2021

TRAFFIC IMPACT ANALYSIS GUIDELINES

LAST UPDATED: JANUARY 2021

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PREFACE

Traffic impacts and their potential need for mitigation are important for any community to consider with new development proposals. 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 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. A TIA *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 for all roadway users?
- Can the existing and planned multimodal transportation system accommodate the additional traffic generated by the planned development?
- Are there additional transportation needs, beyond those already programmed or included in the local transportation plan, required to maintain a satisfactory level of service (LOS)?
- What are the recommended roadway improvements that may be necessary to accommodate the expected development traffic?

The TIA preparer **shall** complete the TIA prior to finalizing the development design, while there is still flexibility in the development's site design. Prior to obtaining any permits, the developer **shall** receive WisDOT's acceptance of the completed TIA.

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 to the State Trunk Network (STN). 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 effect on the state highway.

WisDOT is accountable for operating a safe and efficient state highway system. Proactive access management is vital in maintaining the overall safety and efficiency of this system. WisDOT manages access to the state highway system through statutes 84.09, 84.25, and 86.07 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 regional office may require a TIA for proposed access requests. Facilities Development Manual (FDM) procedure 7-35-10.2 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 *should* be given to requiring a TIA on an already congested or unsafe highway than on one with lower

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

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 format of the TIA is acceptable for the department to review. Typically, the regional traffic contact will provide a summary of the department's position and issues on the proposed recommendations outlined in the submitted TIA. The developer needs to address the region's issues 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 will 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 typically more suitable for larger developments (greater than 500 peak hour vehicles) and requires involvement from the WisDOT forecasting team for horizon year traffic projections. The regional traffic contact will send a letter that identifies the need for an abbreviated or full TIA, defines the parameters of the study, and outlines the proposed study years.

INITIAL REVIEW

Prior to preparing a TIA, 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 for their use in developing the TIA parameters as part of the initial review process. Typically, WisDOT will inform the preparer 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 trip generation of the proposed development. If required, the TIA preparer **shall** submit at least one copy of the initial review document in the format, either hard copy or electronic copy, specified by the WisDOT regional TIA representative. For additional information on the initial review process, contact the appropriate WisDOT regional TIA representative.

IMPLEMENTATION OF TIA-REQUIRED IMPROVEMENTS

In response to the findings of the TIA, WisDOT will provide correspondence to identify the required development- driven improvements.

Improvements required to mitigate operational or safety related traffic impacts caused by development are based on, but not limited to, the recommendations section of a TIA. In response to the findings of the TIA, WisDOT will send a letter, memorandum, or email correspondence to identify the required development-driven improvements. These requirements are subject to WisDOT's authority and jurisdiction over any given highway. The mechanism for requiring TIA-related improvements is typically the permitting process (e.g., work on highway right-of-way, access, utility, etc.) overseen by the regional maintenance or planning units. Cited improvements and the methods for implementing them will become a condition of the permit. All improvements **shall** comply with current FDM policies.

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 plans
- Pavement details
- Structural details
- Intersection layouts
- Storm sewer details
- Plan/profile views
- Traffic control designs (e.g., traffic signal plans)
- Lighting designs
- Signing & marking plans
- Work zone traffic control plans
- Standard detail drawings
- Standard sign plates
- Cross-sections
- Specifications
- Project cost estimates

The TIA preparer **shall** make this information available in hardcopy and AutoCAD format (e.g., .dwg) as requested by WisDOT. Coordination and plan review meetings between the developer, developer's agents, and the appropriate municipal and WisDOT staff are encouraged.

QUALIFICATIONS OF THE PREPARER

A transportation professional with training and experience in traffic engineering and transportation planning *should* prepare the TIA. The TIA **shall** be prepared by, or under the supervision of, a professional engineer (PE) who has a valid Wisconsin PE license/registration and experience in traffic engineering operations. The responsible PE **shall** include their signature, PE seal, and the following statement of certification at the beginning of the TIA:

> *"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

One or more of WisDOT's professional staff, along with staff from 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) **shall** review the TIA.

ETHICS AND OBJECTIVITY

Although TIA preparers and reviewers might have different goals and perspectives, they *should* adhere to the established engineering and planning 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 include within the TIA and outlines 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 that show the current document submittal date
- Table of contents
- Tabs or dividers to assist in identifying each chapter and appendices of the TIA

The TIA preparer **shall** submit at least one ring-bound hard copy of the full TIA report and analysis output as well as one copy of the electronic files used in the study. The regional office may request additional or no hard copies of the TIA report; thus, the TIA preparer *should* coordinate with the regional office to verify the number of hard copies to submit. Electronic files **shall** include a portable document format (PDF) of the report and appendices, the capacity analysis files in their software file format (.syn, etc.), and other relevant project files and analyses.

TIA SCOPING CHECKLIST

The following checklist may serve as a guide for TIA preparers and reviewers to aid them in determining the appropriate scope of a development-related traffic study. This list is not all-inclusive and thus may not cover all aspects that a specific TIA may need to address. Therefore, the TIA preparer and reviewer *should* carefully consider the issues that may be unique to a specific study and *should* adjust the scope as necessary.

- ☐ Determine study objectives and purpose
- ☐ Verify development land use and, if specific land use is unknown, make reasonable development assumptions
- ☐ Identify off-site development(s)
- ☐ If available, review site plan
- ☐ Verify development staging
- ☐ Determine build-out, interim, and study horizon year(s)
- ☐ Based on land use trip generation, identify peak periods for analysis
- ☐ Determine area of significant traffic impact and identify specific study area intersections
- ☐ Determine appropriate site access
- ☐ Determine the best level of service that is practical (typically LOS D or better)
- ☐ Identify any alternative analyses to consider within the study such as those needed to address 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-speeds, or specialized studies (saturation flow, delay, etc.) and arrange to collect additional field data as necessary
- ☐ Consider the impacts to, and needs of, other transportation modes (e.g., pedestrian, bicycle, public transit, etc.) within the study area
- ☐ Determine the appropriate source for trip generation information - typically the most current version of the Institute of Transportation Engineers (ITE) *Trip Generation Manual* and any supplements that have been released
- ☐ Estimate pass-by and linked-trips
- ☐ Determine development trip distribution
- ☐ Arrange for a WisDOT traffic forecast based on the analysis years
- ☐ Identify traffic analysis software to use for the evaluation of each alternative
- ☐ Determine the specific analysis requirements including, but not limited to, the analysis software inputs such as peak hour factor (PHF), saturation flow rate, right turn on red (RTOR) volumes, pedestrian/truck volume considerations, etc.
- ☐ Identify any special considerations to address within the study

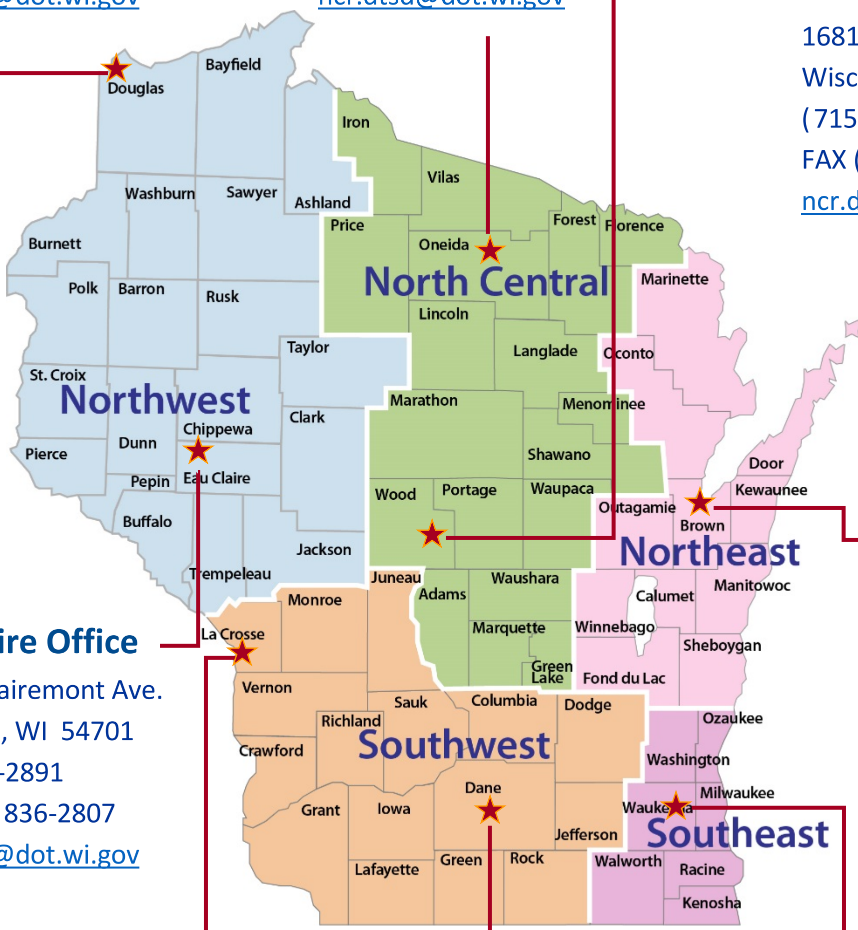
IMPORTANT NOTICE

Prior to preparing a TIA, contact the WisDOT regional office and request an initial review of your proposed development. The following map provides the contact information for each regional office.

Superior Office
1701 N. 4th St.
Superior, WI 54880
(715) 392-7925
FAX (715) 392-7863
nwr.dtsd@dot.wi.gov

Rhinelander Office
510 N. Hanson Lake Rd.
Rhinelander, WI 54501
(715) 365-3490
FAX (715) 365-5780
ncr.dtsd@dot.wi.gov

Wisconsin Rapids Office
1681 2nd Ave South
Wisconsin Rapids, WI 54495
(715) 421-8302
FAX (715) 423-0334
ncr.dtsd@dot.wi.gov



Green Bay Office
944 Vanderperren Way
Green Bay, WI 54304
(920) 492-5643
FAX (920) 492-5640
ner.dtsd@dot.wi.gov

Eau Claire Office
718 W. Clairemont Ave.
Eau Claire, WI 54701
(715) 836-2891
FAX (715) 836-2807
nwr.dtsd@dot.wi.gov

La Crosse Office
3550 Mormon Coulee Rd.
La Crosse, WI 54601
(608) 785-9022
FAX (608) 785-9969
swr.dtsd@dot.wi.gov

Madison Office
2101 Wright St.
Madison, WI 53704
(608) 246-3800
FAX (608) 246-7996
swr.dtsd@dot.wi.gov

Waukesha Office
141 NW Barstow St.
Waukesha, WI 53187
(262) 548-5902
FAX (262) 548-5662
ser.dtsd@dot.wi.gov

TRAFFIC IMPACT ANALYSIS OUTLINE

LIST OF REQUIRED EXHIBITS

Notes:

- Label multiple interim years or alternatives sequentially (e.g., Exhibit 4-5E, Exhibit 6-1C).
- 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.

APPENDICES

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-built plans)

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

Appendix J: Intersection Control Evaluation (ICE)

- Phase I: Scoping ICE for each intersection (Label I, II, III, Etc.)

CHAPTER 1 INTRODUCTION & EXECUTIVE SUMMARY

The TIA preparer *should* briefly describe the development and provide a summary of its potential traffic impacts at the beginning of the TIA report. Chapter 1 of the TIA **shall** include the following exhibits, as applicable to the proposed development:

PART A — PURPOSE OF REPORT AND STUDY OBJECTIVES

Identify the purpose of the report, highlighting who conducted the analysis and why. 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 TIA preparer **shall** include an Executive Summary 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:

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

- 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 including existing traffic conditions, programmed transportation improvements (if applicable), amount of site-generated traffic, and projected background traffic volumes
- Summary of the study conclusions including future levels of service with and without the proposed development
- Identification of all mitigation measures recommended to achieve the best level of service that is practical (typically LOS D or better) on the area transportation network, including a discussion of when to implement the improvements

CHAPTER 2 PROPOSED DEVELOPMENT

Narratives and exhibits provide the reviewer with a complete description of the proposed development. Descriptions must explain the time frame 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 all at one time, the site plan **shall** illustrate the development-staging plan to highlight the location where each phase of the development will occur in relationship to the full project buildout.

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:

1. Development Description and Site Location

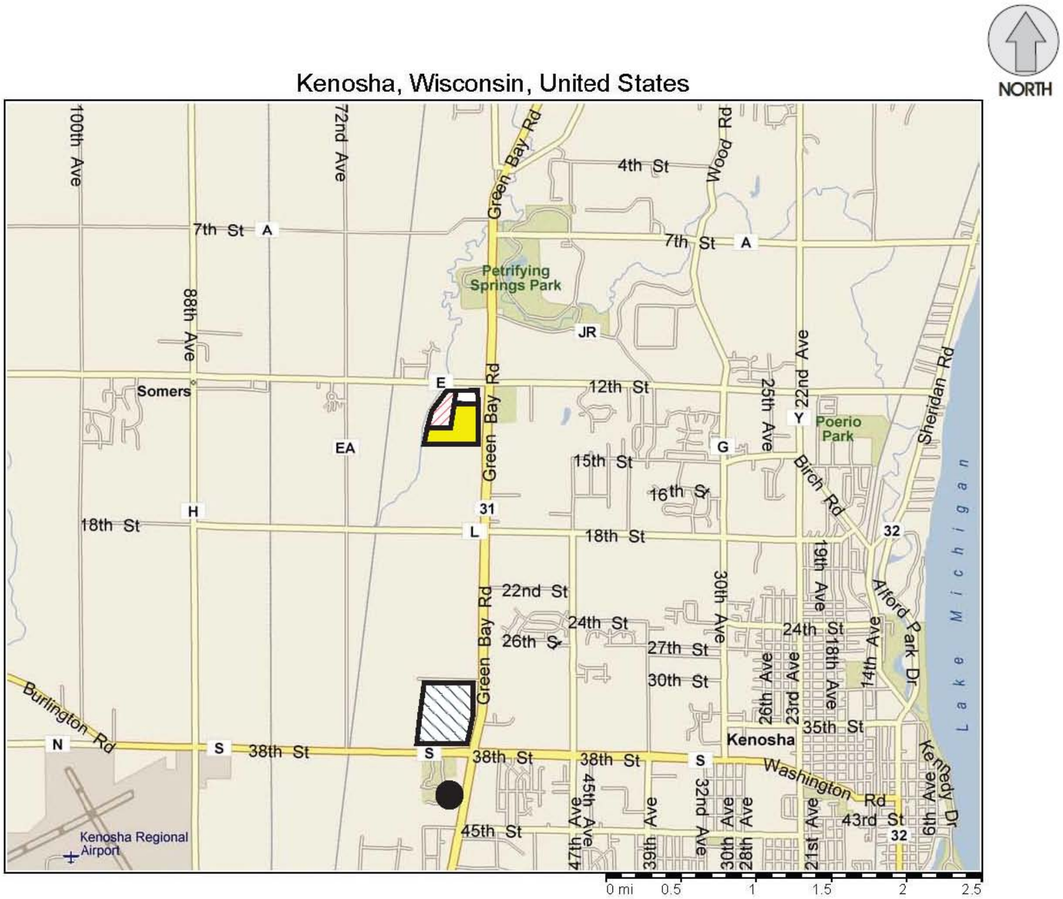
Identify the name of the proposed development and describe its general intended use. The report **shall** provide a legible map showing the study site in relation to the surrounding roadway network. The site map or the accompanying text **shall** note the size of the site in acres and the amount of frontage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

2. Land Use and Intensity

The project description *should* provide as much detail as possible, including the local zoning designation, for all proposed land uses for the site. If specific tenants are known (e.g., Walmart, 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), note these in the project description. Avoid the use of generalized land use categories (e.g., commercial/retail) whenever possible.

The TIA **shall** describe the size of each land use component within the development in terms of square feet of gross building area (for retail, office, and 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* and any supplements that have been released.

Exhibit 2-1



- PROPOSED ROLLING WILLOW CENTER ON-SITE DEVELOPMENT
- WILLOW CREEK CONDOS OFF-SITE DEVELOPMENT
- CONNOLLY SUBDIVISION OFF-SITE DEVELOPMENT
- SAVANNAH & AVALON PARC OFF-SITE DEVELOPMENTS
- PARCEL A OFF-SITE DEVELOPMENT

Exhibit 2-1
Site Location Map

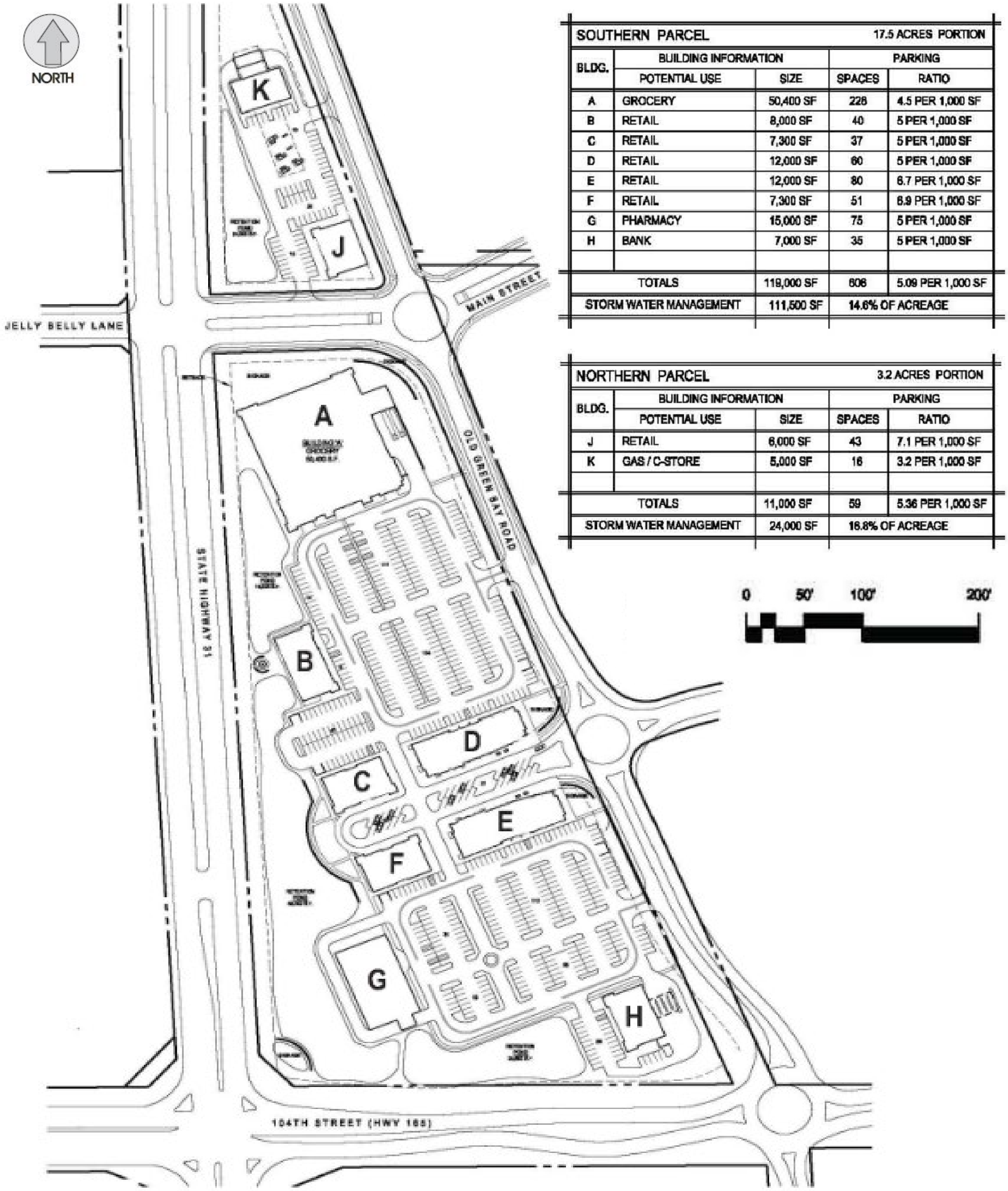
3. Proposed Site Plan

The TIA **shall** include a scaled drawing of the proposed development plan. The report **shall** also include a brief narrative to help identify key features on the drawing. The site plan **shall** illustrate the following information:

- North Arrow
- Dimensions of the site
- Site boundaries and adjacent streets
- Location of existing driveways and street intersections near the site (scalable or include dimensions)
- Location and design of all proposed driveways and street intersections near the site (scalable or include dimensions)
- Existing and proposed rights-of-way on all adjacent streets
- Location, configuration, and dimensions of the following to demonstrate compliance with applicable WisDOT policies and the American with Disabilities Act (ADA) standards as appropriate:
    - » Travel lanes, shoulders, and bike accommodations
    - » Pedestrian accommodations (e.g., sidewalks, curb ramps, etc.)
    - » Shared-use paths
- Location and dimensions of transit stops (if applicable) indicating transit facilities are accessible and compliant with applicable WisDOT policies and ADA standards (e.g., show bus boarding alighting area dimensions are at least five feet by eight feet)
- Location and size of all land uses within the project
- Building configurations (if known), pedestrian access, and sidewalks
- Parking layout, internal circulation, and location of bike racks
- Applicable deed restrictions or access control
- Medians
- Median Openings

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

Exhibit 2-2



SOUTHERN PARCEL			17.5 ACRES PORTION	
BLDG.	BUILDING INFORMATION		PARKING	
	POTENTIAL USE	SIZE	SPACES	RATIO
A	GROCERY	50,400 SF	228	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	16.8% OF ACREAGE	

Exhibit 2-2 Site Plan

4. Development Phasing and Timing

The TIA **shall** identify the anticipated opening date for the proposed development. If the developer plans to build a large project over a period of five years or more, the TIA **shall** provide the expected phasing schedule. The phasing schedule *should* indicate the specific construction details (land-use, size, and type) and the projected completion date for each phase of development. The TIA *should* supplement the phasing schedule with a drawing of the site that highlights each of the various stages of development. The phasing schedule and development plan may help illustrate whether the entire project requires any improvement needs that exceed what is necessary during the initial stage(s) of development.

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

PART B — STUDY AREA

The purpose of this section is to identify those areas that the traffic generated by the proposed development could potentially affect. This section *should* also describe the area that may influence how traffic travels to/from the development site. Typically, this area depends upon the prevailing traffic conditions of the surrounding roadway network and the type, size, and location of the proposed development.

The study area *should* be determined based on the project's influence area and its area of significant traffic impact.

1. Influence Area

The influence area is typically the starting point for estimating the distribution of trips to/from 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 the starting point for estimating the distribution of vehicle trips to/from the site. Describe the influence area for the project and identify the method used to establish it.

2. Area of Significant Traffic Impact

WisDOT's regional office will confirm the study area 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, as compared to smaller projects, is likely to affect traffic conditions over a wider area. Therefore, it is appropriate to require a bigger study area for the analysis of larger projects. WisDOT's regional office will confirm the study area during the initial review process. The TIA preparer *should* use this section to describe the anticipated roadway system to include in the analyses.

Exhibit 2-3

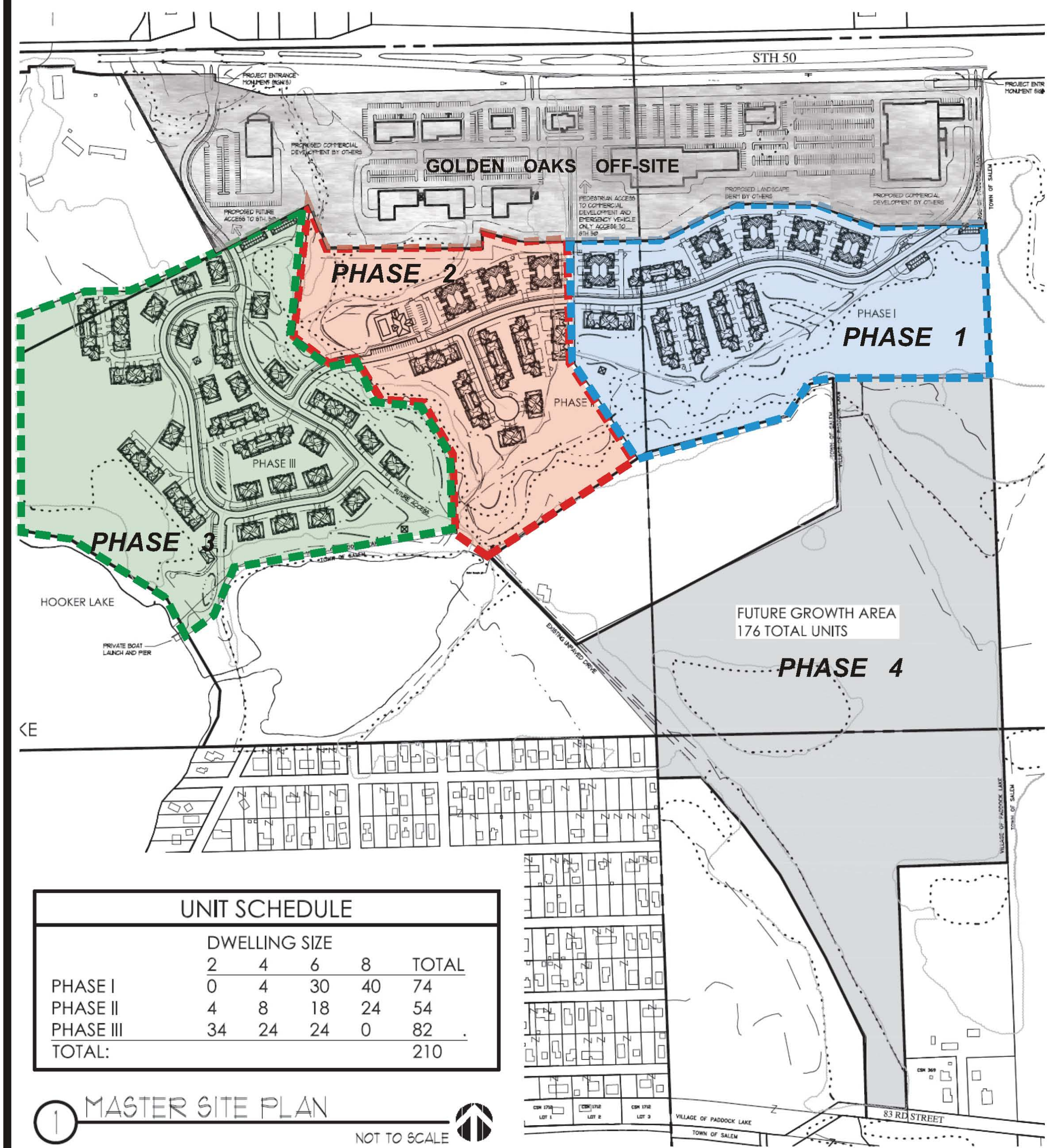


Exhibit 2-3 Development Phasing

PART C — OFF-SITE LAND USE AND DEVELOPMENT

Note any planned projects that may have a significant impact on future travel conditions.

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 study area, to allow the reader to recognize the potential conflicts, impacts, and opportunities for incorporating improvements as part of the proposed development.

This section *should* provide a brief description of current land uses and anticipated future development near the proposed site. Note any available information on planned projects that, due to their size or location, would have a significant impact on future travel conditions in the study area.

Contact the WisDOT regional office, refer to the WisDOT TIA/Project Traffic Study (PTS) status maps, and consult the local entities within the study area to identify other proposed developments. Discuss the latest land use and short term (within 5 years) plans for the area with the local metropolitan planning organization (MPO), regional planning commission (RPC), or local government agency. Contact information for the MPOs and RPCs within Wisconsin is available via the WisDOT planning resources webpage. This section **shall** show the local entity's master plan for the area.

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

PART D — SITE ACCESSIBILITY

This section should provide a description of the existing roadway system.

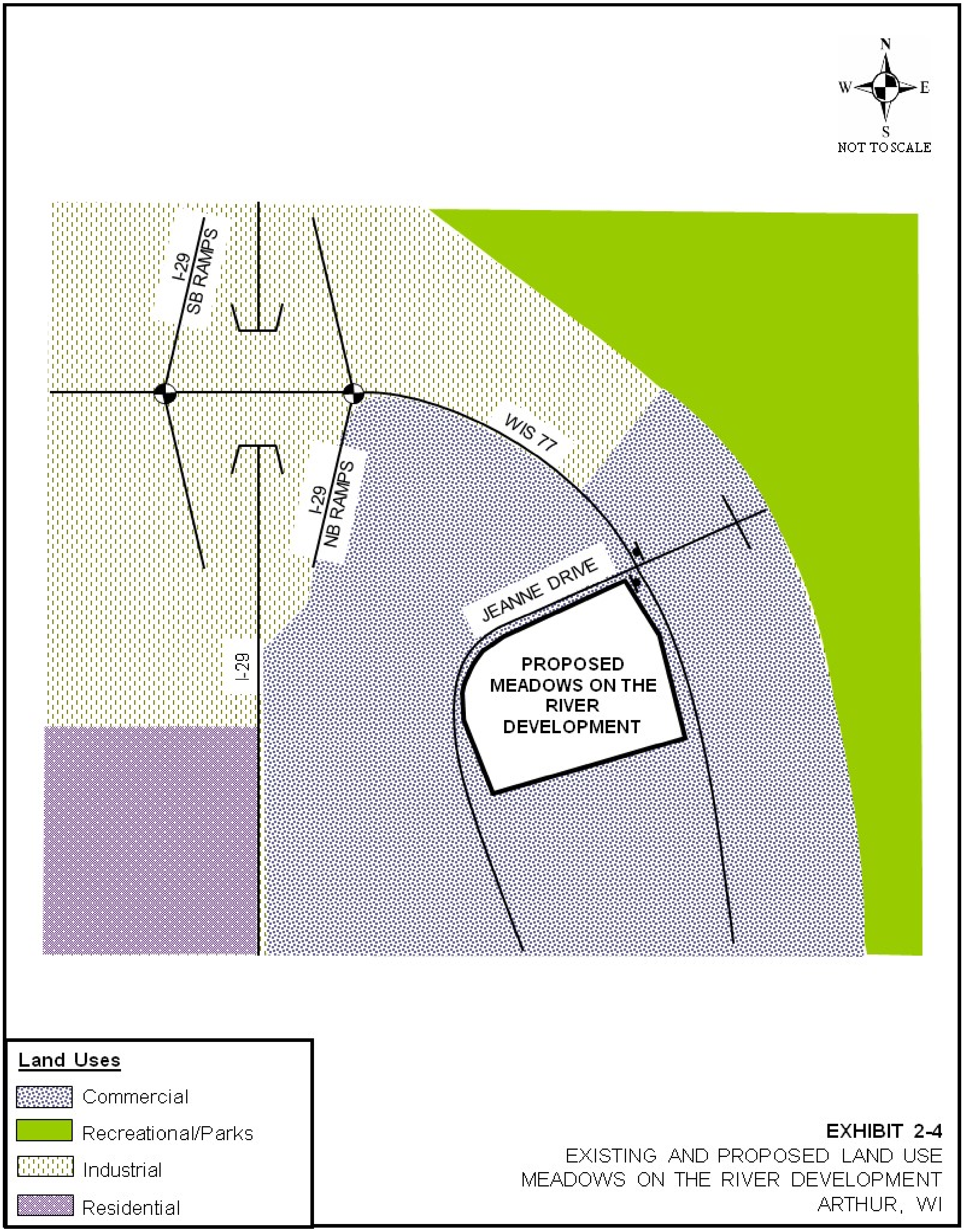
The purpose of this section is to present the existing and future multimodal transportation system in the area servicing the proposed development. The TIA *should* present this information in both a narrative form and as an illustration in the site location map or site plan.

This section of the report *should* provide a description of the existing transportation system, emphasizing the major travel routes to and from the site. The narrative *should* include such items as existing roadways, adjacent driveways, frontage roads/ interconnections, private roads, sidewalks, bike accommodations, and transit routes and facilities within the study area. The TIA preparer **shall** identify the existing traffic control at each intersection and **shall** discuss any travel restrictions (e.g., one-way streets, left-turn prohibitions) that are present in the study area.

The TIA preparer **shall** consult with the local entities including the maintaining authorities and transit operators to identify if there are any potential roadway improvement projects within the study area. These projects might include construction of new roadways, widening or extension of existing facilities, or installation of new traffic signals, to name a few. The TIA *should* provide the schedule for the completion date for such improvements.

This section of the TIA **shall** include a discussion of all modes of transportation that may service the development. Modes of transportation include personal vehicles, transit, carpools, vanpools, bicycles, pedestrians, and others. In addition, the TIA *should* discuss alternative work hours, future transit service, and other considerations that effect travel to/from the site as appropriate. For further information, see Chapter 4 – Part B.

Exhibit 2-4


N
W
E
S
NOT TO SCALE
I-29 SB RAMPS
I-29 NB RAMPS
WIS 77
JEANNE DRIVE
I-29
PROPOSED MEADOWS ON THE RIVER DEVELOPMENT
Land Uses
Commercial
Recreational/Parks
Industrial
Residential
EXHIBIT 2-4
EXISTING AND PROPOSED LAND USE
MEADOWS ON THE RIVER DEVELOPMENT
ARTHUR, WI

CHAPTER 3 ANALYSIS OF EXISTING CONDITIONS

The analysis of existing conditions provides a base against which to measure the incremental traffic impacts of the proposed development. This chapter of the TIA **shall** address the following topics:

- Physical characteristics
- Traffic volumes
- Capacity/LOS
- Sources of data

PART A — PHYSICAL CHARACTERISTICS

This section **shall** provide detailed information regarding the physical characteristics of the existing transportation system for the study area. Indicate any currently planned roadway or traffic control changes (identify the agency initiating the improvement and state the year they plan to complete the improvement). Discuss this topic in narrative form. The narrative *should* also include a discussion of existing multimodal facilities including bicycle, pedestrian, and transit infrastructure as appropriate. When applicable, include a discussion of transit service frequency (e.g., headways). Contact WisDOT regional multimodal staff with any questions.

The report **shall** provide a general discussion and a detailed exhibit highlighting the characteristics of the existing transportation system. This section of the TIA **shall** include the following exhibits:

Exhibit 3-1A ....Existing Transportation System
Exhibit 3-1B .... Planned Transportation System (if known project in study area)

Exhibit 3-1A and ***Exhibit 3-1B*** **shall** include the following items:

a. North arrow
b. Major highways and streets (include roadway names)
c. Roadway system characteristics including:
   » Roadway geometry
      ▪ Indicate if roadways are divided or undivided
      ▪ Identify median openings
   » Intersection geometry (e.g., medians, islands, curb ramps)
   » Distances between major roadways and proposed site
   » Location of driveways within the immediate area
   » Lane configuration at each study intersection (can show as arrows)
   » Location and type of traffic control devices
   » Posted speed limits
   » Pedestrian, bicycle, and shared-use paths (as applicable)
   » Transit service and bus stop locations (as applicable)
   » Restrictions such as one-way streets or left-turn prohibitions

Note: A scaled exhibit is not required; however, the exhibits **shall** show the distances to major roadways, driveways, access points, median openings, etc., to allow for the easy identification of access spacing issues that may arise during the review.

Exhibit 3-1 is an example of how to illustrate the transportation system.

Exhibit 3-1

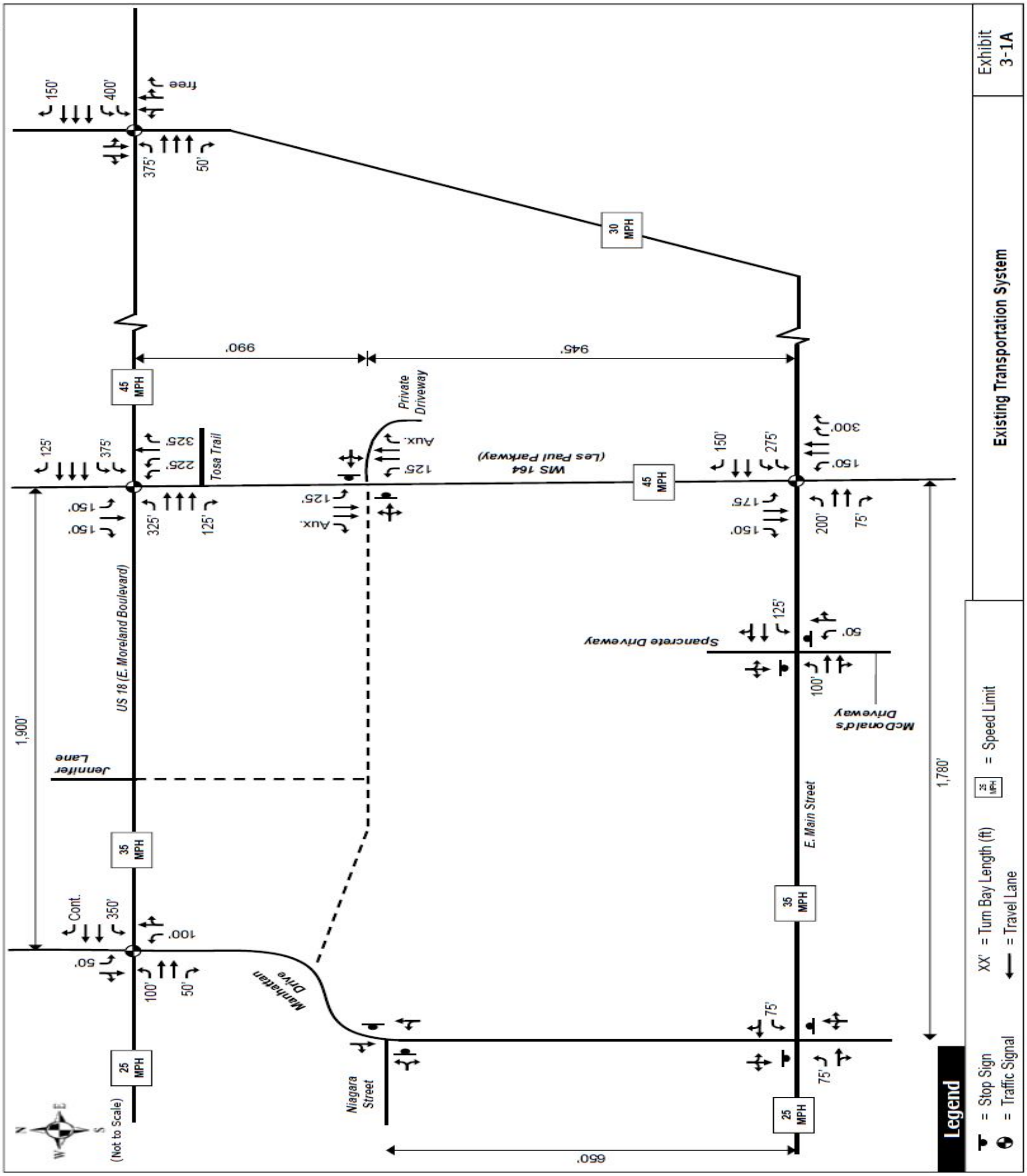


Exhibit 3-1A
Existing Transportation System
Legend
= Stop Sign
= Traffic Signal
XX' = Turn Bay Length (ft)
= Travel Lane
= Speed Limit
US 18 (E. Moreland Boulevard)
WIS 164 (Les Paul Parkway)
E. Main Street
Tosa Trail
Private Driveway
Spancrete Driveway
McDonald's Driveway
Jennifer Lane
Manhattan Drive
Niagara Street
(Not to Scale)
990'
945'
1,900'
1,780'
650'
free
Cont.
Aux.

PART B — TRAFFIC VOLUMES

The report *should* contain information on existing 24-hour traffic volumes for the highways and streets in the study area. This section *should* also provide the existing peak-hour turning movement volumes for the major intersections in the study area.

At a minimum, the traffic volumes *should* identify the annual average daily traffic (AADT) or annual average weekday daily traffic (AAWDT) volumes and *should* address the 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 that will generate the highest volume of traffic to/from the development. Timeframes 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.

Under the following situations, it may be appropriate to specify other peak periods in addition to, or in place of, the typical morning and afternoon peak hours:

- 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 will generate little or no traffic during the AM or PM peak periods, or
- The proposed land use has unusual peaking characteristics (e.g., a church or theater).

Propose improvements to meet the highest traffic volumes for a particular movement and discuss them in the conclusions and recommendations.

Show the current turning movement volumes at the intersections where the proposed development may have an impact. The exhibit **shall** show both the AM and PM peak volumes for all major intersections. The highest traffic volumes for a given maneuver at a major intersection may be higher during a period that 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 TIA **shall** still provide an evaluation of the traffic volumes for the intersection's peak hours to ensure the improvements are appropriate to handle the system's traffic. Propose improvements to meet the highest traffic volume and discuss them in the conclusions and recommendations.

WisDOT collects mainline traffic volume data at just over 26,000 sites (26,000 short-term coverage-count sites and over 300 continuous count sites) on streets and highways around the state. These coverage and continuous count sites are located on freeways, major and minor arterials, and collector streets in all 72 Wisconsin counties. The coverage count data includes AADT, raw data, and hourly volumes. Summaries of the AADT are available via the WisDOT Traffic Count Map (TCMap).

TIA preparers benefit from information about how traffic volumes vary by time of 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 Southeast region currently counts signalized intersections in a system on a three-year cycle while they count standalone signalized intersections every six years. Other regional offices may perform manual turning movement counts at certain intersections as part of an improvement project or for periodic signal timing evaluations. Traffic volume data (mainline or intersection counts) might also be available from the local municipality. The WisDOT Bureau of Traffic Operations (BTO) Data Hub provides a list of additional data sources that may be useful during the preparation of the TIA.

The TIA preparer *should* use the traffic data sources above as the primary basis of existing traffic volumes and **shall** only conduct new traffic counts when valid traffic data does not already exist. WisDOT does not typically conduct counts for private entrances; thus, the TIA preparer will most likely need to collect the traffic data at these locations. The TIA **shall** document the data sources and independent data collection methods.

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

Unless the WisDOT regional traffic engineer preapproves otherwise, utilize traffic volume data that is at most three years old. Traffic volume data for multiple intersections in the same corridor *should* be within the same year. Contact the WisDOT regional office with requests for existing traffic volume information that is not available from the sources provided above.

The TIA preparer **shall** consult with the WisDOT regional office prior to conducting any traffic counts to confirm the need to collect new counts and to identify the time frames to cover with the counts.

If the completion date of the development is not within two years of the oldest count in the study area, the TIA preparer **shall** establish base year traffic. Base year traffic refers to the anticipated opening year of the development. If applicable, the TIA preparer **shall** submit a forecast request for the base year traffic to the WisDOT regional traffic forecasting contact. Refer to the *Transportation Planning Manual (TPM)* for additional details on obtaining a traffic forecast for the TIA.

This section of the TIA **shall** include the following exhibits:

Exhibit 3-2A .... Existing Traffic Volumes
Exhibit 3-2B ....Base Year Background Traffic Volumes

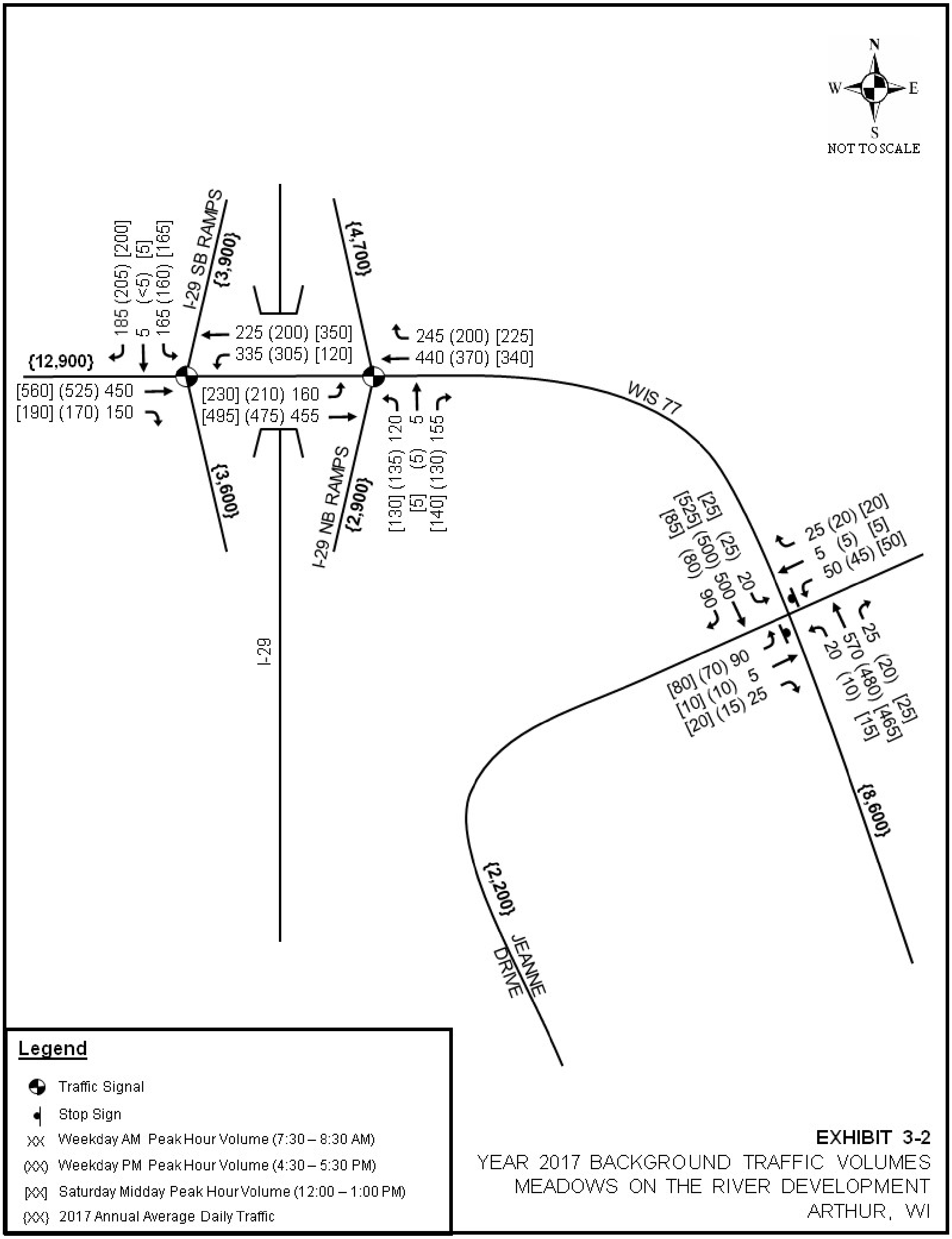
Exhibit 3-2A and ***Exhibit 3-2B*** **shall** illustrate the existing and base year AADT/AAWDT, respectively, for all highway segments within the study area, and, **shall** show all peak hour movements for the critical hours of ingress or egress. ***Exhibit 3-2B*** is necessary if the development is not building in the existing year.

Exhibits 3-2A and ***3-2B*** **shall** include the following items:

- North arrow
- All major highways, streets, and access points (include roadway names)
- Legend indicating the peak hour movements by time. Use the following format to differentiate between each hour:
  - » AM
  - » (PM)
  - » [Other critical hours]

Exhibit 3-2 is an example of how to display the traffic volume data. ***Appendix A*** **shall** include any raw data used to create ***Exhibits 3-2A*** and ***3-2B***.

Exhibit 3-2


N
W
E
S
NOT TO SCALE
I-29 SB RAMPS
{3,900}
{4,700}
185 (205) [200]
5 (<5) [5]
165 (160) [165]
225 (200) [350]
335 (305) [120]
245 (200) [225]
440 (370) [340]
{12,900}
[560] (525) 450
[190] (170) 150
[230] (210) 160
[495] (475) 455
120 (135) [130]
5 (5) [5]
155 (130) [140]
{3,600}
I-29 NB RAMPS
{2,900}
WIS 77
I-29
[25] (25) 20
[525] (500) 500
[85] (80) 90
25 (20) [20]
5 (5) [5]
50 (45) [50]
[80] (70) 90
[10] (10) 5
[20] (15) 25
20 (10) [15]
570 (480) [465]
25 (20) [25]
{8,600}
{2,200}
JEANNE DRIVE
Legend
Traffic Signal
Stop Sign
XX Weekday AM Peak Hour Volume (7:30 – 8:30 AM)
(XX) Weekday PM Peak Hour Volume (4:30 – 5:30 PM)
[XX] Saturday Midday Peak Hour Volume (12:00 – 1:00 PM)
{XX} 2017 Annual Average Daily Traffic
EXHIBIT 3-2
YEAR 2017 BACKGROUND TRAFFIC VOLUMES
MEADOWS ON THE RIVER DEVELOPMENT
ARTHUR, WI

PART C — CAPACITY / LEVEL OF SERVICE

The purpose of the capacity/level of service (LOS) analysis is to show the relationship between traffic operations and roadway geometrics, assess needs, and identify alternatives for further consideration. The TIA preparer **shall** conduct analysis of traffic volumes, facility capacity, and LOS for each intersection and driveway in the immediate area of the development within the study area.

Consider analysis of pedestrian, bicycle, and transit facilities when such services are present or planned for the area.

Consider analysis of pedestrian, bicycle, and transit facilities when such services are present or planned for the area, especially if the proposed development will generate bicycle, pedestrian, or transit trips. Bicycle accommodations may include bike lanes, wide outside travel lanes, paved shoulders, and shared-use paths. Where existing or proposed transit stops are located within 2,000 feet of the proposed development, it may be advantageous to include an analysis of transit service. Transit service analysis may be applicable if the proposed development is in an area with frequent fixed transit service or where there is substantial transit ridership. Coordinate with regional multimodal planning staff and transit operators to determine when to conduct analysis of the pedestrian, bicycle, or transit service.

*The methods of the latest HCM **shall** be the basis for the intersection capacity analysis.*

The procedures, methods, and techniques recommended in the *Highway Capacity Manual* (HCM) **shall** be the basis for the intersection capacity analysis. Unless the WisDOT regional engineer provides prior authorization, the analysis shall follow the HCM 6th Edition methodologies.

TEOpS 16-10 provides a list of the WisDOT supported software packages that implement the HCM methodology for capacity analysis.

The TIA preparer **shall** use the most current version/build of the WisDOT supported software packages to conduct the intersection capacity analysis. Refer to the BTO Traffic Analysis, Modeling and Data Management Program area webpage for the version and build of the software that WisDOT currently supports. Note that Synchro 10, the Highway Capacity Software (HCS) 7, and Sidra Intersection 7 are the first versions to implement the methodologies within the HCM 6th Edition. Obtain approval from the WisDOT regional office prior to using earlier versions of Synchro, HCS, Sidra, Vistro, or other software programs not included in the WisDOT supported Traffic Analysis Tools.

For studies that require a traffic signal system analysis, the WisDOT regional office will determine the appropriate software program. For all analyses, clearly label both the input and output data and include in ***Appendix B***.

When using Synchro to perform the analysis, the appendix **shall** include the following reports:

Signalized Intersections:

- Intersection report with the following data:
  - Lane Inputs
  - Volume Inputs
  - Timing Inputs
  - Actuated Inputs
  - Queues
- HCM 6th Signalized "Summary" report (with 95th percentile queue) *

Unsignalized Intersections (AWSC and TWSC):

- Intersection report with the following data:
  - Lane Inputs
  - Volume Inputs
- HCM 6th AWSC or TWSC report

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

* To present the 95th percentile queue within the HCM 6th Signalized report, change the Queue Length Percentile to "95" under Synchro's HCM 6th tab.

When using HCS to perform the analysis, the appendix **shall** include the full formatted report for signalized intersections and the formatted summary report for unsignalized (AWSC, TWSC, and roundabout) intersections.

When using Sidra to perform the analysis (applicable only for roundabout analysis), make sure to select the appropriate roundabout model options (either US HCM 2010 or US HCM 6) that corresponds to the HCM methodologies as directed by the WisDOT regional office. Use the Wisconsin-specific minimum headway and follow-up headway values as discussed in TEOpS 16-5-20 Table 20.1. Provide the following Sidra output worksheets in the appendix:

- Site Layout
- Input Report
- Site Output - Movement Summary
- Site Output - Lane Summary

When using Vistro to perform the analysis, coordinate with the WisDOT regional engineer to identify which report printouts to include in the appendix.

The roadway system characteristics such as traffic volume, lane geometry, percentage of trucks, peak-hour factor (PHF), number of lanes, roadway grades, parking conditions, and pedestrian flows are the basis for the intersection LOS analysis.

The analyst **shall** calculate the percent heavy vehicles for each approach based on the most recent manual vehicle classification/distribution count. They **shall** gather geometric information such as the number of lanes, lane widths, approach grades, and lane usage from either as-built plans or field observations. Additionally, the TIA preparer **shall** obtain transit information including route locations, stop locations, and frequency of buses from the appropriate transit agency.

The analyst **shall** calculate the PHF for each study intersection based on the most recent manual traffic count. In general, the analyst **shall** apply the total intersection PHF to all turning movements and approaches. In those cases where one approach to the intersection has significantly different peaking characteristics than the rest of the intersection (e.g., one approach provides direct access to a church, movie theater, factory, school), coordinate with the WisDOT regional engineer to determine whether it is appropriate to use a different PHF for that one approach or movement.

Contact the regional office for current signal timings and sequence of operations.

For signalized intersections, additional features including saturation flow, signal progression, and ratio of signal green time to cycle time, influence the LOS analysis. Refer to the WisDOT *Traffic Engineering, Operations and Safety (TEOpS) Manual* 16-15-5.2.2 for the recommended saturation flow rate to utilize in the analysis. For the analysis of an existing signalized intersection, contact the WisDOT 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, the TIA preparer *should* conduct a field study to determine the average green time for each movement.

The intersection typically must have an exclusive right turn lane before the analyst can include right turn on red (RTOR) in the capacity analysis of a signalized intersection. Obtain approval from WisDOT regional traffic staff prior to including RTOR volumes within the capacity analysis for shared through/right lanes. Refer to TEOpS 16-15-5.2.1 for the recommended RTOR adjustments to utilize in the analysis.

At **unsignalized intersections,** LOS analysis for one-way stop-controlled (OWSC), two-way stop-controlled (TWSC), all-way stop-controlled (AWSC), and roundabout-controlled intersections depends upon a clear understanding of the interaction of drivers on the controlled approaches with drivers on the uncontrolled approaches (if any). The current HCM methodologies use both gap acceptance and empirical models to describe this interaction. The TIA preparer may supplement the results from the HCM-based analysis with a gap study. There are two fundamental issues related to gap studies, however, which preclude its use as a replacement of the HCM procedures.

1. The gap study only considers the existing available gaps; as such, a gap study does not allow the evaluation of the gap reduction due to increased traffic along the main highway.
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 there is other traffic on the main highway 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.

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

The HCM procedure defines LOS for the overall intersection (applicable only for signalized and roundabout-controlled intersections), each intersection approach, and each lane group. Control delay characterizes the LOS for the overall intersection or intersection approach, while the combinations of control delay and volume-to-capacity ratio (v/c) characterize the 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 full utilization of the cycle capacity at a signalized intersection or the presence of inadequate gaps for the minor street demand volume (i.e., gap sizes are too small to allow vehicles to safely cross/enter the intersection) at a stop-controlled intersection. A v/c equal to or greater than 1.0 represents failure from a capacity perspective just as LOS F represents significant failure from a delay perspective. A critical v/c greater than 1.0 indicates that the overall signal, stop control, or lane configuration provides inadequate capacity for the given flows.

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

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 transportation and intersection conditions plus any programmed improvements that will be in place prior to completion of the development. 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 note the methods used to calculate them.

This section of the TIA **shall** include the following exhibit:

Exhibit 3-3............ Base Year Background Traffic Capacity/LOS Analysis, Existing/Planned Transportation System

Exhibit 3-3 **shall** illustrate in a table or graphic format the delay, v/c, and 95th percentile queues for each movement. Consult with the WisDOT regional office for their format preference. ***Exhibit 3-3*** is an example of how to display the traffic capacity/LOS information in a table format. The TIA submittal **shall** include an electronic copy of the analysis files, clearly labeled as a digital submission (e.g., .syn). The electronic files are necessary to allow the WisDOT regional office to conduct a peer review of the traffic analysis in accordance with TEOpS 16-25.

PART D — SOURCES OF DATA

In this section, list the type, year, and source of all traffic data including: turning movement counts, average daily traffic, traffic forecasts, existing signal timings, crash data, and programmed improvement plans/analysis files (if available). WisDOT provides data on the state trunk highway and connecting highway systems. Additional sources of data include:

- RPCs and MPOs
- Municipal and county traffic departments
- Other recent traffic studies
- Highway design data for recent projects
- TOPS Lab
- BTO data hub

Exhibit 3-3

Example table format

<table>
<tr><th rowspan="3">Intersection</th><th rowspan="3">Traffic control</th><th rowspan="3">Peak Hour</th><th rowspan="3">Parameters</th><th colspan="12">Level of Service per Movement by Approach</th><th rowspan="3">Overall Intersection LOS</th></tr>
<tr><th colspan="3">Eastbound</th><th colspan="3">Westbound</th><th colspan="3">Northbound</th><th colspan="3">Southbound</th></tr>
<tr><th>LT</th><th>TH</th><th>RT</th><th>LT</th><th>TH</th><th>RT</th><th>LT</th><th>TH</th><th>RT</th><th>LT</th><th>TH</th><th>RT</th></tr>
<tr><td rowspan="10">(Intersection #1 name)</td><td rowspan="10">(Signal, AWSC, TWSC, OWSC)</td><td colspan="2">Number of Lanes</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="5"></td></tr>
<tr><td rowspan="4">AM</td><td>LOS</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Delay (sec)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>v/c</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Queue (ft)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td rowspan="4">PM</td><td>LOS</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td rowspan="10">(Intersection #2 name)</td><td rowspan="10">(Signal, AWSC, TWSC, OWSC)</td><td colspan="2">Number of Lanes</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="5"></td></tr>
<tr><td rowspan="4">AM</td><td>LOS</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td rowspan="10">(Intersection #3 name)</td><td rowspan="10">(Signal, AWSC, TWSC, OWSC)</td><td colspan="2">Number of Lanes</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="5"></td></tr>
<tr><td rowspan="4">AM</td><td>LOS</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>Queue (ft)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Use a hyphen (-) or leave blank for movement that isn't available or allowed.

CHAPTER 4 PROJECTED TRAFFIC

Future traffic volumes in the study area **shall** consist of background traffic plus development traffic plus the additional off-site development traffic. Because the accuracy of the traffic analysis is dependent upon the accuracy of the traffic projections, it is very important to document all assumptions and methodologies used in the preparation of future traffic such that the WisDOT regional engineer can judge them 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

*Typically, the horizon year **shall** represent 10 years after the opening of the proposed development or five years after buildout, whichever is greater.*

Background traffic volumes represent the amount of traffic that will be on the area roadway network without any proposed development. The analyst **shall** complete a traffic projection of this background volume to an appropriate horizon (future) year. WisDOT regional staff **shall** establish the horizon year prior to proceeding with the study. There may be more than one horizon year (i.e., interim years) required for phased development. Typically, the horizon year **shall** represent 10 years after the opening of the proposed development or five years after buildout, whichever is greater.

The WisDOT regional traffic forecasting contact will typically provide traffic volume forecasts for the state trunk highways and connecting highways involved. Allow adequate time for the traffic forecasting section to gather and provide data. After obtaining the traffic forecasts, the TIA preparer, in coordination with the WisDOT regional traffic engineer, *should* review them against the latest coverage counts and consider them for use in the analysis. The WisDOT forecasting unit **shall** review and approve any forecasts not developed by WisDOT forecasting staff.

Potential sources of background traffic projections are:

- WisDOT regional traffic forecasting contact
- Local or regional planning commissions or MPOs
- Trends and growth rates used in projects within the study area
- Area or sub-area transportation models

The TIA Preparer should allow for plenty of time for Traffic Forecasting to gather and provide data.

Prior to developing traffic forecasts, the preparer **shall** discuss with the WisDOT regional traffic forecasting contact the availability of background traffic projections and the methodology to use in developing such estimates when none are available.

This section of the TIA **shall** include the following exhibits:

Exhibit 4-1... Interim Year Background Traffic Volumes
Exhibit 4-2...Horizon Year Background Traffic Volumes

Exhibit 4-1 and ***Exhibit 4-2*** **shall** illustrate the anticipated interim and horizon-year traffic volumes, respectively for each period chosen for analysis. ***Exhibit 4-1*** and ***4-2*** **shall** have a similar structure as ***Exhibit 3-2A*** and ***Exhibit 3-2B***.

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

To determine the impact, if any, the proposed development will have on future conditions, it is necessary to estimate the trip generation potential of the development and identify how to distribute this additional traffic to the area roadway network. This requires the following five steps:

1. Trip generation
2. Mode split
3. Pass-by and linked-trip traffic estimation (if applicable)
4. Trip distribution
5. Trip assignment

The TIA preparer **shall** estimate the trip generation and trip distribution potential associated with the on-site and off-site developments for each horizon year included in the analysis. Phased developments may have more than one horizon year. It may be appropriate to use different traffic assignments for the same development when:

- There is a multi-phased project, in which case, each phase may require a different traffic assignment,
- There is significant traffic growth expected between horizon years, or
- There are major roadway, bicycle, pedestrian, or transit improvements which result in a notable change in travel patterns between horizon years.

This section of the TIA **shall** include the following exhibits:

Exhibit 4-3... Trip Generation Table
Exhibit 4-4... Trip Distribution

1. Trip Generation

The major factors that influence the amount of traffic a development will generate include the development's size and land use types. The type of land use (e.g., residential, retail, industrial, office, etc.) is of particular importance as it will significantly impact not only the volume of new traffic the development will add to the area roadway network also the time of day in which the new traffic will be added.

The most commonly accepted source for trip generation data for land use developments is the current version of the ITE *Trip Generation Manual*. ITE Trip generation provides data in terms of trip rates (average, maximum, and minimum), fitted curve equations (i.e., regression equations) and data plots. The ITE *Trip Generation Handbook* provides guidelines for when to use each source of data for estimating the trip generation characteristics of a land use. (As of the date of this publication, the most current version of these documents is the ITE *Trip Generation Manual, 10th Edition* and *Supplement,* and the ITE *Trip Generation Handbook, 3rd Edition*.)

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

The ITE *Trip Generation Handbook, 3rd Edition* recommends using the following guidelines to determine whether to use the fitted curve equations, the weighted average rates, or whether it is best to collect local data in order to estimate the trip generation potential of a development. The following page provides a flow chart that outlines the process for selecting the average rate or fitted curve equation.

I. Use fitted curve equation when:

- A fitted curve equation is provided and the data plot has at least 20 data points

  OR

- A fitted curve equation is provided, there are between 3 (preferably 6 or more) and 20 data points, the curve has an R^2 of at least 0.75, the fitted curve falls within the data cluster, and the weighted standard deviation is greater than 55 percent of the weighted average rate.

II. Use weighted average rate when:

- The data plot has between 3 (preferably 6 or more) and 20 data points; the R^2 value for the fitted curve is less than 0.75 or no fitted curve equation is provided;
- The weighted standard deviation for the average rate is less than or equal to 55 percent of the weighted average rate;

  AND

- The weighted average rate falls within the data cluster.

III. Choose either the fitted curve or weighted average rate (whichever line best fits the data cluster for the size of the development) when:

- The data plot has between 3 (preferably 6 or more) and 20 data points; the fitted curve equation is provided, the curve has an R^2 of at least 0.75, the fitted curve falls within the data cluster;

  AND

- The weighted standard deviation for the average rate is less than or equal to 55 percent of the weighted average rate and the weighted average rate falls within the data cluster.

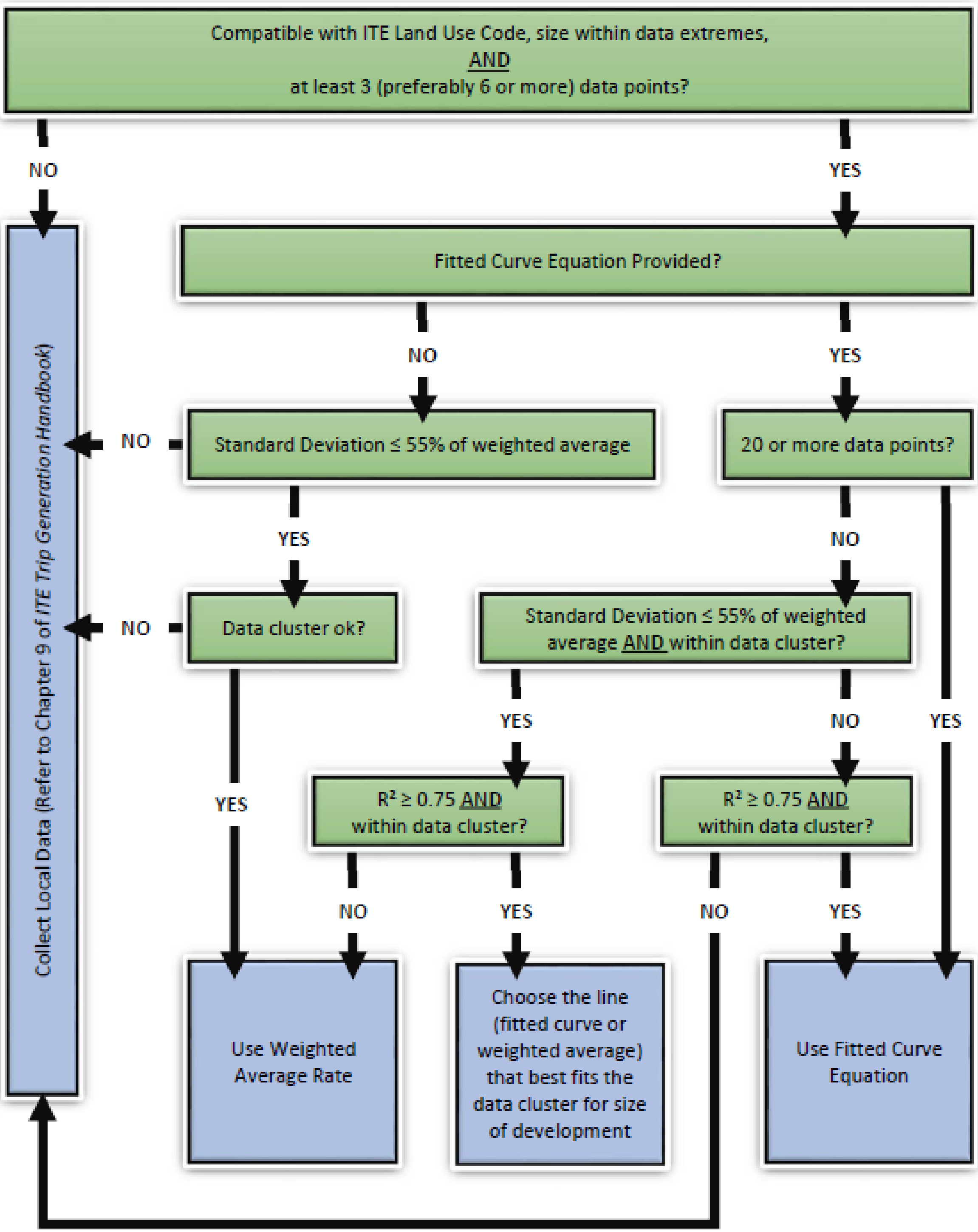
IV. Collect local data when any of the following exist:

- Study site is not compatible with ITE land use code definition;
- The independent variable does not fall within the range of data;
- Data plot has only one or two data points (and preferably, when five or fewer);
- The data plot has between 3 (preferably 6 or more) and 20 data points; the R^2 value for the fitted curve is less than 0.75 or no fitted curve equation is provided; and the weighted standard deviation for the average rate is greater than 55 percent of the weighted average rate;

  OR

- Neither the weighted average rate line nor the fitted curve fall within the data cluster for the size of the development.

ITE *Trip Generation Handbook* Process for Selecting Fitted Curve Equation, Weighted Average Rate or Local Data Collection



Source: Figure 4.2, ITE *Trip Generation Handbook, 3rd Edition*

ITE *Trip Generation Manual, 10th Edition* provides multivariable trip generation equations for the following ITE land use codes:

- ITE 231 – Mid-Rise Residential with 1st-Floor Commercial
- ITE 945 – Gasoline/Service Station with Convenience Market
- ITE 960 – Super Convenience Market/Gas Station

Currently, WisDOT does not allow the use of the multivariable trip generation equations for these land use codes; however, WisDOT may consider the use of the multivariable equation for a super convenience market/gas station (ITE 960) in an area where there are no other gas stations. Prior to utilizing the multivariable trip generation equations, contact the WisDOT regional traffic office to obtain approval.

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

Typically, the analyst *should* use the trip generation rates or regression equations published in the latest edition of ITE *Trip Generation Manual* and any supplements that have been released to estimate site traffic. Exceptions to this include times when an individual trip generation study for the proposed development exists or when there is trip generation data available for an individual company/entity within the proposed development. In cases where ITE Trip generation data is very limited or unavailable, it may be appropriate to use trip generation rates available via one or more of the following sources:

- Local data for comparable developments
- Other published references such as the ITE Journal
- The open source trip generation data available from Spack Consulting
- Trip generation studies conducted at sites comparable to the proposed development
- The April 7, 2017 *Mixed-Use Development (MXD) Trip Generation Study* prepared for WisDOT by TADI

There are cases where more than one ITE Land Use Code could be applicable to a specific development. For example, both ITE Land Use Codes 945 and 960 are applicable to gas stations with a convenience store. In these instances, the analyst should review the detailed description of each land use code to assess which land use code is most appropriate for the proposed development. For the specific case of ITE 945 versus 960, ITE 945 is recommended for gas stations with the smaller convenience store (2,000-3,000 square feet) and ITE 960 is recommended for gas stations with the larger convenience store which typically has full grocery service (greater than 3,000 – 6,300 square feet).

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

The TIA **shall** document all sources used to determine the trip generation for each land use. If the source is from something other than the ITE *Trip Generation Manual*, the TIA preparer **shall** provide, in writing, justification as to their suitability for the proposed development. 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 **shall** be reasonable and defensible.

Commonly used ITE Land use codes can be found on the WisDOT Traffic Analysis website.

The TIA *should* present the trip generation information in ***Exhibit 4-3*** in an organized manner that makes it easy for the reader to understand the exact process used to derive the trip generation estimates. Typically, the table would identify the following:

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

2. Mode Split

The ITE *Trip Generation Manual* primarily uses data collected throughout the United States and Canada at low-density, single-use, homogeneous, general urban, or suburban developments with little or no public transit service and little or no convenient pedestrian access as the basis for the trip generation rates. Thus, in almost all cases, the ITE trip rates represent 95 percent or more auto usage, and in most cases, represent 100 percent motor vehicle travel. This assumption may be appropriate for many of the developments that occur in Wisconsin; however, there will be occasions where the development trips will include pedestrian, bike, transit, or other non-passenger vehicle modal trips. These trips would normally occur in populated areas where transit services or bicycle/pedestrian facilities are available.

The WisDOT regional office will review any assumptions regarding mode split, specifically the non-passenger vehicle trips, for reasonableness.

The ITE *Trip Generation Handbook, 3rd Edition* provides guidance on how to analyze trips in units of either person trips or vehicle trips. Where person trips consist of trips made to or from a site by each individual person using any mode of transportation including walk trips, bike trips, transit trips, truck trips, and personal passenger-vehicle trips. Vehicle trips consist of trips made to or from a site by an automobile (e.g., personal passenger vehicle, bus, truck, etc.). Vehicle trips may consist of one or more-person trips (e.g., an automobile with two people in it counts as one vehicle trip but two-person trips). Using the information available in the ITE *Trip Generation Handbook, 3rd Edition*, the analyst, to the limits possible with available or readily collectible data, can estimate the inbound and outbound trips of a development by travel mode. Local data collection can also assist in determining the appropriate mode split percentages to use in calculating the developments trip generation potential. The TIA **shall** document the availability of transit service and pedestrian/bicycle facilities and **shall** summarize any surveys of current travel behaviors or other relevant data to support the mode split assumptions. The WisDOT regional office will review any assumptions regarding mode split, specifically the non-passenger vehicle trips, for reasonableness.

3. Pass-By and Linked Trip Traffic Estimation

New trips (or primary trips) are trips made for the specific purpose of visiting the trip generator. Therefore, these trips are new traffic on the area roadway network. Actual traffic counts conducted at the driveways of various developments are the primary source for trip generation rates. 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 those particular land uses will add to the area roadway network.

Pass-by trips are trips currently on the roadway system, which make an intermediate stop at a generator (i.e., the development under study) with direct access to the roadway network that is adjacent to the original travel route between the origin and primary destination. Pass-by trips do not include trips that divert from their original travel path non-adjacent to the site (i.e., diverted trips). Pass-by trips are convenience-oriented, for example, stopping to refuel a vehicle during a commute from work. Pass-by trips are only applicable for retail-oriented land uses. Thus, the analyst *should* only consider the use of pass-by trips when the proposed development is a retail-oriented development that will attract existing traffic off an adjacent roadway or street.

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 added to the adjacent street system by the proposed development (i.e., new trips). Depending on the type of development and adjacent street traffic volumes, predicted pass-by trips can vary significantly, so the analyst **shall** apply these adjustments carefully. Calculate the number of pass-by trips after accounting for internal trips (Total Site Trip Generation – Internally-Linked Trips = External Trips; apply pass-by reduction to External Trips).

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

Typically, pass-by traffic *should* not exceed 5 to 10 percent of the traffic volumes on the adjacent roadways and it *should* have equal ingress and egress volumes. WisDOT **shall** approve the use of any pass-by trip estimates greater than 10 percent of the adjacent roadway traffic volumes. Refer to the WisDOT *Pass-By Trips* table for the acceptable ranges of pass-by rates developed for use in Wisconsin. The ITE *Trip Generation Handbook, 3rd Edition* provides additional guidance on the use of pass-by trip reductions.

*WisDOT **shall** approve any pass-by trip estimate greater than 10 percent of the adjacent roadway traffic volumes.*

The TIA **shall** define the pass-by percentages assumed in the analysis and **shall** provide documentation supporting the use of the pass-by percentages in ***Appendix A***. This is especially important when the pass-by percentage exceeds 10 percent of the adjacent roadway traffic volumes.

Linked trips are trips with one common point of origin and multiple destinations points (i.e., chaining or linking multiple stops together in a single trip). Linked trips can occur between different land uses along the travel route (i.e., the trips use the major roadway system to get from one land use to another) or they can occur between different land uses within the same development (i.e., the trips are captured internally on-site and do not use the off-site roadway system).

When trips between multiple land uses make use of the major roadway network (also known as multi-linked or externally-linked trips), there may be an increase in the number of trips entering/exiting a specific driveway as one driveway may serve two or more separate trips. When the multiple land uses are part of the same development, the analyst *should* adjust the trip generation estimates of the development as appropriate. When the multiple land uses are associated with different developments; however, in most cases, depending on access locations and connectivity among developments, the analyst *should* treat each development separately when estimating the trip generation potential.

When trips occur between multiple land uses within the same mixed-use or multi-use development (MXD) without use of the adjacent roadway network (also known as internally-linked or internally-captured trips), there is typically a reduction in the number of trips entering/exiting the proposed MXD as one driveway trip can result in multiple trips between land uses within the development itself. Since trips between two or more land uses within the MXD can occur without use of the external street system, internally linked trips also reduce the amount of traffic the new development will add to the adjacent roadway.

Internal capture rates vary by the mix of land uses, the size of the land uses, the amount of potential interaction between complementary land uses, and the availability of convenient internal on-or off-street facilities and connections. Typically, MXD sites need to contain the necessary facilities and land uses to support a significant amount of interaction to justify that the development will capture some of the generated trips internally and thus allow the analyst to apply internal capture rates when estimating the development's trip generation potential.

In evaluating a proposed internal capture rate, the analyst *should* consider the following general guidance:

- 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 there is a hotel or motel within the site.
- Residential 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 affect the internal capture rate. 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 analyst may need to adjust the internal capture rate.
- Internal capture rates are not applicable for the ITE land use code 820 (shopping centers) as the ITE trip rates for this land use already reflect the mixed-use nature of the shopping center. Therefore, the analyst *should not* use internal capture rates to forecast trips for this land use.
- Use the ITE land use code 750 (office park); rather than a MXD with internal capture rates, to estimate the trip generation potential for developments consisting of general office buildings and support services (e.g., banks, restaurants, gas stations) arranged in a park-or campus-like setting. Likewise, use ITE land use code 710 (general office building) for office buildings with support retail or restaurant facilities contained within the same building.
- The analyst *should* not apply internal capture rates to hotels with an on-site restaurant or small retail, as the trip rates for ITE land use code 310 (hotel) already reflects the interaction of these land uses.

- The TIA preparer *should* calculate internal trip capture rates for each phase of a multi-use development. If, during the review process, the development plans change, the analyst *should* update all internal capture calculations and submit the TIA for additional review.

Results of a study to evaluate the trip generation and internal trip capture rates for various mixed-use developments located across Wisconsin is available on the WisDOT BTO webpage. Contact the WisDOT regional traffic engineer or BTO (DOTTrafficAnalysisModeling@dot.wi.gov) for additional details and guidance on if/how to use the findings from this study when estimating the trip generation potential of proposed MXD sites.

In absence of Wisconsin-specific data, use the methodology outlined in Chapter 6 of the ITE *Trip Generation Handbook, 3rd Edition* to estimate internal trip capture and trip generation for mixed-use developments. A spreadsheet tool, which automates several of the calculations, is available for download from the ITE website. The analyst can also reference the *National Cooperative Highway Research Program (NCHRP) Report 684: Enhancing Internal Trip Capture Estimation for Mixed-Use Developments*, which is the source for much of the ITE methodology, for additional details on the process for estimating the internal trip capture and trip generation of MXD sites.

The ITE process and spreadsheet tool described above enables the analyst to evaluate the morning and afternoon peak period internal capture rates at a MXD site with any combination of the following six land use categories:

- Office
- Retail
- Restaurant
- Residential
- Cinema/Entertainment
- Hotel

Refer to Chapter 6 of the ITE *Trip Generation Handbook, 3rd Edition for* suggested internal trip capture rates for each of the above land use pairs. Data on internal capture rates is currently only available for the six land use categories listed above for the morning and afternoon peak, thus the analyst *should not* apply the ITE internal capture rates and methodology to other land uses or time frames (e.g., weekend peak period, weekday midday peak period, daily period).

WisDOT encourages the analyst to make logical and supportable assumptions in the use of the ITE internal trip capture and mixed-use trip generation methodologies described above. After checking the results for reasonableness, the analyst *should* typically use the total estimated internal trip capture from the ITE spreadsheet estimation tool for estimating the trip generation potential of a proposed MXD site. Consult with your regional contact to determine a maximum acceptable value for internal capture rates. WisDOT **shall** approve the use of all the internal trip capture rates greater than 10 percent of the total new trip generation for the development.

Both TIA preparers and reviewers *should* familiarize themselves with the ITE internal capture methodologies and underlying assumptions. It is critical that both the TIA preparer and reviewer have a clear understanding as to when the methodology is or is not appropriate for the proposed MXD.

Use the procedures described above only at those MXD sites that have characteristics that resemble the sites used to derive the internal capture rates. Per the ITE Trip

Determine whether the internal trip-capture methodology is appropriate for your mixed-use development

Generation Handbook, 3rd Edition, the TIA preparer and reviewer *should* consider the following factors when assessing the appropriateness of the procedure for a particular mixed-use development.

- "Development Type: The mixed-use development *should* be a single, physically and functionally integrated development on a single block or a group of contiguous blocks with two or more 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 demand periods.
- Development Location: The mixed-use development *should* be downtown fringe, general urban, or suburban. It *should* not be located either within or adjacent to a central business district [(CBD)]. Trip Generation for a study site in a CBD setting is addressed in Chapter 7 [of the ITE *Trip Generation Handbook, 3rd Edition*].
- Development Size: The mixed-use development *should* have between 100,000 and 2 million sq. ft. of building space within an overall acreage of up to roughly 300 acres. The mixed-use development 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 development composed of different adjacent, but not directly connected, land uses. Adjacent blocks can be considered to be directly connected if there is an internal street, driveway, alley system, [or] pedestrian way by which person trips can be made to travel from one block to another. If the development site has multiple land uses but blocks are configured in such a way that these trips must use an external street system, then the site is not a mixed-use development.
- Land Use Mix: The mixed-use development *should* consist of a combination of at least two of the following uses: retail, restaurant, office, residential, hotel, and cinema/entertainment. 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 [ITE *Trip Generation] Handbook* internal capture rates might not be appropriate. Alternatively, the analyst can collect internal capture data at proxy sites in the same area with similar land use and setting characteristics.
- ITE *Trip Generation Manual* Database: The mixed-use development *should* not already be covered in the ITE trip generation database as reported in the latest edition of [the] *Trip Generation Manual* or any supplements that have been released. Current ITE land use types 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 [the ITE *Trip Generation Handbook* methodology] cover the weekday AM and PM peak periods for adjacent street traffic. Internal capture rates for weekend peak periods, for weekday midday peak periods, or for a daily period *should* not be

> assumed to be the same as or even a simple, direct function of the weekday AM and PM peak period rates. [For an application that requires internal capture information outside the weekday AM and PM peak periods,] the analyst *should* collect additional data."

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.

The TIA **shall** clearly identify and display pass-by and linked-trip adjustments. See ***Chapter D*** for the appropriate exhibit numbering.

4. Trip Distribution

The major factors to consider 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 comparable to the subject development. Typically, the analogy method uses existing segment and turning-movement count data.

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, the analyst can use population data as a surrogate 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, which corresponds to the area that generates or attracts 90 percent or more of the trip ends to/from 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 available for determining the boundaries of the study area for trip distribution.

5. Origin-Destination Method

   This method makes use of origin-destination (O-D) data that is available from WisDOT travel demand models (TDMs), regional transportation plans, or local plans. The WisDOT Traffic Forecasting Section (TFS) develops and maintains a statewide TDM as well as TDMs for most of the MPOs within the state. For developments located within one of the TDM areas, the WisDOT TFS may be able to provide O-D tables or select zone information, which the TIA preparer can use to help develop the trip distribution for the proposed development. Refer to the WisDOT *TPM* for additional information regarding the travel demand models.

   In areas where TDMs are unavailable, the analyst can reference regional or local transportation plans to identify the location and type of land uses that would either generate (point of origin) or attract (point of destination) trips to/from the proposed development. Two examples of major local and regional transportation plans include:

   » Madison Area Transportation Planning Board
   » Southeastern Wisconsin Regional Planning Commission (SEWRPC)

Depict on-site and offsite development traffic distributions as percentages for each direction of travel.

Document the trip distribution methodology and the source of data within the report. The analyst *should* estimate the directional distribution for each land use component of the proposed project and for each horizon year included in the analysis. In some cases, inbound and outbound trips may have different distributions depending upon applicable operating conditions (e.g., one-way streets, medians, difficulty in making left turns, etc.). The analyst *should* provide an explanation of any such differences within the TIA.

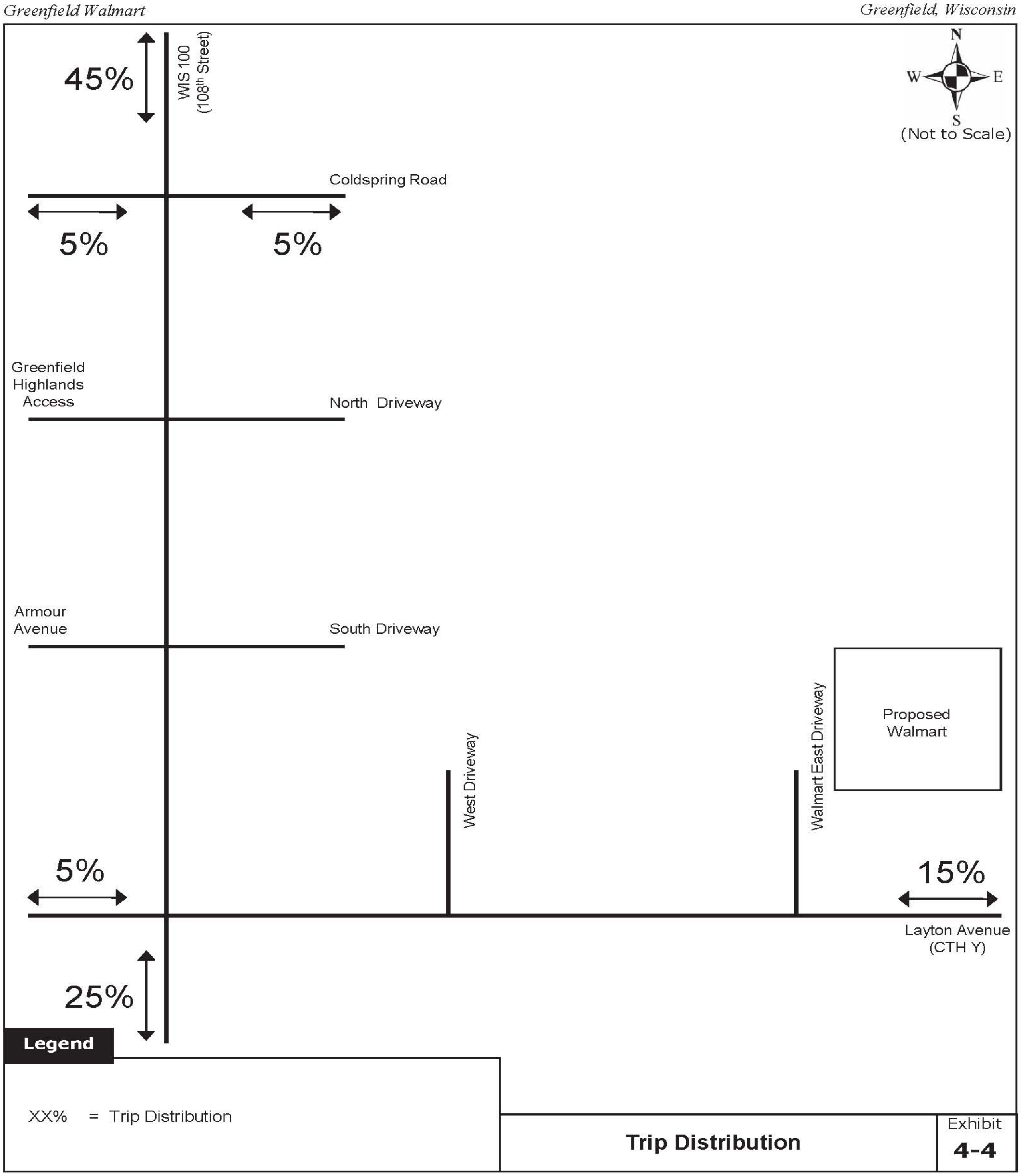
Depict on-site and off-site development traffic distributions as percentages for each direction of travel. Displaying this information on a map provides the best method of showing the directional distribution of traffic for the development. **Exhibit *4-4*** provides an example of a trip distribution graphic.

5. Trip Assignment

Trip assignment involves assigning the projected on-site and off-site development traffic (peak hour and daily) to specific access points and travel routes along the roadway network. To do this, the analyst needs to multiply the projected on-site and off-site development traffic volumes by the percentage of traffic arriving/departing via a particular route after accounting for any reduction for less than 100 percent auto usage, pass-by traffic, and linked-trip traffic.

The trip assignment process establishes the directional project-related traffic volumes (i.e., turning and through movements) at each access point, intersection, and roadway segment within the study area. The product of this step of the process is traffic volumes appropriate for use in assessing the project-related impacts as detailed in ***Chapter 5***.

Exhibit 4-1



Greenfield Walmart
Greenfield, Wisconsin
N
W
E
S
(Not to Scale)
45%
WIS 100
(108th Street)
Coldspring Road
5%
5%
Greenfield
Highlands
Access
North Driveway
Armour
Avenue
South Driveway
West Driveway
Walmart East Driveway
Proposed
Walmart
5%
15%
Layton Avenue
(CTH Y)
25%
Legend
XX% = Trip Distribution
Trip Distribution
Exhibit
4-4

The analyst *should* begin the trip assignment process by identifying all possible paths between origins and destinations. They *should* then evaluate the potential for the development traffic to use these paths on a comparative basis, taking into consideration the following:

- Driver tendencies and characteristics
  - Drivers will often use the first convenient driveway they reach to access a site with multiple driveways
  - Local drivers tend to use back roads/local connections where drivers who are new to the area tend towards major travel routes
- Internal circulation design
  - The design of the internal circulation may determine what driveway the drivers will use
  - The internal circulation design can influence whether the driver decides to stay on-site or use the external roadway network to travel between land uses
- Available roadway capacities
  - Known capacity constraints may impact the route selection, especially if alternate routes are available
  - Turn restrictions, particularly left-turn restrictions, may force a driver to take a non-direct route to access the site
- Analysis year travel conditions
  - Assuming the travel conditions (including level of congestion, roadway geometrics, and roadway network) are comparable, the interim and horizon year traffic assignment will typically be the same as the existing/base year traffic assignment
  - Planned roadway improvements or network changes could result in modifications to the horizon year trip assignment
- Proposed land use characteristics
  - Employment land uses primarily attract commuter trips which typically travel during the weekday morning and afternoon peak periods
  - Destination or entertainment land uses typically generate more recreational or event-based trips which tend to travel outside of the typical weekday peak periods
  - Commuter trips and recreational trips may use different travel routes
- Trip distribution percentages and traffic assignment 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 nearby on/off ramps at interchanges
  - » Developments located near interchanges tend to attract a high volume of regional trips
  - » Developments without direct/convenient access to an interchange tend to attract a high volume of local trips
  - » The presence of nearby on/off ramps at an interchange enables drivers to easily divert from their primary route to make an interim stop at the development site, thus potentially increasing the number of diverted trips

  The above considerations are adapted from the *Transportation Impact Analyses for Site Development: An ITE Recommended Practice*, ITE 2010

The analyst **shall** make manual assignments for each analysis period for each base, interim, and horizon year. To achieve realistic estimates, they *should* assign multiple paths between origin and destinations as deemed appropriate based on experience and professional judgment.

The exhibit order for illustrating the trip assignment **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

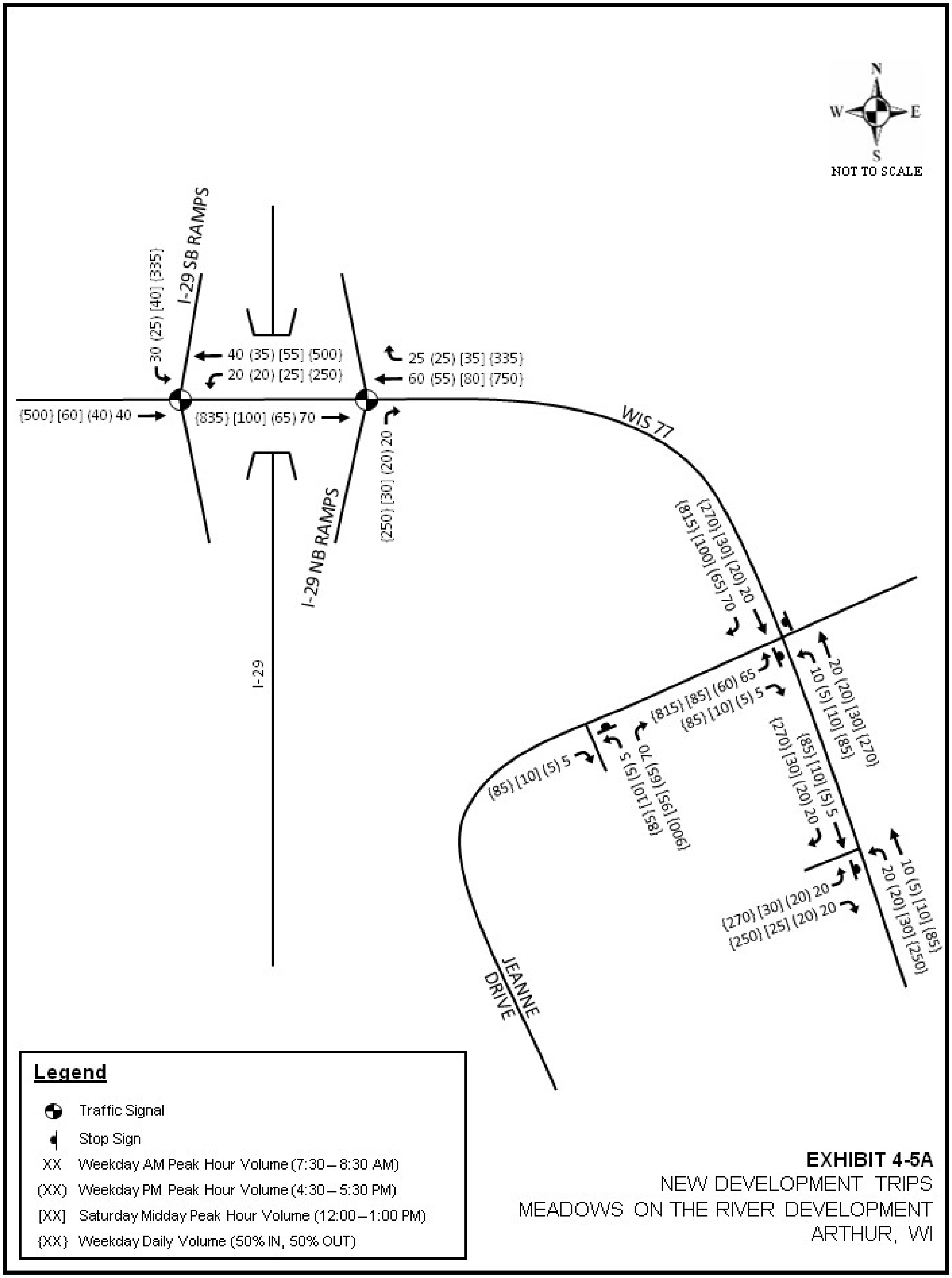
The following illustrates a sample exhibit order:

Base Year On-Site Development Traffic
Exhibit 4-5A .... New Trips
Exhibit 4-5B .... 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.

Exhibit *4-5* provides an example of a trip assignment graphic.

Exhibit 4-4


NOT TO SCALE
N
S
E
W
I-29 SB RAMPS
I-29 NB RAMPS
I-29
WIS 77
JEANNE DRIVE
30 (25) [40] {335}
40 (35) [55] {500}
20 (20) [25] {250}
25 (25) [35] {335}
60 (55) [80] {750}
{500} [60] (40) 40
{835} [100] (65) 70
{250} [30] (20) 20
{270} [30] (20) 20
{815} [100] (65) 70
20 (20) [30] {270}
10 (5) [10] {85}
{815} [85] (60) 65
{85} [10] (5) 5
{85} [10] (5) 5
5 (5) [10] {85}
70 (65) [95] {900}
{270} [30] (20) 20
{85} [10] (5) 5
10 (5) [10] {85}
20 (20) [30] {250}
{270} [30] (20) 20
{250} [25] (20) 20
Legend
Traffic Signal
Stop Sign
XX Weekday AM Peak Hour Volume (7:30 – 8:30 AM)
(XX) Weekday PM Peak Hour Volume (4:30 – 5:30 PM)
[XX] Saturday Midday Peak Hour Volume (12:00 – 1:00 PM)
{XX} Weekday Daily Volume (50% IN, 50% OUT)
EXHIBIT 4-5A
NEW DEVELOPMENT TRIPS
MEADOWS ON THE RIVER DEVELOPMENT
ARTHUR, WI

PART C — BUILD AND TOTAL TRAFFIC

The TIA preparer **shall** develop build and total traffic volume assignments for each period and horizon year chosen for analysis.

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

The analyst *should* confirm the use of on-site or off-site development traffic for this analysis with the WisDOT 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, regardless if it is on-site or off-site.

Note: If off-site development(s) do not exist or will not occur prior to the on-site development, then a total traffic analysis scenario does not apply and is thus 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 **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
- Linked trips
- Trip distribution
- Trip assignment, etc.

CHAPTER 5 TRAFFIC AND IMPROVEMENT ANALYSIS

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. The TIA **shall** provide an analysis of all state highway intersections and select driveways within the defined study.

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

- Site access
- Capacity/LOS analysis
- Queuing analysis
- Traffic safety
- Pedestrian, bicycle, and shared-use path 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 thus, the TIA preparer *should* analyze it with respect to capacity, traffic operations, and safety. Review the location of the access points on the site plan 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 TIA preparer and reviewer *should* also examine the site plan to ensure that the design of the external access points account for pedestrian and bicycle safety. As part of the site plan review, the analyst *should* also include an assessment of the transit-stop locations.

The application of sound access management principles can often minimize any potential adverse impacts to roadways adjacent to the site. The location and design of the site access *should* be in accordance with the following guidelines:

- The design *should* limit the number of access points 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. The site plan *should* align opposing access points where possible.
- The site plan *should* provide/maintain adequate spacing between adjacent streets and driveway intersections. Factors to consider when evaluating intersection spacing include, but are not limited to, the following:
  - » Intersection spacing *should* be such that it minimizes driveway blockage
  - » Intersection spacing requirements depend on roadway classification, posted speed, and influence of adjacent intersections

- » All access locations are subject to WisDOT approval.
- » Median openings **shall** conform to the requirements of FDM 11-25.

- The department will encourage joint or cross access between adjacent properties.
- The on-site circulation pattern **shall** integrate the access point locations to allow for efficient ingress and egress, and to avoid queuing on the adjacent highway.
- Turning lanes **shall** provide adequate storage lengths. Provide acceleration and deceleration lanes as necessary.
- The design of the access points **shall** ensure adequate sight distance. This could include the addition of safety-related improvements such as offset right turn lanes, pork chop islands on the side street, or slotted left turn lanes on the mainline.
- The design of the width and radii of an access point *should* accommodate entering and exiting vehicles efficiently and safely.
- Access points *should* typically intersect the adjacent roadways at a 90-degree angle.
- Where applicable, the site plan *should* provide for multimodal access between the right-of-way and the development (multimodal facilities **shall** consider pedestrians, bicycles, and transit).

PART B — CAPACITY/LEVEL OF SERVICE ANALYSIS

Similar to the capacity/LOS analysis conducted for the existing conditions (Chapter 3, Part C); conduct additional analysis for the following conditions:

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 transportation and intersection conditions plus any programmed improvements expected to be complete by the end of the respective horizon year.

Determine if the transportation system will operate acceptably with the additional site generated trips.

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 will operate acceptably with the additional site-generated trips. If not, one must determine mitigation requirements. Consider analysis of pedestrian, bicycle, and transit facilities when such services are present or planned for the area, especially if the proposed development will generate bicycle, pedestrian, or transit trips. Bicycle accommodations may include bike lanes, wide outside travel lanes, paved shoulders, and shared-use paths. Transit service analysis may be applicable if the proposed development is in an area with frequent fixed transit service or where there is substantial transit ridership. Coordinate with WisDOT regional multimodal planning staff and transit operators to determine when to conduct analysis of the pedestrian, bicycle, and transit service.

The WisDOT regional traffic engineer may require modification or expansion of the above-specified analysis.

There is a need to provide detailed information regarding the physical characteristics of the existing conditions as well as the planned transportation system improvements proposed.

Exhibit 3-1B *should* have identified any currently programmed roadway or traffic control modifications to include in this analysis. ***Exhibits 1-4, 1-7,*** and ***1-10*** *should* have identified any additional improvements for the proposed development included in the analysis.

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. Clearly label both the input and output data and include 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. Clearly label both the input and output data and include 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. Clearly label both the input and output data and include 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. Clearly label both the input and output data and include 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. Clearly label both the input and output data and include 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. Clearly label both the input and output data and include in ***Appendix G***.

Refer to ***Chapter 3, Part C*** for appropriate procedures, methods, techniques, and software to utilize in the analysis. If proposing any of the following improvements, discuss their implications with the WisDOT regional traffic contact prior to completing the study:

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

Recalculate the pedestrian and vehicular clearances and verify their appropriate usage for all modifications that increase the distance a vehicle must travel to clear the intersection. In addition, 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 TIA *should* evaluate various access locations and configurations to determine how they could handle the proposed traffic. The HCM procedure cannot identify all potential problems with ingress and egress; thus, the TIA preparer **shall** review merging conflicts, roadway and intersection control improvements, and driver behavior and expectations. The TIA **shall** identify appropriate mitigation measures as necessary. The various evaluations conducted *should* comply with the FDM.

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

Note that the acceptance of the TIA is not an approval of proposed recommendations outlined in the TIA but an acknowledgment that the format of the submitted TIA was acceptable for WisDOT to review. Typically, the WisDOT regional traffic contact will provide a summary of the department's position and identify any issues regarding the proposed recommendations outlined in the submitted TIA. The TIA preparer and developer will need to address any of the department's outstanding issues prior to moving forward with the permitting process.

FDM 11-5-3 states, "… designers should strive to achieve the best intersection level of service (LOS) that is practical given the local land use, economic, social, and environmental characteristics. The designer should aim to balance the level of service for all users of the intersection (e.g., vehicles, pedestrian, bicycles, etc.)." Where practical, the analyst should strive to provide LOS D or better operations on corridors 2030 (C2030) and national highway system (NHS) routes and mid-LOS E or better operations on non-NHS routes. Aim to provide these levels of operation for all movements at the intersection (left, through, and right turning movements on each approach) during the peak hours of travel.

In accordance with the FDM, the TIA **shall** propose improvements under the following conditions:

1. Case 1 exists when specific movements at the roadway intersection will operate at or above the best intersection LOS practical (typically LOS D) in the horizon year(s) without the development but operate at reduced LOS operations (typically LOS E or worse) with the development. In this case, the TIA **shall** propose improvements to bring the LOS back to the predevelopment horizon year level of operation or better.

2. Case 2 exists when specific movements at the roadway intersection will operate at reduced LOS operations (typically LOS E or worse) in the horizon year(s) without the development but operate at an even lower LOS with the development. In this case, the TIA **shall** propose improvements to maintain the amount of delay (in seconds per vehicle) expected to occur without the development using HCM methodology.

At the discretion and approval of the WisDOT regional traffic engineer, mitigation to reduced LOS operations may be acceptable at certain locations, specifically where it is not practical to achieve the levels of operations described above (LOS D for C2030 and NHS routes and mid-LOS E for non-NHS routes). WisDOT will consider reduced LOS operations for specific intersection movements on a case-by-case basis to determine the most practical level of service.

Mitigation measures to improve the LOS could include the following:

- Additional/modified left or right turn lanes
- Additional intersection through lanes
- Additional highway lanes
- Access modifications/alternative access
- 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
- Change in signal operation including re-phasing or re-timing of the existing signal
- Redesigning/relocating bus stops
- Introduction of grade separation
- Restriction of turning movements
- Accommodating two-stage left-turn/crossing movements

The TIA *should* provide a comprehensive review of the proposed roadway 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 required for each proposed improvement.

The analyst **shall** perform a queuing analysis for all intersections, access points, and ramp termini within the study area controlled by stop signs, traffic signals, or roundabouts. The primary purpose of this analysis is to estimate the queue lengths and associated storage requirements that the intersection design *should* accommodate. The TIA **shall** evaluate queue lengths for left- and right-turn lanes to ensure that queues do not overflow into adjacent through lanes. The analyst *should* also evaluate the queues for through lanes to confirm that they do not obstruct turn lane entrances or extend back into neighboring intersections. Refer to FDM 11-25-2.3 for additional details on the queue storage requirements for intersections.

The HCM has a procedure for estimating the intersection queue lengths. TEOpS 16-10 provides a summary of the traffic analysis tools that WisDOT supports for implementing the HCM procedures. The analyst **shall** use the HCM procedures, or other preapproved methodologies such as microscopic simulation, and the WisDOT supported software to estimate the storage lane requirements. Use professional judgement in conjunction with the results of the queuing and operational analysis to verify the final storage lengths to use for design.

Identify the expected queue storage lengths required with the proposed improvements in each peak period analyzed. The TIA **shall** utilize the following order for exhibits to summarize the 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 — MULTI-MODAL CONSIDERATIONS

Evaluate the site plan, and recommend improvements to ensure that, where needed and feasible, it can accommodate pedestrian, bicycle, and transit users safely and efficiently.

The TIA preparer and reviewer shall evaluate the site plan and recommend improvements to ensure that, where needed and feasible, it can accommodate pedestrian, bicycle, and transit users safely and efficiently. Reference FDM 11-46 and consult with WisDOT regional multimodal staff for guidance regarding need and feasibility. Additional guidance on multimodal accommodations is available through the following:

- *Wisconsin Bicycle Facility Design Handbook*
- *Wisconsin Guide to Pedestrian Best Practices*
- American Association of State Highway and Transportation Officials (AASHTO) *Guide for the Development of Bicycle Facilities, 4th Edition*
- AASHTO *Guide for Geometric Design of Transit Facilities on Highway and Streets*

- The following guides from the National Association of City Transportation Officials (NACTO):
  - » *Urban Bikeway Design Guide*
  - » *Urban Street Design Guide*
  - » *Transit Street Design Guide*
- The *Revised Draft Guidelines for Accessible Public Rights-of-Way* from the U.S. Access Board

Pedestrian facilities, including shared-use paths, **shall** be accessible to people with disabilities. Newly constructed and altered facilities **shall** comply with ADA requirements.

PART E — SPEED CONSIDERATIONS/SIGHT DISTANCE

This section of the TIA **shall** include the following exhibit:

Exhibit 5-27..Intersection Sight Distance Photos/Drawings

Vehicle speed is a key element for estimating safe stopping, intersection, and corner sight distances. In general, the posted speed limit is representative of the 85th percentile speed on the highway. A speed of 5 miles per hour (mph) greater than the posted speed (i.e., design speed) or a measured 85th percentile speed **shall** be the basis for estimating safe stopping, intersection, and corner sight distances for highways. The TIA **shall** base all analyses and improvement recommendations on a design speed derived from the existing posted speed limit. Recommendations for modifications to existing speed limits/design speeds fall outside the scope of a TIA. However, the TIA preparer may coordinate with the WisDOT regional traffic engineer to make requests/ recommendations to reduce the existing posted speed limit separately from the TIA process.

Discuss the design speed used to estimate safe stopping, intersection, and corner sight distances as part of the safety review and recommend improvements to address any deficiencies. The calculations for intersection sight distance at new driveways **shall** include adjustments for proposed geometry, including turn lanes and medians along the highway. For all intersections, including off-ramps, the analyst *should* evaluate sight distance to ensure that there is sufficient stopping sight distance to allow drivers to stop their vehicles completely prior to reaching the back of queue waiting at the intersection. To document the minimum and desirable sight distance requirements in relation to the field conditions, the TIA **shall** include photos or drawings as part of Exhibit 5-27.

*The WisDOT regional traffic engineer **shall** approve the safe stopping, intersection, and corner sight distances.*

The design vehicle to use in assessing intersection sight distance is dependent upon the land uses the access point will be serving. However, for most intersections, the analyst *should* evaluate sight distance based on a single-unit truck (SU) design vehicle. Due to the height difference of a passenger vehicle compared to a single-unit truck, the analyst *should* also evaluate intersection sight distance based on a passenger vehicle. Design vehicle decisions may require engineering judgment or discussions with WisDOT staff for further clarification. WisDOT may request adjustments to the calculated safe stopping, intersection, or corner sight distances. The WisDOT regional traffic engineer **shall** approve the safe stopping, intersection, and corner sight distances.

For additional information regarding intersection sight distance, refer to FDM 11-10-5.1 and AASHTO's *A Policy on Geometric Design of Highways and Streets, 6th Edition* (i.e., AASHTO 2011 Green Book).

PART F — TRAFFIC CONTROL NEEDS

Situations that typically trigger the need for an ICE study include:

- *New traffic control*
- *Change in traffic control*
- *New or alternative type of intersection or interchange*
- *Introduction of access/median restrictions*
- *Off-setting intersections*

The TIA *should* identify, discuss, and describe the need for the recommended traffic control treatments as they relate to the proposed development. This includes identifying the appropriate type and location of the required traffic control (e.g., no-control, yield-control, stop-control, or signal-control) and recommended intersection/interchange type (e.g., roundabout, reduced conflict intersection, diamond interchange, etc.). Refer to FDM 11-25-3.1.3 for descriptions of the various traffic control and intersection/interchange types and guidance on when or when not to consider them. The TIA preparer *should* consult with the WisDOT regional office when considering traffic control and intersection type. It may be possible to address some of the requirements within the TIA scoping process.

The TIA **shall** identify and discuss the recommended traffic control treatments for the proposed development and describe their need. If the TIA considers an alternative form of traffic control or type of intersection/interchange as part of its recommended improvements and the subject intersection is on the STN, including those along connecting highways, the analyst **shall** perform an Intersection Control Evaluation (ICE) study for that intersection. The TIA preparer **shall** include the ICE study as part of ***Appendix J*** of the TIA submittal to the WisDOT regional office.

Situations that typically trigger the need for an ICE study include, but are not limited to, the following:

- New traffic control
- A change in traffic control
- A new or alternative type of intersection or interchange (e.g., reduced conflict intersection/interchange)
- Introduction of access/median restrictions on the STN (may not be necessary if the TIA addresses potential operational impacts to adjacent intersections)
- Off-setting intersections (e.g., converting one 4-legged intersection into two T-intersections)

As detailed in FDM 11-25-3, the ICE process consists of the following two phases: 1) Phase I: Scoping ICE and 2) Phase II: Alternative Selection ICE. For purposes of the TIA report, the analyst **shall** provide a Phase I: Scoping ICE analysis for all study intersections as deemed appropriate by the WisDOT regional office. Coordinate with the WisDOT regional office to assess the need for a Phase II ICE: Alternative Selection ICE. If deemed necessary, WisDOT may require submittal and acceptance of the Phase II: ICE prior to issuing any permits.

The analyst **shall** complete the Phase I: Scoping ICE in accordance with FDM 11-25-3. The Phase I: Scoping ICE consists of a memorandum which documents all intersection types and traffic control alternatives under consideration. The specific content of the

Phase I: ICE memorandum will vary depending on the project's location, scope, and the available data. However, the Phase I: Scoping ICE **shall** provide the following information:

- Project Description
- Description of Alternatives
- Safety Considerations
- Operational Considerations
- Other Considerations
- Feasibility of Alternatives
- Conclusions/Recommendations

The TIA *should* already include most of the information needed for the Phase I: Scoping ICE. A safety analysis that evaluates the crash data is the only additional information required for the analysis. See FDM 11-25-3.2.1.3 for instructions on how to obtain and illustrate the crash data. The safety analysis **shall** identify existing crash patterns that may be of concern, emphasizing movements potentially impacted by the proposed development.

In Chapter 5, include a summary of the ICE analysis, focusing on the analysis that is not already part of the TIA. The engineer reviewing the TIA will share the Phase I: Scoping ICE with the WisDOT regional traffic operations staff and BTO for comment with a goal of establishing consensus on the recommended traffic control and intersection improvements.

PART G — TRAFFIC SIGNAL WARRANT ANALYSIS

Traffic signal warrants are the guiding principle for when to consider the installation of a traffic signal. See the Wisconsin Manual on Uniform Traffic Control Devices (MUTCD) - Section 4C and the Traffic Signal Design Manual (TSDM) - Chapter 2 for traffic signal warrants (TSDM 2-3). Also, see the TSDM and TEOpS 16-15 for design, capacity, and operational guidance for signal control. The TIA **shall** include the traffic signal warrant analysis for all proposed traffic signals.

For WisDOT to consider signalization of an intersection, the proposed signal location must meet at least one of the signal warrants. However, the analyst *should* conduct a complete engineering study (i.e., ICE) to assist with the decision to install a traffic signal at a specific intersection. At a minimum, the analyst *should* evaluate WisMUTCD warrants 1, 2, and 3 for each proposed signal location. Depending on the specifics of the intersection, WisDOT may deem it necessary for the analyst to evaluate additional warrants. At least one of the warrants (typically warrants 1 or 2) must be satisfied before the State Traffic Signal Systems Engineer will consider the approval for the installation of a traffic signal. Satisfaction of Warrant 3 alone is not sufficient justification for the installation of the traffic signal.

The primary justification for the installation of a traffic signal should be the intersection's safety and operational improvement needs.

The TIA preparer *should* view the warrants as guidelines and a decision-aid, not a legal requirement for the installation of a traffic signal. The satisfaction of warrants *should* not be the sole factor in determining the need to install a traffic signal. Rather, the primary justification for the installation of a traffic signal *should* be the intersection's safety and operational improvement needs.

Refer to the TSDM for additional information on typical procedures used in conducting a signal warrant study. The TIA preparer *should* discuss region-specific procedures and methodologies with the WisDOT regional traffic engineer prior to submittal of the TIA.

If proposing a signalized intersection, the analyst **shall** conduct, at a minimum, a 12-hour intersection traffic count. Coordinate with the WisDOT regional office prior to collecting the counts as some regions may require longer duration counts (e.g., the southeast region typically requires 13-hour counts).

WisDOT has developed hourly trip distribution percentages for specific land uses (e.g., shopping center, office, residential) that the analyst may apply to existing or new intersections when determining 12-hour volumes that include proposed development traffic. A spreadsheet showing the hourly trip distribution percentages available for use in Wisconsin is available on the WisDOT BTO webpage. Additionally, ITE has published 24-hour directional count distributions for 73 land uses. Prior to using the ITE hourly distributions, review the location of the data source as data from sites located on the east coast may not be reflective of Wisconsin travel patterns. For land uses that have both WisDOT and ITE hourly distributions available, coordinate with the WisDOT regional traffic engineer to confirm which distribution to utilize.

It is important to note that showing an unsignalized intersection operating at LOS F is not an acceptable justification for requiring traffic signal control. The analyst **shall** evaluate the need for traffic signals from a system standpoint, showing that the installation has positive benefits with minimal impact on progressive traffic flow.

If the intersection meets signal warrants and WisDOT agrees to and subsequently approves the signal installation, the signal *should* be located to facilitate signal coordination and traffic progression. WisDOT prefers a minimum spacing of 1200 feet between signalized intersections but may require additional spacing on specific roadways. Consider traffic signal coordination 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

Appendix I **shall** include any supporting documentation and calculations used to complete a warrant analysis for any recommended type of intersection control.

CHAPTER 6 CONCLUSIONS AND RECOMMENDATIONS

This chapter **shall** discuss conclusions about the analysis of existing and future conditions. Based on the conclusions of the analysis, the TIA **shall** make recommendations to mitigate identified operational and safety related 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 turn lanes
- Required turn lane extensions
- Any horizontal or vertical realignment
- Required traffic control devices
- Transportation demand management strategies which may be applicable to the development

FEASIBILITY OF IMPROVEMENTS

The TIA preparer and reviewer **shall** review all proposals to mitigate identified deficiencies to determine if they are feasible. For all feasible mitigation measures, identify the consequences, if any, of each measure (e.g., median closure, additional right-of-way needed, etc.). If it is uncertain as to whether a mitigation measure is feasible, contact the WisDOT regional traffic engineer for further guidance.

*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."

See FDM 11-25-3 and coordinate with your WisDOT regional contact to determine if/when to complete the Phase I: Scoping ICE analysis. If applicable, include the ICE analysis with the submittal of the TIA to assist WisDOT in selecting the appropriate traffic control, lane configuration, and intersection type for an intersection. If, after completion of the Phase I ICE, there is more than one feasible alternative, WisDOT may require submittal and acceptance of the Phase II ICE prior to making a final determination on the recommended improvements.

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

The TIA **shall** provide conceptual drawings for any alternative that has proposed changes to intersection geometry, including turn lane extensions. For improvements that do not result in a change in intersection geometry, the TIA preparer **shall** provide a list of potential issues or conflicts as applicable (e.g., right-of-way, signal equipment locations, etc.). The conceptual drawing **shall** be to scale and superimposed on an aerial photo or topographic map.

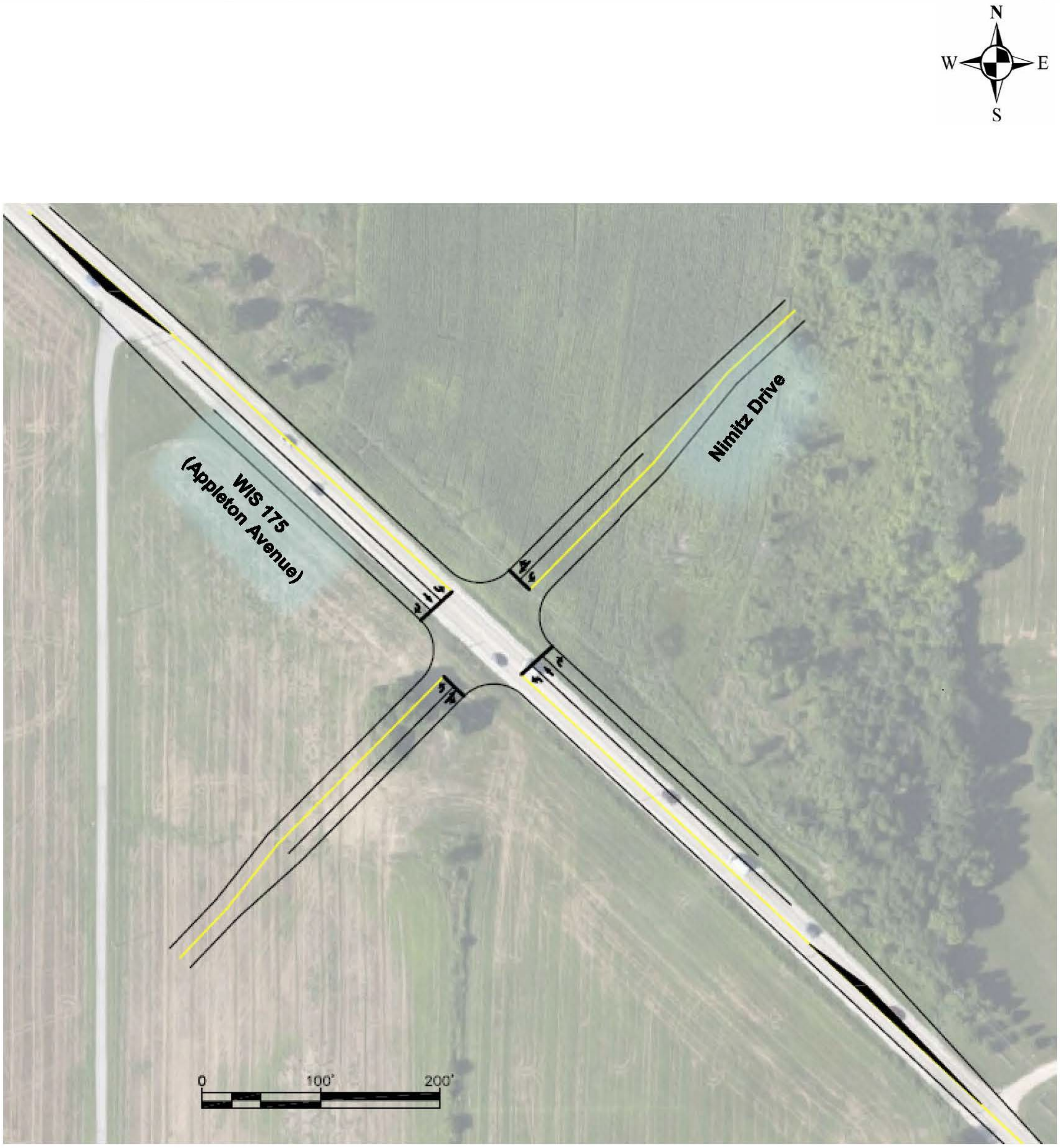
Conceptual drawings for a roundabout **shall** include the outer diameter of the roundabout and the approximate approach geometry. Conceptual drawings for all-way stop control, signal control, or any non-traditional intersection type **shall** include the proposed lane configurations, median width (if any), turn lane storage lengths, and transitions to match the existing roadway. The conceptual drawings **shall** show the existing right-of-way limits. Do not include pavement markings, signing, stationing, profiles, or turning radii. The intent of the conceptual drawings is to show the approximate impacts of each intersection control alternative to assist in the determination of the appropriate alternative(s). ***Exhibit 6-1A*** and ***Exhibit 6-1B*** illustrate examples of acceptable conceptual drawings.

This chapter **shall** also include documentation on how the developer will notify others, if applicable, of the potential impacts associated with the proposed mitigation measures.

Exhibit 6-1A

Willow Creek Development Traffic Study

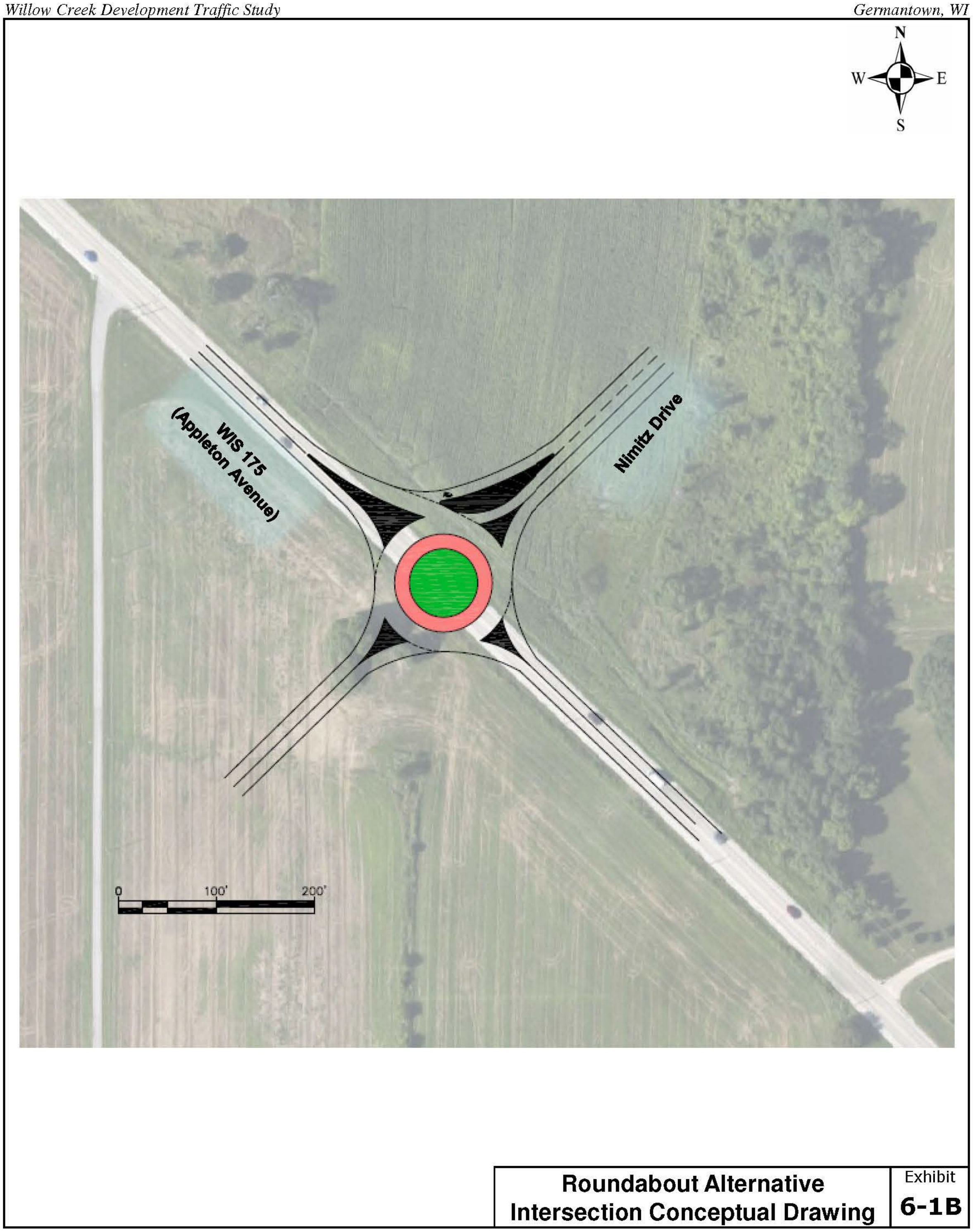
Germantown, WI



Traffic Signal Alternative
Intersection Conceptual Drawing

Exhibit
6-1A

Exhibit 6-1B


Willow Creek Development Traffic Study
Germantown, WI
N
W
E
S
WIS 175
(Appleton Avenue)
Nimitz Drive
0
100'
200'
Roundabout Alternative
Intersection Conceptual Drawing
Exhibit
6-1B

CHAPTER 7 DESIGN CONSIDERATIONS

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. Note that these design considerations may not reflect the most recent updates made to the FDM, and thus, the FDM policies supersede the guidance provided below. See noted reference for additional information.

The following design considerations are for guidance only. The TIA preparer **shall** not include this chapter in the official TIA report.

NEW ACCESS LOCATIONS

- Coordinate with the WisDOT regional office to determine the proper spacing requirements between access points and adjacent intersections.
    - » Spacing between rural access points **shall** be in accordance with FDM 11-5-5, Attachment 5.1
- Where possible, avoid locating the proposed access within the functional area of an existing intersection. The functional area includes (FDM 11-25-2.2):
    - » Queue storage area
    - » Turn lane tapers
    - » Perception-reaction distance
- The following guidance detailed in FDM 11-10-5 **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, specifically where proposing traffic signals or roundabouts

NEW LANES

- Consider the following:
    - » Are the recommended lane widths appropriate? Are multimodal considerations included?
    - » Are the recommended lane widths consistent with existing widths?
    - » Is there adequate space to accommodate additional lanes, especially if there are space restrictions?
    - » Is there an adequate number of receiving lanes for right and left-turn lanes?

- Note: The analysis *should* reflect the recommended lane widths. WisDOT, or other appropriate maintaining authority, will have the final say in determining the appropriate lane widths. New turn lanes or extended existing turn lanes *should* not block adjacent streets or median openings. It may be necessary to require access restrictions.
- If there is sufficient median width at an access, the design *should* provide for the construction of a left-turn lane in accordance with FDM 11-25-5. If there is insufficient width or it is infeasible to expand the median to include a left-turn lane, the design *should* restrict inbound left-turn movements at the access point.
- For safety reasons, at locations where there is no median and left turn movements are present, unless volumes are very low, the design *should* provide for the installation of a left-turn lane or bypass lane (FDM 11-25-5).
- As detailed in FDM 11-25-10, the design *should* consider providing for right-turn lanes at the following locations:
  - At intersections on urban roadways posted 40 mph or lower that have significant right turn volumes
  - At all rural 2-lane public road intersections
  - At signalized intersections
- Coordinate with the WisDOT regional office for other situations that might warrant the consideration of right-turn lanes.
- In accordance with FDM 11-25-5.5, the design *should* consider a left-turn bypass lane (i.e., tee intersection bypass lane) at tee intersections along rural 2-lane non-community roads. Do not use left-turn bypass lanes on 2-lane community roads; rather, use exclusive left turn lanes with positive offsets.

RIGHT OF WAY

- Consider whether there is adequate right of way (ROW) available for the suggested improvements.
- Consider whether there is the ability to purchase additional ROW if necessary.
- Consider whether the ROW needs will affect an adjacent building's parking lot, drive through, or other critical facility.
- Consider impacts to multimodal transportation.

TURN LANE LENGTH

- Design the storage and taper lengths for turn lanes in accordance with the guidance provided in FDM 11-25-2.3
- Contact the WisDOT regional traffic engineer for specific guidance regarding storage lengths and turn lane tapers

QUEUE LENGTH CHECKS

- Per FDM 11-25-2, the turn lane queue *should* fit within the existing/proposed storage at a minimum
- When evaluating the queues, consider whether the through queue blocks:
  - » Turn lane storage openings
  - » Median openings
  - » Adjacent streets

SIGNALS

- Proposed signals *should* be a minimum distance of 1200 feet from adjacent signals (TSDM 3-3-3; FDM 11-5-5.3). Minimum spacing may be greater on certain roadways. Coordinate with the WisDOT regional traffic engineer to determine proper spacing.
- Proposed signals *should* follow existing spacing patterns along the corridor
- Per TSDM 3-4-1, consider providing left turn phasing on an intersection approach when the product of the left turning volume and its opposing through and right-turn volume meet or exceed the following requirements:
  - » 50,000 for single left-turn lane crossing one through lane
  - » 100,000 for single left-turn lane crossing two or more through lanes
- Per TSDM 3-3-5, the design *should* consider dual left turn lanes at locations where left turn volumes exceed 300 vehicles per hour (vph).
- If no signal exists and the TIA recommends the installation of a new signal, the analyst **shall** conduct a warrant analysis in accordance with FDM 11-50-50 and TSDM 2-3. As part of the signal warrant analysis, the analyst **shall:**
  - » Locate the WisDOT 12-hour count for the intersection or nearest intersection for proposed new access if available. If a WisDOT 12-hour count is not available, the consultant *should* collect/develop one as part of a signal warrant analysis. Coordinate with the WisDOT regional office prior to collecting the counts as some regions may require longer duration counts (e.g., the southeast region typically requires 13-hour counts).
  - » Determine the timeframe most likely to meet signal warrants (amount of development buildout).
- For the design and capacity analysis of a signalized intersection, the analyst *should* consider:
  - » Whether the application of RTOR is appropriate. If so, they *should* refer to TEOpS 16-15 for the appropriate reduction rates
  - » Whether the traffic signal is (or will be) and isolated signal or whether it is (or will be) part of an existing or new signal system

ROUNDABOUT CAPACITY ANALYSIS

- Per FDM 11-25-3.1.3, when recommending new or modified traffic control at an intersection, consider the modern roundabout as a traffic control alternative when the minimum vehicular volume warrants for either all-way stop control or traffic signal control are met. There may also be situations where it is appropriate to consider a roundabout where an intersection has unique safety (e.g., significant right-angle crashes, limited intersection sight distance, etc.) or geometric concerns (e.g., significant intersection skew, 5 plus approaches, etc.).
  - » Use the HCM methodology for the capacity analysis of a roundabout. As defined in TEOpS 16-15-20.2.2, the supported HCM-based traffic engineering software programs for roundabout analysis are:
    1. HCS
    2. SIDRA Intersection (HCM mode only)
- If access to either of the software packages listed above is not available, the analyst can program the HCM equations into a spreadsheet to conduct the roundabout capacity analysis.
- TEOpS 16-15-20, Table 20.2 provides the Wisconsin-specific minimum headway and follow-up headway values the analyst **shall** use for the roundabout analysis.

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

BRIDGES

- Consider whether the structure can accommodate the proposed improvements.
- When considering improvements to a structure, note that a raised median on a structure is extremely difficult to remove. Thus, the analyst *should* consider potential improvements that avoid median removal.
- Assess whether it is feasible to widen the existing structure to accommodate the proposed improvements.
- Verify that the bridge clearance heights to the underpass roadway meet FDM requirements (FDM 11-35-1).
- When proposing improvements underneath a bridge structure, the analyst *should* review the width available under the structure to verify that it is sufficient to accommodate the proposed improvements (lanes and *should*ers).

RAMP STORAGE

- The proposed design **shall** provide sufficient stopping sight distance (SSD) for vehicles exiting the mainline to stop safely before reaching the back of queue for the upstream intersection. AASHTO's requirements for SSD on ramps, as specified in Chapter 10 of the AASHTO *2011 Green Book*, are as follows:
  - » The ramp storage distance, or the distance from the point on the ramp where the traveled width is 12' to the back of queue, **shall** be at least as great as the distance needed to allow appropriate deceleration from the design speed on the mainline to a stop condition.
  - » The analyst *should* use an iterative process to determine the design speed for loop/curved ramps.
- Contact the WisDOT regional traffic engineer for additional details on calculating the appropriate ramp storage distance

BICYCLE AND PEDESTRIAN ACCOMMODATIONS

- In accordance with FDM 11-46, follow design guidance and evaluation criteria for bikeways and pedestrian ways. Specific FDM sections to refer to include:
  - » FDM 11-46-5 Pedestrian Facilities
  - » FDM 11-46-10 Curb Ramps
  - » FDM 11-46-15 Bicycle Facilities
- See the following additional references for guidance on bicycle and pedestrian facilities:
  - » *Wisconsin Bicycle Facility Design Handbook*
  - » *Wisconsin Bicycle Facility Design Handbook*, Chapter 4, Shared-use Paths
  - » *Wisconsin Guide to Pedestrian Best Practices*
- Per FDM 11-46-5.1, pedestrian facilities are required to be accessible to people with disabilities. Newly constructed and altered facilities **shall** be ADA-compliant.
- Provide ADA-compliant curb ramps at intersections (including traffic islands and medians) and mid-block crossings where a sidewalk or other pedestrian walkway crosses the curb at locations where crosswalks (either marked or unmarked) are present on alteration improvement project types.
- Coordinate with the WisDOT regional and statewide bicycle and pedestrian coordinators for additional guidance. Contact information is available via the WisDOT website.

GLOSSARY

Reference the following glossary for guidance only. The TIA preparer **shall** not include the glossary 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.
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 upon which the site traffic will have a significant impact on the transportation facilities
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 expected to be using the roadway network first (include whichever development that occurs first in the build traffic)
Capacity	▶ The maximum hourly rate at which vehicles can 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
Feasibility analysis	▶ The determination of whether it is possible to implement a mitigation measure 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. Typically, the horizon year is the greater of either 10 years after the opening of the proposed development or 5 years after buildout of the project.
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 highway network. 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 a scale of A to F, with LOS A representing the best and LOS F representing the worst operating conditions from the traveler's perspective.
Mode split	▶ The estimation of the number of trips made by each mode (automobile, pedestrian, transit, etc.) used by site-generated traffic
Off-site traffic	▶ Traffic volumes generated by off-site developments within the study area

Pass-by trips	Trips, currently on the roadway system, which make an intermediate stop at a generator (i.e., the development under study) with direct access to the roadway network that is adjacent to the original travel route between the origin and primary destination. Pass-by trips do not include trips that divert from their original travel path non-adjacent to the site (i.e., diverted trips).
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 analyst **shall** calculate the peak hour factor by intersection.
Saturation flow rate	The equivalent hourly rate at which previously queued vehicles can traverse an intersection approach under prevailing conditions; assuming the green signal is always available, 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 include within the scope of the TIA analysis.
Total traffic	Background traffic plus the on-site development traffic and, if applicable, the off-site development traffic.
Trip generation	The estimation of the number of trips generated to and from 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 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 intersections to provide the best intersection level of service practical (typically LOS D)
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 between all potential approach and departure routes