of future traffic be fully documented so that they can be judged for reasonableness and completeness.

A description of the projected traffic **shall** include:

- Background traffic forecasting
- Development traffic and off-site forecasting
- Total traffic (i.e. background plus development plus off-site development traffic)

PART A — BACKGROUND TRAFFIC FORECASTING

*Generally, the horizon year **shall** be established as 10 years after the opening of the proposed development or five years after build-out, whichever is greater.*

Background traffic volumes represent the amount of traffic that will be on the area roadway network without any proposed development. A traffic projection of this background volume to an appropriate horizon (future) year **shall** be completed. Regional staff **shall** establish the horizon year prior to proceeding with the study. There may be multiple horizon years (i.e. interim years) required for phased development. Generally, the horizon year **shall** be established as 10 years after the opening of the proposed development or five years after build out, whichever is greater.

The WisDOT Regional Traffic Forecasting Contact will generally provide traffic volume forecasts for the state trunk highways and connecting highways involved. These *should* be obtained, reviewed against the latest coverage counts, and considered for use in the analysis. Any forecasts not developed by WisDOT forecasting staff **shall** be reviewed and approved by the WisDOT forecasting unit.

Four potential sources of background traffic projections are:

- WisDOT Regional Traffic Forecasting Contact
- Local or Regional Planning Commissions
- Trends and growth rates used in projects within the study area
- Area or sub-area transportation models

Prior to making traffic forecasts, the preparer **shall** discuss with the Regional Traffic Forecasting Contact the availability of non-site traffic projections and the method to be used in developing such estimates when none are available.

Exhibit 4-1 Interim Year Background Traffic Volumes and Exhibit 4-2 Horizon Year Background Traffic Volumes **shall** illustrate the anticipated interim and horizon year traffic volumes respectively for each time period chosen for analysis. Exhibit 4-1 and 4-2 **shall** be structured similar to Exhibit 3-2A & B.

PART B — ON-SITE AND OFF-SITE DEVELOPMENT TRAFFIC FORECASTING

To determine the impact of the proposed development on the future traffic operating conditions, it is necessary to estimate the general characteristics of the additional traffic that it may generate and the distribution of this traffic on the area roadway network. This requires five steps:

1. Trip generation
2. Mode split
3. Determination of pass-by, internally-linked, multi-linked, and externally-linked trip traffic, (if applicable)
4. Trip distribution
5. Trip assignment

On-site and off-site development traffic forecasting **shall** be performed for each horizon year to be analyzed. There may be multiple horizon years required for phased developments. Different site traffic assignments would be expected in the following situations:

- For each phase of a multi-phase project
- Where significant traffic growth is expected between horizon years
- Where major roadway or transit improvements are expected to result in a significant change in travel patterns between horizon years

1. Trip Generation

The major factors determining the amount of traffic that may be generated are the on-site and off-site development's size and land uses. In particular, the type of land use (e.g. residential, retail, industrial, office, etc.) will have a significant impact on the amount of new traffic that may be added to the area roadway network and the time of day in which it occurs.

Evaluate whether the trip generation data is applicable to the specific site.

The most commonly accepted source for trip generation data for land use developments is the Institute of Transportation Engineers (ITE) Trip Generation, an ITE Informational Report. ITE Trip generation provides data in terms of trip rates (average, maximum and minimum), regression equations (i.e. fitted curve equations) and data plots. A guideline of when to use each source of data in estimating the trip generation characteristics of a land use is provided in the *Trip Generation Handbook*. The following are ITE's recommended guidelines on using the rates or equations provided in ITE Trip Generation, or when local data *should* be collected.

I. Use regression equation when:

- Regression equation is provided;
- Independent variable is within the range of data;
- Data plot has at least 20 points;
- $R2 \geq 0.75$;
- Equation falls within data cluster in plot; and
- Standard deviation > 110 percent of weighted average rate.

II. Use weighted average rate when:

- At least 3 data points are available;
- Independent variable is within the range of data;
- Standard deviation ≤ 110 percent of weighted average rate;
- R2 < 0.75 or no equation provided; and
- Weighted average rate falls within data cluster in plot.

III. Local data should be collected when:

- Study site is not compatible with ITE land use code definition;
- Only 1 or 2 data points are provided;
- Independent variable does not fall within range of data; and
- Neither weighted average rate line, or fitted curve, fall within data cluster at size of development.

Document the methods used to determine the trip generation for each land use.

Trip generation rates or regression equations published in the latest edition of ITE *Trip Generation should* be used to estimate site traffic unless individual studies have been conducted specifically for the proposed development, or individual company data exists. Also, ITE data are not available – or are very limited – for many types of land uses. In these cases, appropriate trip generation rates may be available from one or more of the following sources:

- Local data for comparable developments
- Other published references such as the ITE Journal
- Trip generation studies conducted at sites similar to the proposed development

Trip generation rates can have a significant impact on the outcome of the traffic analysis.

All sources used **shall** be referenced. If the source is not from ITE *Trip Generation,* evidence **shall** be provided, in writing, as to their suitability for this particular application. The outcome of the entire traffic analysis can often depend solely on the question of appropriate trip generation rates, thus any use of non-ITE rates must be reasonable and defensible.

Exhibit 4-3 Trip Generation Table *should* be organized in a manner that will help both the author of the report and the many users of it understand the process. Typically, the table would identify the following:

- Land use
- ITE code
- Land use size
- Trip rates (i.e. in, out and total for peak hours) for two-way and daily traffic
- Number of vehicle trips generated (i.e. in, out, total for peak hours) for two-way and daily traffic

2. Mode Split

The ITE rates are based on numerous surveys taken at developments where there is no significant transit or pedestrian activity, and therefore represent 100 percent auto usage. This is an appropriate assumption for many of the developments that will be reviewed. There will be occasions, however, when some of the trips to and from the project would

likely be made by another mode of transportation (e.g. transit, bicycle or walking). These trips would normally occur in populated areas where such services or facilities are available. Any assumptions regarding non-auto trips will be reviewed for reasonableness and must be well supported by documentation of the availability of transit service, surveys of current travel behavior and/or similar relevant data.

3. Determination of Pass-By, Internally-Linked, Multi-Linked, and Externally-Linked Trip Traffic

New trips are trips made for the specific purpose of visiting the trip generator. Therefore, these trips are new traffic on the area roadway network. Trip generation rates are derived from actual traffic counts conducted at the driveways of various developments. When dealing with non-commercial land uses such as residential projects, office buildings, hotels, and industrial parks, these driveway volumes usually represent the amount of new traffic being added to the area roadway network by those particular uses.

Generally, pass-by traffic should not exceed 5 to 10 percent of the traffic on the adjacent roadway.

Pass-by trips are trips that are currently on the roadway system and pass directly by a generator on the way to their primary destination. Pass-by trips are convenience-oriented; for example, stopping to refuel a vehicle during a commute from work. Pass-by trips are applied only to retail-oriented land uses that would have utilized the roadway adjacent to the retail land use even if the development was not present. The amount of pass-by traffic does not affect the number of trips that may enter and exit a proposed development (i.e. driveway volumes). However, it does reduce the amount of traffic that may be added to the adjacent street system by the new development (i.e. new trips). Depending on the type of development and adjacent street traffic volumes, predicted pass-by trips can vary significantly, so these adjustments must be applied carefully. The number of pass-by trips is calculated after accounting for internal trips (Total Site Trip Generation – Internally-Linked Trips = External Trips; apply pass-by reduction to External Trips).

*A pass-by trip estimate greater than 10 percent **shall** be approved by WisDOT.*

Generally, pass-by traffic *should* not exceed 5 to 10 percent of the traffic volumes on the adjacent roadways. Any assumptions regarding the amount of pass-by traffic greater than 10 percent of the adjacent roadway traffic volumes attracted to the new development **shall** be clearly stated in the traffic study and **shall** be accompanied by appropriate documentation supporting the percentage of pass-by traffic used in the analysis. A pass-by trip estimate greater than 10 percent **shall** be approved by WisDOT. Pass-by traffic *should* have equal ingress and egress volumes. WisDOT has developed a set of acceptable ranges for pass-by rates based on data from the ITE Trip Generation Handbook, 2nd Edition for use in TIA submittals. Please contact the Regional Traffic Engineer to obtain this information.

Internally-Linked trips are trips made without utilizing the major road system. An internal trip may stop at a drugstore, fast-food restaurant and a service station within the mixed-use development (MXD) without using the state highway facility to travel from one land use to another. Internally-Linked trips reduce the estimates of the number of trips entering and exiting the proposed MXD because one entrance and exit to the study area may serve two or more trips. Internally-linked trips also reduce

the amount of traffic that may be added to the adjacent street system by the new development. Internal capture rates vary by the mix of land uses, size, the amount of potential interaction between complementary land uses and the availability of convenient internal on or off street facilities and connections. Typically, internally linked trips may be applied to mixed use developments that contain the facilities and land uses to justify a significant amount of interaction to capture generated trips internally.

In evaluating a proposed internal capture rate, the following general guidance *should* be considered:

- Sites having a mix of residential and nonresidential components have the highest potential for internal capture trips. Mixes of nonresidential land uses are less likely to have a significant internal capture rate unless a hotel or motel is contained with in the site.
- Residence and employment centers at the mixed-use development *should* be income compatible so residents have ample employment opportunities in the community.
- The design of the internal roadway system of the development as well as the pedestrian/bicycle facilities may impact internal capture. A well-designed development with good internal connectivity can make it more convenient for trips to stay on the site.
- If there are nearby competing destinations, the internal capture rate may need to be adjusted.
- The ITE land use "shopping centers" (ITE code 820) is not considered a mixed-use development. Therefore, internal capture rates *should* not be used to forecast trips for this land use.
- Internal trip capture rates *should* be calculated for each phase of a multi-use development. If development plans change during the review process, all internal capture calculations *should* be updated and the TIA submitted for additional review.

Use the methodology established by NCHRP Report 684 Enhancing Internal Trip Capture Estimation for Mixed-Use Developments (http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_684.pdf) when estimating internal trip capture for the 6 land use groups discussed below. The report enhances the methodology established by the ITE Trip Generation Handbook and provides a spreadsheet estimation tool (Link) to facilitate application of the internal trip capture methodology. The methodology estimates morning and afternoon peak period trips to and from six specific land use categories:

- Office
- Retail
- Restaurant
- Residential
- Cinema
- Hotel

Use the total estimated internal trip capture from the spreadsheet estimation tool. Consult with your Region Contact to determine a maximum acceptable value if the internal trip capture is estimated to be greater than 10 percent of the new trips.
TIA preparers and reviewers are cautioned to become familiar with the procedure established in the report as well as understanding when the methodology is appropriate for the proposed MXD.

Determine whether the methodology is appropriate for your development.

The procedure *should* only be used for estimating internal capture at an MXD that has characteristics resembling the sites from which the internal capture rates have been derived. The following steps should be used to determine sites for which the procedure is appropriate.

- Development Type: The MXD *should* be a single, physically and functionally integrated development on a single block or a group of contiguous blocks with three or more revenue-producing uses, with internal pedestrian and vehicular connectivity, and with shared parking among some or all uses. The site *should* have sufficient parking supply to meet demand although the most convenient parking may sometimes fill during peak periods.

- Development Location: The MXD *should* be downtown fringe, general urban, or suburban. It *should* not be located either within or adjacent to a central business district (CBD).

- Development Size: The MXD *should* have at least 100,000 sq ft of building space within an overall acreage of up to roughly 300 acres. The MXD can be a single site, a block, or a district or neighborhood (with multiple interconnected or interactive blocks within a defined boundary); however, this procedure *should* not be used for a suburban activity center (SAC) composed of different adjacent, but not directly connected, land uses.

- Land Use Mix: The MXD *should* consist of a combination of at least three of the following uses: retail, restaurant, office, residential, hotel, and cinema. Internal capture for land uses beyond these six *should* be considered to be zero (unless comparable survey data for other land uses are provided) because there are no supporting data from which to derive an appropriate percentage. In addition, if a substantial portion of the land use at a mixed-use site is outside these six land uses, the reported internal capture rates might not be appropriate.

- ITE Trip Generation Database: The MXD *should not* already be covered in the ITE trip generation database as reported in the latest edition of Trip Generation. Current ITE land use classifications that already account for internal trip-making include shopping center, office park with retail, office building with ground floor retail or on-site cafeteria, and hotel with limited retail and restaurant space.

- Time Period for Analysis: The internal capture rates contained in this methodology cover the weekday A.M. and P.M. peak periods for adjacent street traffic. Weekday peak period internal capture rates are not appropriate for estimating weekend internal capture or weekday midday internal capture or daily internal capture unless survey data for those periods become available.

Multi-linked trips will use the state highway facility to travel between uses.

Multi-linked trips are similar to internally linked trips. Multi-linked trips may stop at multiple land uses and will use the state highway facility to travel from one land use to another land use. Multi-linked trips affect the estimates of the number of trips entering and exiting the proposed development. One entrance/exit to the study area may serve two or more trips. Multi-linked trips will increase the estimate of the number of trips at specific driveway locations for the new development. Multi-linked trips *should* have a trip generation reduction and be accompanied by a separate trip distribution exhibit. Any assumptions regarding the amount of multi-linked trip traffic attracted to the new development **shall** be clearly stated in the report and **shall** be accompanied by appropriate documentation supporting the percentage of multi-linked trip traffic used in the analysis.

Externally-linked trips occur when an existing trip stops at a land use within the development and stops at an existing land use within the study area boundaries of the development. Externally-linked trips *should* be considered only for developments occurring in heavily developed areas. Externally-linked trips *should* be shown as a distribution point in Exhibit 4-2 Trip Distribution. As an example, if 10% of the new trips are determined to be externally-linked, Exhibit 4-2 would show 90% of the traffic entering the boundaries of the study area with the other 10% of trips distributed from existing land uses within the study area boundaries. Externally-linked trips **shall** be limited to the lesser of 10% of the existing commercial and institutional trips or 10% of the new development trips.

All linked trip assumptions are subject to WisDOT approval.

All linked trip assumptions are subject to WisDOT approval and *should* be determined during the initial review process. It is important to note that linked trips refer to the internal capture of trips within a multi-use development site and *should* not be confused with diverted linked trips. Diverted linked trips refer to the number of trips attracted from the existing traffic on roadways within the vicinity of the generator but require a diversion from that roadway to another roadway to gain access to the site.

Pass-by and multi-linked trip adjustments **shall** be identified and displayed. Please see section 5, Trips Assignment for Exhibit Numbering.

4. Trip Distribution

The major factors to be considered in estimating the orientation of the on-site and off-site development generated traffic include the distribution of potential trip origins and destinations within the proposed development's influence area and the relative efficiencies (in terms of travel times) on the various approach routes to the site. Drivers normally choose the fastest, not necessarily the most direct, route to and from a traffic generator. This is particularly true when drivers are very familiar with likely travel conditions (as project residents or employees commuting to the site every day would be) and when alternative routes are available.

Common methods for estimating trip distribution are:

1. Analogy Method
   This method derives the trip distribution of a proposed development based on existing data at sites that are similar to the subject development. Typically, traffic count and turning movement data are used in the analogy method.

2. Gravity Model Method
   Trip distribution models estimate trip distribution based on characteristics of the land-use pattern within the influence area and the transportation system. The most common model used for trip distribution is the gravity model.

3. Surrogate Data
   This method is useful if an extensive socioeconomic or demographic database exists for the influence area. For example, population data can be used as a surrogate data for retail trips. Employment is a reasonable surrogate for residential trips.

4. Market Area Analysis Method
   This method uses the influence area of the proposed development, corresponding to 90 percent or more of the trip ends that may be attracted to the site. A market study, if available, and a delineated influence area, typically a circle with a radius corresponding to a travel time appropriate for the type of development, are two options to determine the boundaries of the study area for trip distribution.

5. Origin-Destination Method
   Use Origin-Destination data from Regional Transportation Plans or Local Plans. Two examples of major local and regional transportation plans available are:

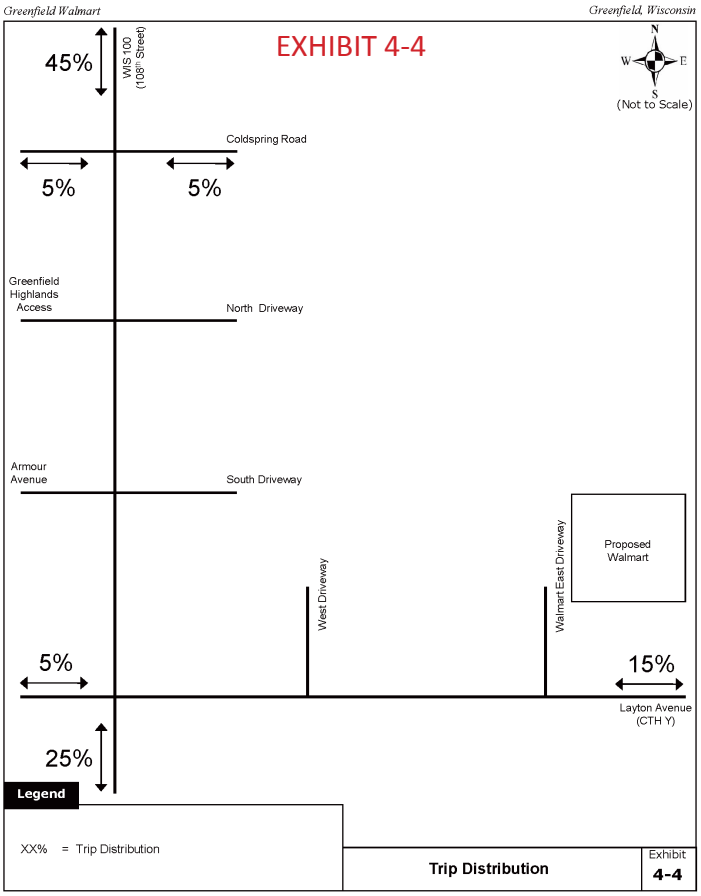
   » Madison Area Transportation Planning Board:
   www.madisonareampo.org/planning/regionalplan.cfm

   » Southeastern Wisconsin Regional Planning Commission:
   www.sewrpc.org/SEWRPC/Transportation/2035RegionalTransportationPlan.htm

On-site and off-site development traffic distributions should be represented as percentages for each direction of travel.

The method used and the source of data **shall** be documented in the report. Directions of approach and departure *should* be estimated for each land use component of the proposed project and for each horizon year. In some cases, inbound and outbound trips may have different distributions depending upon applicable operating conditions (for example, one-way streets, medians, or difficulty in making left turns). Any such differences *should* be explained.

On-site and off-site development traffic distributions *should* be depicted as percentages for each direction of travel. Displaying this information on a map provides the best method of showing the directional distribution of traffic for the development. A sample distribution is shown in Exhibit 4-4 Trip Distribution.



5. Trip Assignment

Trip assignment involves determining the amount of traffic expected to use each access point and the route this traffic is expected to take through the roadway network. It establishes the number of generated turning and through movements at each intersection and roadway segment of the study area network. The product of this step of the process is traffic volumes appropriate for use in the Traffic and Improvement Analysis of Chapter 5.

Projected on-site and off-site development traffic volumes would be assigned to the area roadway network using the directional distributions developed by the trip distribution analysis. This is accomplished by multiplying the projected on-site and off-site development traffic volumes by the percentage of traffic expected to arrive and depart via a particular route after accounting for any reduction for less than 100 percent auto usage, pass-by traffic or multi-linked trip traffic.

Several important points *should* be considered when preparing trip assignment. Trip assignment *should* begin by identifying all possible paths between origins and destinations. The potential for using these paths can then be evaluated on a comparative basis considering:

- Driver tendencies and local patterns in developing logical travel routes
  - » For example, drivers often will use the first convenient driveway they reach to access a site with multiple driveways.
  - » Driver characteristics reflecting the proposed land use (i.e. will drivers tend to use back roads/local connections or are they new to the area and will tend towards major travel routes).
- The design of the internal circulation and the location of residential land uses
  - » The design of the internal circulation for a multi-use development may determine what driveway drivers will use for specific land uses.
- Available roadway capacities
  - » The known capacity constraints may impact route alternative selection.
  - » Turn movement capacity and restrictions; particularly for left-turns.
- Relative travel times
  - » Horizon year and potential corresponding conditions at that time.
  - » Planned improvements or network changes could result in modifications to

the trip assignment compared to current conditions or when evaluating horizon years.
  - » The proposed land use may impact driver needs and tendencies (e.g. the differences between a daily commute trip and a recreational trip).

- Assignment percentages typically apply to two-way trips.
  - » Turn movements will likely be different or reversed between an entering and exiting trip.
  - » One-way streets may influence assignment patterns.

- The presence of on/off ramps at interchanges.
  - » Pass-by trips enter from adjacent streets and typically exit to the same street to continue on their original path.

Adapted from: Transportation Impact Analyses for Site Development, ITE 2010

Manual assignments for each analysis period **shall** be made for each base, interim and horizon year. Multiple paths *should* be assigned between origin and destinations based on experience and judgment to achieve realistic estimates.

The trip assignment exhibit order **shall** be:

Exhibit 4-5 . . . . . Base Year On-Site Development Traffic Assignment
Exhibit 4-6 . . . . . Interim Year On-Site Development Traffic Assignment
Exhibit 4-7 . . . . . Horizon Year On-Site Development Traffic Assignment
Exhibit 4-8 . . . . . Base Year Off-Site Development Traffic Assignment
Exhibit 4-9 . . . . . Interim Year Off-Site Development Traffic Assignment
Exhibit 4-10 . . . . . Horizon Year Off-Site Development Traffic Assignment

A sample exhibit order is shown as follows:

Base Year On-Site Development Traffic
Exhibit 4-5A . . . . . New Trips
Exhibit 4-5B . . . . . Multi-Linked Trips
Exhibit 4-5C . . . . . Pass-by Trips
Exhibit 4-5D . . . . . Driveway Trips

Note: In the case of multiple interim years, the lettering **shall** continue with E for new trips, and so on.

PART C — BUILD AND TOTAL TRAFFIC

Build and total traffic volume assignments **shall** be developed for each time period and horizon year chosen for analysis.

Build traffic is defined as the background/base traffic plus the on-site development or off-site development (new) traffic that is expected to be using the roadway network first (whichever development that occurs first is to be included in the build traffic).

The use of on-site or off-site development traffic for this analysis *should* be confirmed with the Regional traffic contact. The purpose of the build traffic analysis is to determine any capacity concerns that may require improvements due to the expected development that is to occur first whether it is on-site or off-site.

Note: If there is no off-site development expected (first) then a total traffic analysis scenario does not apply and is not necessary.

Total traffic volume consists of the summation of the background/base traffic plus the on-site development traffic and the off-site development traffic. These may be a combination of the following:

Exhibit 3-2A/B . . . . Existing/Base year traffic volumes
Exhibit 4-1 & 4-2 . . . Background traffic forecasts
Exhibit 4-5 to 4-7 . . . Base/Interim/Horizon Year On-site Development Traffic Assignment
Exhibit 4-8 to 4-10 . . Base/Interim/Horizon Year Off-site Development Traffic Assignment

The following three exhibits **shall** illustrate the base, interim and horizon year build traffic respectively:

Exhibit 4-11 . . . . . Base Year Build Development Traffic Volumes
Exhibit 4-12 . . . . . Interim Year Build Development Traffic Volumes
Exhibit 4-13 . . . . . Horizon Year Build Development Traffic Volumes

The following three exhibits **shall** illustrate the base, interim and horizon year total traffic respectively:

Exhibit 4-14 . . . . . Base Year Total Development Traffic Volumes
Exhibit 4-15 . . . . . Interim Year Total Development Traffic Volumes
Exhibit 4-16 . . . . . Horizon Year Total Development Traffic Volumes

Appendix A Traffic – Future Traffic Projections **shall** include any raw data, supporting information, and calculations used to develop the traffic forecasts including:

- Base Forecasts,
- Trip Generation,
- Mode Split,
- Pass-By Trips,
- Multi-Linked Trips,
- Trip Distribution,
- Trip Assignment, etc.

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Given total projected traffic for each horizon year, the next step in the process is to analyze the future traffic conditions, identify needs, if any, and analyze alternative improvements. All state highway segments, intersections and select driveways within the defined study area **shall** be analyzed.

The analysis of the roadway and intersections *should* include the following elements:

- Site access
- Capacity/Level of Service analysis
- Queuing analysis
- Traffic safety
- Pedestrian, bicycle, and multi-use trail needs
- Speed considerations/Sight distance
- Traffic control needs
- Traffic signal warrant analysis

PART A — SITE ACCESS

Describe all proposed access driveways anticipated to serve the development site. An access driveway to a state highway is an intersection and *should* be fully analyzed with respect to capacity, traffic operations and safety. The location of the access points on the site plan *should* be reviewed in relation to existing nearby access points and intersections. In some cases the relocation of an access point may be necessary to improve safety and traffic operations. The site plan *should* also be reviewed to ensure that the external access points are designed to account for pedestrian and bicycle safety. Location for transit stops *should* be reviewed also.

Adverse impacts to roadways adjacent to the site can often be minimized by applying sound access management principles. The site access *should* be located and designed in accordance with the following guidelines:

- The number of access points *should* be limited to minimize traffic conflicts.
- Access points *should* intercept traffic approaching the site in an efficient and safe manner. The location *should* minimize impacts to traffic operations on the adjacent highway. Opposing access points *should* be aligned where possible.
- Adequate spacing *should* be maintained from adjacent streets and driveway intersections.
  - » Intersection spacing *should* be such that driveway blockage is minimized.
  - » Generally, WisDOT requires a minimum of 500 feet between driveway locations and adjacent intersections.
  - » All access locations, whether or not the spacing requirements are met, are subject to WisDOT approval.
  - » Median openings **shall** conform to the requirements of the WisDOT Facilities Development Manual.
- Joint access of adjacent properties and/or cross access will be encouraged where adjacent frontages are relatively short or where multi-linked trips may be reasonably expected because of existing or proposed land use.

- The access point locations **shall** be integrated into the on-site circulation pattern to allow efficient ingress and egress, and to avoid queuing on the adjacent high way.
- Adequate storage lengths **shall** be provided for turning lanes. Speed change lanes **shall** be provided as necessary.
- Access points **shall** be designed to ensure adequate sight distance.
- The width and radii of an access point *should* be designed to accommodate entering and exiting vehicles efficiently and safely.
- Access points *should* generally intersect the adjacent roadways at a 90-degree angle.
- Where applicable, multi-use access *should* be provided from right-of-way to the development (multi-use facilities *should* consider pedestrians, bicycles, and transit).

PART B — CAPACITY/LEVEL OF SERVICE ANALYSIS

Similar to the Capacity/Level of service analysis conducted for the existing conditions (Chapter 3, Part C), conduct additional analysis for the following conditions:

Determine if the transportation system can be expected to operate acceptably with the additional site-generated trips.

Existing conditions with:

1. Background traffic (without the proposed development or off-site development) for the base year (if not the existing year) and each horizon year identified.
2. Build traffic for the base year and each horizon year identified.
3. Total traffic for the base year and each horizon year identified.

The existing conditions for this section of the analysis include the existing roadway and intersection conditions plus any programmed improvements, expected to be completed by the end of the respective horizon year.

Proposed Improvements with:

1. Background traffic for the base year and each horizon year identified.
2. Build traffic for the base year and each horizon year identified.
3. Total traffic for the base year and each horizon year identified.

The purpose of the future conditions analysis is to determine if the transportation system can be expected to operate acceptably with the additional site-generated trips. If not, one must determine what mitigation may be required.

The Regional Traffic Engineer may require modification of the analysis beyond what is specified above.

Detailed information is needed regarding the physical characteristics of the existing conditions as well as the planned transportation system improvements proposed.

Exhibit 3-1B Planned Transportation System *should* have identified any currently programmed roadway or traffic control modifications to be used in this analysis. Any additional improvements for the proposed development that were analyzed *should* have been identified in Exhibit 1-4 Base Year Total Traffic Recommended Improvements, Exhibit 1-7 Interim Year Total Traffic Recommended Improvements, and Exhibit 1-10 Horizon Year Total Traffic Recommended Improvements.

Exhibits 3-3, 5-1, and 5-2 **shall** show, in tabular format, the Capacity/LOS analysis for the existing transportation system with Background traffic for the base year, interim year, and horizon years, respectively. Both the input and output data must be clearly labeled and included in Appendix B.

Exhibits 5-3 through 5-5 **shall** show, in tabular format, the Capacity/LOS analysis for the existing transportation system with Build development traffic for the base year, interim year, and horizon years, respectively. Both the input and output data must be clearly labeled and included in Appendix C.

Exhibits 5-6 through 5-8 **shall** show, in tabular format, the Capacity/LOS analysis for the existing transportation system with Total development traffic for the base year, interim year, and horizon years, respectively. Both the input and output data must be clearly labeled and included in Appendix D.

Exhibits 5-9 through 5-11 **shall** show, in tabular format, the Capacity/LOS analysis for the transportation system improvements with Background traffic for the base year, interim year, and horizon years, respectively, for each alternative. Both the input and output data must clearly be labeled and included in Appendix E.

Exhibits 5-12 through 5-14 **shall** show, in tabular format, the Capacity/LOS analysis for the transportation system improvements with Build development traffic for the base year, interim year, and horizon years, respectively, for each alternative. Both the input and output data must clearly be labeled and included in Appendix F.

Exhibits 5-15 through 5-17 **shall** show, in tabular format, the Capacity/LOS analysis for the transportation system improvements with Total development traffic for the base year, interim year, and horizon years, respectively, for each alternative. Both the input and output data must clearly be labeled and included in Appendix G.

Refer back to **Chapter 3 Existing Conditions**, Part C Capacity/Level of Service Analysis for appropriate procedures, methods, techniques, and software to be utilized in the analysis.

If any of the following improvements are proposed, discuss their implications with the regional traffic contact prior to completing the study:

- A modification to an existing traffic signal
- A proposed traffic signal that will create a signal system, or
- A modification to an existing signal system

For a modification that increases the distance a vehicle must travel to clear the intersection, pedestrian and vehicular clearances must be recalculated and used appropriately. Also, except in rare instances, changing the cycle length for a signal within an existing signal system would require a traffic signal system analysis to document the proposed change.

NOTES REGARDING IMPROVEMENTS

The acceptance of the TIA is not an approval of proposed recommendations in the TIA.

Various access locations and configurations *should* be evaluated to determine how proposed traffic can be handled. The HCM procedure cannot identify all potential problems with ingress and egress; roadway and/or intersection control improvements, driver behavior and expectations, and merging conflicts must be reviewed and mitigated as necessary. The various evaluations conducted *should* comply with WisDOT's FDM. Note that the acceptance of the TIA is not an approval of proposed recommendations outlined in the TIA but an acknowledgment that the TIA was submitted in a format that was acceptable for WisDOT to review. Typically, the regional traffic contact will provide a summary of the Department's position and issues that need to be addressed on the proposed recommendations outlined in the submitted TIA prior to moving forward with the permitting process.

Roadway and/or intersection improvements are required under the following conditions:

1. If specific movements on the roadway segment and/or roadway intersection are expected to operate at LOS C or better and have a v/c ratio less than 1 in the horizon year(s) without the development but operate at LOS D or worse or with a v/c ratio greater or equal to 1 with the development. In this case, improvements **shall** be proposed to bring the LOS from D or worse to LOS C and a v/c ratio less than 1.

2. If specific movements on the roadway segment and/or roadway intersection are expected to operate below LOS C and/or above a v/c ratio of 1 in the horizon year(s) without the development, but operate at an even lower LOS with the development. In this case, improvements **shall** be proposed to maintain the amount of delay (in seconds per vehicle) expected to occur without the development using HCM methodology.

Mitigation to level of service D may be acceptable at certain locations at the discretion and approval of the Regional Traffic Engineer. The regional engineer **shall** be consulted if a roundabout operates with LOS C or lower or if any individual lane or approach operates with LOS D or lower to determine if these LOS are acceptable. The roundabout capacity analysis **shall** be performed using the methodology of the most current version of the HCM.

Possible improvements to increase the level of service could include the following:

- Left-turn or right-turn lanes
- Additional intersection through lanes
- Additional highway lanes
- Access modifications / alternative access means
- Construction of a median / two way left-turn lane (TWLTL)
- Expansion of an existing median
- Change in traffic control
- Addition of a traffic signal, roundabout, or other type of traffic control alternative
- Changing signal operation
- Re-phasing of existing signal
- Re-timing of existing signal
- Redesigning/relocating bus stops
- Grade separation
- Restriction of particular turning movements
- Two-stage left-turn/crossing movements

At all off-ramp intersections that are being evaluated, sufficient stopping sight distance must be provided to ensure that drivers exiting onto the off-ramp can stop their vehicles completely prior to the back of queue waiting at the intersection. The required stopping sight distance is defined as follows:

- The distance from the point where the ramp is 12 feet wide to the back of queue **shall** equal the deceleration length from the design speed for the mainline to a stop condition as shown in AASHTO Green Book (2011) Table 10-5, page 10-115.

- For loop ramps/ramps with curves, the design speed used will be based on an iterative process dependent on the design speed of the curves and where the back of queue is likely to be.

A comprehensive review of roadway improvements *should* be made with respect to the following:

- Right of way
- Intersection spacing
- Relationship of highway with site access
- Design criteria
- Practical feasibility

PART C — QUEUING ANALYSIS

Identify the expected queue storage lengths that may be required for each proposed improvement.

A queuing analysis **shall** be performed for all lanes and ramp termini controlled by stop signs, traffic signals or roundabouts within the study area. The primary purpose of this analysis is to estimate queue lengths that *should* be accommodated at intersections. Queue lengths **shall** be evaluated for left-turn and right-turn lanes to ensure that queues do not overflow into adjacent through lanes. Through queues *should* be evaluated to confirm that they do not obstruct turn lane entrances or extend back into neighboring intersections.

Urban-area turn lanes *should* be designed to accommodate the "90% Probable Queue Length" (95% for Synchro) for signalized intersections and "95% Probable Queue Length" for unsignalized intersections. Additional lengths for deceleration may be desirable for various situations (see WisDOT's FDM for guidance). For signalized intersection analysis, approved software typically will show output for the "90% Probable Queue Length" (95% for Synchro). The HCM has a procedure for estimating the "95% Probable Queue Length" for stop-controlled intersections. These procedures **shall** be used to estimate the storage lane requirements. These lengths may need to be modified to accommodate the analysis results.

Identify the expected queue storage lengths that may be required with the proposed improvements in each peak period analyzed. The following order for exhibits **shall** be utilized to summarize the maximum queue lengths for the improved transportation system:

Exhibit 5-18 . . . . . Base Year Background Traffic
Exhibit 5-19 . . . . . Interim Year Background Traffic
Exhibit 5-20 . . . . . Horizon Year Background Traffic
Exhibit 5-21 . . . . . Base Year Build Development
Exhibit 5-22 . . . . . Interim Year Build Development
Exhibit 5-23 . . . . . Horizon Year Build Development
Exhibit 5-24 . . . . . Base Year Total Traffic
Exhibit 5-25 . . . . . Interim Year Total Traffic
Exhibit 5-26 . . . . . Horizon Year Total Traffic

PART D — PEDESTRIAN, BICYCLE, AND MULTI-USE TRAIL CONSIDERATIONS

Discuss any pedestrian, bicycle, multi-use trail, or other special transportation accommodations required for the proposed development.

The site plan and recommended improvements **shall** be reviewed to ensure that pedestrian, bicycle and multi-use trail traffic can be accommodated safely and efficiently, where appropriate. In many locations, non-highway traffic may be very low and special considerations in the design of the driveways or intersections will not be required. However, commercially developed areas or locations near schools may require that driveways or street intersections be designed for multi-use traffic.

The AASHTO Guide for the Development of Bicycle Facilities and the Wisconsin Bicycle Facility Design Handbook (http://www.dot.wisconsin.gov/projects/state/docs/bike-facility.pdf) *should* be consulted for specific guidance. All facilities serving pedestrians **shall** comply with ADA requirements.

PART E — SPEED CONSIDERATIONS/SIGHT DISTANCE

Vehicle speed is used to estimate safe stopping, intersection, and vision corner sight distances. In general, the posted speed limit is representative of the 85th percentile speed on the highway. A speed of 5 mph greater than the posted speed (i.e. design speed) or a measured 85th percentile speed **shall** be used to estimate safe stopping, intersection, and vision corner sight distances for highways. Any recommended modifications to existing speed limits are not within the scope of a TIA. Requests for a reduction to the existing posted speed limit may be directed to the Regional Traffic Engineer. However, all analyses and suggested improvements **shall** be based on a design speed derived from the existing posted speed limit.

Discuss the design speed used to estimate safe stopping, intersection, and vision corner sight distances as part of the safety review, and recommend improvements to address any deficiencies. Photos and/or drawings **shall** be included as Exhibit 5-27 Intersection Sight Distance Photos/Drawings to document the minimum and desirable sight distance requirements in relation to the field conditions. Intersection sight distance calculations for new driveways **shall** include adjustments for proposed geometry, including turn lanes and medians along the highway.

A single-unit truck (SU) design vehicle *should* be used for consideration at most intersections, but is dependent upon the land uses the access point will be serving. Passenger car sight distance *should* also be reviewed due to the height difference from a single-unit truck. Design vehicle decisions may require engineering judgment and discussions with WisDOT staff, if further clarification is needed. The safe stopping sight distances and corner sight distances **shall** be adjusted based on the Region's approval.

For additional information regarding intersection sight distance refer to FDM 11-10-5 (http://roadwaystandards.dot.wi.gov/standards/fdm/11-10.pdf)

PART F — TRAFFIC CONTROL NEEDS

The appropriate type and location of required traffic control, such as stop signs, yield signs, traffic signals, and roundabouts *should* be identified as part of the analysis. As indicated in WisDOT's FDM (Chapters 11-25-3 and 11-26). FHWA's "Roundabouts: An Informational Guide," as well as other sources identify numerous site-specific conditions that may favor or preclude the use of a roundabout for various situations. Other types of reduced-conflict intersection types, such as Continuous Flow intersections (CFI) and J-turn intersections, *should* be taken into consideration and may prove advantageous, depending on the site-specific safety and operational concerns that are present (See FDM 11-25-3). The WisDOT Regional Office *should* be consulted when considering control type. Some requirements may be addressed within the TIA Scoping Process.

An ICE is required for proposed:

- *New traffic control*
- *Change in traffic control*
- *New intersection type*

If new traffic control, a change in traffic control or a new intersection type is proposed, an Intersection Control Evaluation (ICE) worksheet **shall** be submitted as an attachment to the TIA for intersections on the state trunk highway network (STHN). New intersection traffic control does not include two-way stop control. Minor improvements such as adding turn lanes or signal phases do not warrant an ICE. The ICE worksheet shall be completed using the guidance provided in FDM 11-25-3; however, the only sections that need to be completed in the worksheet are the following:

- Safety
- Operational Analysis
- Practical Feasibility
- Recommendation

Most of the information needed in these sections of the ICE worksheet is already included in the TIA. A safety analysis that evaluates the most recent five years of crash

data is the only additional information required for the analysis. See FDM 11-25-3 for instructions on how to obtain the data. The crash data summary shall be presented in tabular form and include crash type and crash severity information. Also, existing crash patterns that may be of concern **shall** be identified, with an emphasis on movements where the development is expected to add traffic. Preparers are not required to include a crash diagram as part of the crash analysis but are encouraged to do so when evaluating a complex intersection to better identify crash patterns.

The goal of the crash analysis in the TIA is to identify the crash history and potential safety concerns at the intersections and movements where the development is expected to add a significant amount of traffic. The Department recognizes that the existing safety concerns at an intersection are not the responsibility of a developer to address; however, the Department may not be able to address a pre-existing safety concern immediately. Therefore, the proposed traffic control and intersection improvements are intended to address capacity based on the additional traffic and allow for safe and efficient movement of all traffic through the intersection. The Region Safety Engineer shall review the crash data analysis and comment on the proposed traffic control and intersection improvements.

The practical feasibility section of the ICE should summarize the impacts and expected benefits associated with each of the proposed options as well as how each option addresses the development's needs. The ICE worksheet and all supporting information that is not already part of the TIA shall be included in Chapter 6. The engineer reviewing the TIA will share the ICE worksheet with the regional traffic operations staff and the Bureau of Traffic Operations for comment and to establish consensus for the recommended traffic control and intersection improvements.

Identify and discuss the recommended traffic control treatments for the proposed development and describe their need. If proposing a signalized intersection, a 12-hour intersection traffic count **shall** be performed. Appendix I Warrant Analysis for Intersection Control **shall** include any supporting documentation and calculations used to complete a warrant analysis for any recommended type of intersection control.
It's important to note that showing an unsignalized intersection operating at level-of-service "F" is not an acceptable justification for requiring traffic control signals. Traffic signals must be evaluated from a system standpoint, showing that the installation has positive benefits with minimal impact on progressive traffic flow.

If a signal installation is warranted, agreeable and subsequently approved by WisDOT, it *should* be located to facilitate signal coordination and traffic progression. WisDOT prefers a minimum spacing of ¼ mile (1,320 feet) between signalized intersections, but may require additional spacing on specific roadways. Traffic signal coordination *should* be considered at all signalized intersections within ½ mile (2,640 feet) of each other. Preserving the quality of flow and safety along public streets is contingent on the following factors:

- Relatively uniform spacing of traffic signals

- An ideal spacing between traffic signals for a given operating speed (optimum spacing being a function of progression speed and signal cycle length)
- An efficient through roadway bandwidth

PART G — TRAFFIC SIGNAL WARRANT ANALYSIS

A Traffic Signal Warrant Analysis **shall** be included for all proposed traffic signals. The warrants **shall** be conducted according to the WisMUTCD and the TSDM.

The installation of a traffic signal is mainly based on safety and operational needs.

WisDOT has developed hourly trip distribution percentages for specific land uses (e.g. shopping center, office, residential) that may be applied to existing or new intersections when determining 12-hour volumes that include proposed development traffic. Please contact the regional traffic engineer for further information.

The proposed signal location must meet at least one of the signal warrants for signalization to be considered. However, the decision to install a traffic signal at a particular intersection *should* be made based on a complete engineering study of that location (i.e. ICE). At a minimum, WisMUTCD warrants 1, 2, and 3, *should* be evaluated at each location. Additional warrants may be evaluated as deemed necessary by WisDOT. The warrants stated *should* be viewed as guidelines to help the WisDOT engineers decide whether a traffic signal may be installed, not as a legal requirement for their installation. The decision to install a traffic signal is not based solely on the satisfaction of warrants; rather, it is based on the need for safety and/or operational improvements at the intersection.

Please refer to the WisDOT TSDM for additional information on typical procedures used in conducting a signal warrant study. Region-specific procedures and methodologies *should* be discussed with the regional traffic engineer prior to submittal.

6
CHAPTER

This chapter **shall** discuss conclusions in regard to the analysis of existing and future conditions. Based on these conclusions, recommendations **shall** be made to mitigate identified deficiencies. A preferred improvement alternative *should* at a minimum, identify the following:

- Any required phased improvements
- Location and design of site access driveways
- Internal circulation plan
- Additional through and turning lanes
- Required turn lane extensions
- Any horizontal and/or vertical realignment
- Traffic control devices required
- Transportation demand management strategies which may be applicable to the particular development

All proposals to mitigate identified deficiencies **shall** be reviewed to determine if they are feasible. For all feasible mitigation measures, identify the consequences of each measure, if any (e.g. median closure, additional right-of-way needed, etc.). If it is uncertain as to whether a mitigation measure is feasible, contact the Regional Traffic Engineer for further guidance.

See FDM 11-25-3 (http://roadwaystandards.dot.wi.gov/standards/fdm/11-25.pdf#fd11-25) and coordinate with your Regional Contact to determine when an ICE worksheet must be completed and included with the TIA to assist the Region in selecting a traffic control, lane configuration and intersection type for an intersection.

Prior to the list of recommended improvements, the TIA preparer **shall** insert the following language in the TIA:

> *"Note that improvements are recommended to WisDOT for consideration and are not legally binding. WisDOT reserves the right to determine alternative solutions."*

In addition to the development-driven improvements identified within the TIA, the developer/municipality **shall** be responsible for all utility coordination and relocation costs on the existing and proposed roadway network. Utility companies **shall** only be responsible for utility coordination and relocation on standard WisDOT improvement projects involving improvements unrelated to the development.

CONCEPTUAL DRAWINGS

For all intersections that are being evaluated for geometric improvements or modifications to the existing traffic control, provide conceptual drawings of the intersection alternatives included in the study. The conceptual drawing **shall** be to scale and superimposed on an aerial photo or topographic map. Conceptual drawings for a roundabout **shall** include the outer diameter of the roundabout and the approximate approach geometry. Conceptual drawings for all-way stop, signal control or any type of non-traditional intersection **shall** include the proposed lane configurations, median

width (if any), turn lane storage lengths, and transitions to match the existing roadway. Existing right-of-way limits **shall** be shown. **Do not** include pavement marking, signing, stationing, profiles or turning radii. The intent of the conceptual drawings is to show the approximate impacts of each intersection control alternative to better assist in the determination of the appropriate alternative(s). Figure 6-1 and 6-2 show examples of acceptable conceptual drawings.

This chapter **shall** also include documentation on how others impacted by the mitigation measures will be notified of the impact.

FIGURE 6-1

FIGURE 6-2

N
NTS
PEWAUKEE ROAD
HINDU TEMPLE ACCESS
COSTCO ACCESS
EXHIBIT 6-2B
ALTERNATIVE TRAFFIC CONTROL ANALYSIS
2021 TOTAL TRAFFIC
PEWAUKEE, WISCONSIN

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CHAPTER

Consider the following guidance in the decision making process when evaluating the design of access points, intersection traffic controls, lane additions, medians, bridges or ramps. FDM standards may have been updated and will supersede these design considerations. See noted reference for additional information.

These design considerations are provided for guidance only; This chapter **shall** not be included in the official TIA Report

NEW ACCESS LOCATIONS

- Acceptable spacing from other access points as defined by the FDM 11-5-5 (http://roadwaystandards.dot.wi.gov/standards/fdm/11-05-005att.pdf#fd11-5a5.1) Attachment 5.1.
  - » Generally, WisDOT requires a minimum of 500 feet between driveway locations and adjacent intersections. Minimum spacing may be greater on certain road ways. Coordinate with the Region to determine proper spacing.
- Is the proposed access within the functional area of an existing intersection? The functional area includes (FDM 11-25-1):
  - » Queue storage area
  - » Turn lane tapers
  - » Perception-Reaction distance
- The following guidance detailed in FDM 11-10-5, Geometric Elements **shall** be used to establish the proposed geometric design:
  - » Provide adequate sight distance for all vehicles exiting from the minor street.
  - » Provide adequate stopping sight distance for major street volumes approaching the minor street
  - » Provide adequate vision corners and intersection sight distance.
  - » Provide adequate storage for minor street exiting vehicles and major street entering volumes
  - » Provide adequate Decision Sight Distance on all approaches to intersections where traffic signals or roundabouts are proposed.

NEW LANES

- Consider the following:
  - » Are recommended lane widths appropriate?
  - » Are recommended lane widths consistent with existing widths?
  - » Can additional lanes be accommodated if space is restricted?
  - » Is there an adequate number of receiving lanes for right and left-turn lanes?
- Note: The analysis *should* reflect the recommended lane widths. Appropriate lane widths will ultimately be determined by WisDOT or other maintaining authority. New turn lanes/extended existing turn lanes *should* not block adjacent streets or median openings. If necessary, access restrictions may be required.
- If there is sufficient median width at an access, a left-turn lane *should* be constructed (FDM 11-25-5). If there is insufficient width or the median cannot be expanded to include a left-turn lane, the inbound left-turn movements *should* be restricted for the access point.

- At locations where there is no median and left turn movements are present, a left-turn lane *should* be installed for safety reasons unless volumes are very low. (FDM 11-25-5)
- A right-turn lane *should* be considered at intersections on urban roadways posted 40 mph or lower that have significant right turn volumes. Right turn lanes *should* be strongly considered at all rural 2-lane public road intersections. Coordinate with the Region Engineer for other situations.
- A left-turn by-pass lane *should* be considered along rural 2-lane roads at public T-intersections (FDM 11-25-1).

RIGHT OF WAY

- Is there adequate right of way (ROW) for the suggested improvements?
- Can ROW be purchased?
- Will the needed ROW impact an adjacent building's parking lot, drive through or other critical facility

TURN LANE LENGTH

- Storage length **shall** be the greater of the following (FDM 11-25-1):
  - » All turn lanes must have a storage length that accommodates the 90% Probable Queue Length (95% for Synchro) unless a reduction is approved by Region Traffic Engineer.
  - » Additional storage length beyond the 90% Probable Queue Length (95% for Synchro) **shall** be provided to account for vehicle deceleration (maximum rate) unless approved by Region Traffic Engineer as not feasible.

    OR
  - » Storage length **shall** be provided to account for vehicle deceleration (desirable rate) plus a minimum allowable storage of 50 feet.
- Contact the Region Traffic Engineer for specific guidance regarding storage lengths.
- Turn lane taper (Proposed new FDM guidelines; not yet official):
  - » 100 foot taper (8.33:1) for 40 mph posted speed and lower
  - » 150 foot taper (12.5:1) for 45 mph posted speed and higher

QUEUE LENGTH CHECKS

- The turn lane queue *should* fit within the existing/proposed storage at a minimum (FDM 11-25-1: http://roadwaystandards.dot.wi.gov/standards/fdm/11-25.pdf).
- Does the through queue block:
  - » Turn lane storage openings
  - » Median openings
  - » Adjacent streets

SIGNALS

- Proposed signals *should* be a minimum distance of a quarter-mile from adjacent signals. Minimum spacing may be greater on certain roadways. Coordinate with the Region Traffic Engineer to determine proper spacing (TSDM 3-3-3: https://

trust.dot.state.wi.us/nidp/idff/sso?id=14&sid=0&option=credential&sid=0).

- Proposed signals *should* follow existing spacing patterns along the corridor (TSDM 3-3-3).
- Will the signal be isolated or in-system (new system or adding to existing system)?
- Is the cross product met for any recommended protected-permitted phasing (TSDM 3-4TM)?
  – p0,000 for single left-turn lane crossing one through lane
  – 100,000 for single left-turn lane crossing 2+ through lanes
- Dual left turn lanes *should* be considered where left turn volumes exceed 300 vph (TSDM 3-3-5).
- If no signal exists and a signal is being requested, a warrant analysis **shall** be conducted (FDM 11-50-50).
  » Locate the DOT 12-hour count for the intersection or nearest intersection for proposed new access if available.
  » If no 12-hour count is available, the consultant *should* provide one as part of a signal warrant analysis.
  » Determine timeframe when signal warrants are likely to be met (amount of development build-out).
- Right-turn on red reduction
  » Coordinate with Region Traffic Engineer for the appropriate reduction rates.

ROUNDABOUT CAPACITY ANALYSIS

- Are signal or all-way stop warrants met? If yes, a roundabout may be considered at the intersection (FDM 11-25-3).
  » Use HCM methodology for the capacity analysis of a roundabout. The two software packages that can be used are:
    1. Highway Capacity Software (HCS) version 6.3 or later
    2. SIDRA version 5.1 or later
- The HCM capacity equations can also be programmed into a spreadsheet. If access to either of the two software packages listed above is not available, the capacity analysis can be provided in a spreadsheet that the analyst prepares.
- The minimum headway and follow-up headway values determined for Wisconsin drivers that *should* be used in the capacity analysis are shown in the table below.

RECOMMENDED HEADWAY VALUES

Parameters	Symbol	Multi-Lane	Single-Lane
Minimum Headway (aka Minmum Gap)	t_c	4.0 sec	4.2 sec
Follow-Up Headway	t_f	2.8 sec	2.8 sec

MEDIANS

- Minimum width for a median is 6 feet curb face to curb face (FDM 11-25-5).
- Minimum width for a median with pedestrian storage is 8 feet curb face to curb face (FDM 11-25-5).
- Minimum width for a median with a left-turn lane is curb pan + 6 feet curb face to curb face + curb pan + left-turn lane width (times number of lanes) + median separation between the through lane and turn lane (if required) (FDM 11-25-5).
- A minimum 24-foot wide median is required to consider two-stage turning and crossing movements.

BRIDGES

- Can the structure accommodate the proposed improvements?
  - » Consider the width of the structure
  - » A raised median on a structure is extremely difficult to remove. Are there other potential improvements to avoid this?
- Can the structure be widened to accommodate proposed improvements? Bridge clearance heights to the underpass roadway will need to be checked with any proposed widening to ensure that they will meet FDM requirements.
- Is sufficient width available under the structure to accommodate the proposed improvements (lanes & *should*ers)?

RAMP STORAGE

- Sufficient SSD must be provided for vehicles exiting the mainline to the back of queue for the upstream intersection. AASHTO's requirements for SSD on ramps are as follows:
  - » Distance from the point on the ramp where the traveled width is 12' to the back of queue **shall** equal the deceleration length for the design speed on the mainline to a stop condition.
  - » Iterative process *should* be used to determine design speed for loop/curved ramps.
- Example:
  - » Diamond Interchange with an 1100 foot off-ramp (measured from point where ramp is 12' to the stop line of the off-ramp).
  - » Mainline posted speed is 55 mph and mainline design speed is 60 mph.
  - » Use AASHTO Exhibit 10-73, p. 855 GDHS (2001) – "Minimum Deceleration Lengths for Exit Terminals With Flat Grades of 2% or Less"
  - » Using the cited table gives a result of 530 feet for Deceleration. This means the maximum back of the queue for the off-ramp design is 570 feet.

G

GLOSSARY

This glossary is provided for guidance only; it **shall** not be included in the official TIA Report.:

Annual Average Daily Traffic (AADT) ► The estimate of typical daily traffic on a road segment for all days of the week, Sunday through Saturday, over the period of one year. Computed as the average of the 7 AADW's.

Annual Average Weekday Traffic (AAWDT) ► The estimate of typical traffic over the period of one year, for the days Monday through Thursday, calculated from permanent counter data as the sum of Monthly Average Weekday Traffic (MAWDTs) divided by the number of MAWDTs.

ADA ► Americans with Disabilities Act of 1990.

Area of significant traffic impact ► The geographical area that the transportation facilities are significantly impacted by the site traffic.

Background traffic ► Traffic volumes that exist prior to the influence of the subject development or other identified off-site developments in the vicinity.

Build traffic ► The background/base traffic plus the on-site development or off-site development (new) traffic that is expected to be using the roadway network first (whichever development that occurs first is to be included in the build traffic).

Capacity ► The maximum hourly rate at which vehicles can reasonably be expected to traverse a point or uniform section of a lane or roadway during a given time period under prevailing roadway, traffic, and control conditions.

Design speed ► Typically equal to the posted speed plus 5 mph.

Development traffic ► Estimated traffic volumes generated by a proposed development.

Externally-linked trips ► An existing trip that stops at a land use within the development and stops at an existing land use within the study area boundaries of the development. Externally-linked trips differ from pass-by trips in that pass-by trips had no intention of stopping at any existing land use. This reduces the total trips entering/exiting the study area but does not reduce driveway trips.

Feasibility analysis ► The determination of whether or not a mitigation measure can be accomplished without significant harm to other properties, and if it is possible within the confines of the highway corridor.

G/C ► The ratio of green time to total cycle time for a traffic signal.

Horizon year ► The year in the future determined appropriate for the analysis. Generally, the horizon year is established as 10 years after the opening of the proposed development or 5 years after build out, whichever is greater.

Influence area ► The geographical area surrounding the site from which the development is likely to draw a high percentage of the total site traffic.

Internally linked trips ► A trip where a user stops at multiple land uses within the development, but only makes one trip in and one trip out on the State's facility. This reduces the total trips entering the development study area, thus lowering driveway trips.

Level of service (LOS) ► A quantitative stratification of a performance measure or measures that represent quality of service, measured on an A-F scale, with LOS A representing the best operating conditions from the traveler's perspective and LOS F the worst.

Mode split ► The estimation of the number of trips made by each mode (automobile, pedestrian, transit, etc.) used by site-generated traffic.

Multi-linked trips ► A trip where a user stops at multiple land uses within the development, and has to use the State's facility to get from one land use to another. This reduces the total trips entering/exiting the study area but does not reduce driveway trips.

Off-site traffic ► Traffic volumes that are generated by identified off-site developments in the study area.

Pass-by trips ► Trips that are diverted from traffic already on the adjacent roadway on the way to a primary destination.

Peak Hour Factor (PHF) ► The ratio of total hourly volume to four times the maximum 15-minute volume within the analysis hour. A measure of traffic demand fluctuation within the analysis hour. The peak hour factor **shall** be calculated by intersection.

Saturation flow rate ► The equivalent hourly rate at which previously queued vehicles can traverse an intersection approach under prevailing conditions. Assuming that the green signal is available at all times and no lost times are experienced.

Stopped delay ► The amount of time an individual vehicle spends stopped in a queue while waiting to enter an intersection.

Study area ► The portion(s) of the transportation system directly affected by the planned development, to be included within the scope of the TIA analysis.

Total traffic ► Background traffic plus the on-site development traffic and the off-site development traffic, if applicable.

Trip generation ► The estimation of the number of origins from and destinations to a site resulting from the land-use activity on that site.

Traffic generator ► A designated land use (residential, commercial, office, industrial, etc.) that generates vehicular and/or pedestrian traffic to and from the site.

Traffic impact ► The effect of development traffic on highway operations and safety.

Traffic impact analysis ► An engineering study that determines the potential impacts the expected traffic of a proposed traffic generator will have on the surrounding roadway network. The study includes a recommendation of roadway improvements that may be necessary to accommodate the additional traffic. A complete analysis includes an estimation of future traffic with and without the proposed generator, analysis of traffic impacts, and recommended roadway improvements, which may be necessary to accommodate the expected traffic.

Traffic mitigation ► The reduction of traffic impacts on roadways and/or intersections to provide an acceptable level of service.

Trip assignment ► Determines the amount of the proposed development traffic plus off-site traffic that will use each access point and route in the study area.

Trip distribution ► The allocation of the trips generated by the proposed development among all possible approach and departure routes.