Chapter 320 Traffic Analysis

320.01 General

This chapter is intended to address policy-related issues associated with WSDOT multimodal traffic analysis. It is not intended to address the specifics of demand forecasting; mesoscopic, analytical/deterministic, stochastic microsimulation; or safety performance analyses. For those items, see the latest versions of the *Highway Capacity Manual* and *Highway Safety Manual* (HSM).

Traffic analysis is intended to produce information for decision makers; it is not intended as a stand-alone tool for making decisions. Consideration of empirical data, similar traffic situations, studies, local knowledge, and seasoned traffic engineering and planning experience can also add to a pool of traffic information that is provided to decision makers.

Traffic analysis is either "operational" or "planning" in nature. Operational analysis is associated with engineering concepts focusing on near-term or existing/opening year, while planning analyses are generally focused on a horizon year or interim phase years. Planning-level analyses are also used to determine impacts for environmental documentation phases of Environmental Assessment (EA) or Environmental Impact Statement (EIS) work. Much caution should be used when operational tools are used with planning-level future year projection data.

Be aware that operational models were not primarily intended for use with planning-level future year projected volumes, but there is a need to understand the difference between proposed future scenarios. Therefore, operational models need to use data from forecasting models, but analysts need to do so with an understanding of the imperfections.

Forecasting demand volumes 20 years into the future can be difficult to do well, so there should be little expectation that intersection turning movement projection-related traffic analyses by themselves will be sufficient to produce actionable designs. Consequently, some future year Measures of Effectiveness (MOEs) such as turn lane queue length should not be considered accurate, but they may be useful when comparing various scenarios if the reported differences are substantial.

With the aforementioned limitations, project-specific traffic volumes, forecasts, and system capacities are used to establish the extent of improvements needed for facilities to operate acceptably from year of opening or through interim phases and, eventually, through to the horizon year; for example:

- Number of general purpose/ETL/HOV lanes
- Length and number of ramp or auxiliary lanes
- Intersection or interchange spacing
- Channelization
- Signal timing
- Right of way needs
- Roundabout design parameters
- Width of sidewalks
- Extent of bike lanes
- Ferry holding lanes

Traffic analysis should examine multimodal access, mobility, and safety objectives; project benefits and costs; development impacts; and mitigation needs.

Not all projects will require the same level of effort. The specific depth and complexity of a traffic analysis will depend on a variety of factors, including:

- Project proponents (federal, tribal, state, local, and private sector)
- Legal requirements (laws, regulations, procedures, and contractual obligations)
- Lead agency
- Purpose or scope of the traffic analysis
- Data availability
- Time of day (am/pm peak hour or other)
- Funding
- ROW availability

For projects that fall under FHWA approval, coordinate with the HQ Transportation Operations Division for concurrence on traffic analysis details. Other projects can be coordinated through Region Transportation Operation Office. (See Chapter 300 for FHWA oversight and approval policy.)

320.02 Design Year and Forecasting Considerations

Project evaluation requirements can be (1) focused on near-term functionality, (2) contain interim phases, and/or (3) require a long-term focus. The project proponent can be the state (WSDOT or other state agencies) or developers (other public agencies or private concerns).

For Access Revision Reports (AARs), the design year and multimodal travel demand forecasting methodologies are to be documented by the project stakeholders in the Methods and Assumptions (M&A) Documents.

Guidance on the horizon year and interim design year(s) for projects is given in Chapter 1103, Design Controls. When selecting horizon year and interim design year phases, stakeholders need to consider the regional significance of a proposed project, how it functions within the existing system, and the expected lifespan. The traffic analysis for developer-related projects will typically focus on existing conditions and the build-out year of the proposed project.

Some larger developer projects will need to be evaluated in multiple phases, as they have the potential to significantly impact the transportation system and will thus require a longer-term focus. Mitigation measures may also be phased with these projects.

Project teams are encouraged to consider the strategic importance, economic potential, network constraints, and investment scale when determining the analysis methodologies for project phasing, design year, and forecasts. With acceptance/concurrence by the Transportation Operations Office of purview[3], the following are possible approaches to be used individually or in concert to develop future year demand volumes:

- Travel demand models
- Trend line projections
- Cumulative impacts
- Limitations of the surrounding network

[3] See Chapter 300 and the Federal-Aid Highway Program Stewardship and Oversight Agreement: Generally, region for non-Highways of Statewide Significance (HSS) or non-National Highway System (NHS), and Headquarters for HSS and NHS.

320.03 Traffic Analysis Software

With acceptance by the Transportation Operations Office of purview, use the least complex and data-intensive software deemed reasonable for any given project. Agreement for software and versions must be documented in the study's M&A. Use the latest version sanctioned by WSDOT HQ Transportation Operations Division.

- For near-term analysis of locations that do not require an understanding of interactions between various transportation systems, Sidra, Rodel, Synchro, and HCS are the primary analytical tools.
- For systemwide multimodal complex forecasting, EMME3, TransCad, and Visum are the primary tools.
- For choosing between scenarios involving multimodal traffic and/or where various transportation system elements interact, CORSIM, Vissim, or Dynameq are the primary tools.

The software mentioned above may have version limitations due to WSDOT purchased rights and contract limitations. For details about these and other traffic analysis software used by WSDOT, contact the region or HQ Transportation Operations Division.

320.04 Travel Demand Forecasting

Designers, planners, and analysts need to be aware of the practical limitations of the selected method of multimodal traffic demand forecasting and should consider the impact of demand uncertainty when conducting analyses and drawing conclusions from those analyses. Special attention should be given to any post-processing efforts. Following are brief descriptions of the four main methods for demand forecasting.

320.04(1) Travel Demand Models

For the vast majority of projects, this will be the proper approach for developing future year demand volumes. However, caution should be taken when using this approach to draw conclusions from operational model Measures of Effectiveness (MOEs) that are based on such forecasts, because specific and accurate turning movement volumes are needed to produce credible MOEs. Forecast models are most commonly used to produce general volumes that can help Transportation Operations planners evaluate and compare the relative merits of potential solutions against each other.

320.04(2) Trend Line Projections

Where travel demand models are not established or are otherwise considered inadequate, trend data can be used but must be constrained by system flow limitations. Trend line growth cannot account for peak spreading when traffic demand exceeds system supply. Use with caution and consult the HQ Transportation Data & GIS Office (TDGO) for further details about this method and any inherent limitations.

320.04(3) Cumulative Impacts

This method is typically used to forecast volumes in areas that demonstrate uniform growth and exhibit only minor changes and marginal impacts to the region. It is also useful for analyzing growth in suburban areas that are experiencing rapid development, as other methods may not be as reliable. The basic concept is to add volumes for developments to the trending background traffic growth. The comprehensive plan for such areas should be consistent with the expected growth predicted by a project (and include other anticipated projects) in order to result in a reasonable estimate of cumulative impacts. Use with caution due to an inability to fully account for secondary impacts like future environmental issues, local network connectivity, public services, and multimodal demands.

320.04(4) Limitations of the Surrounding Network

For projects that contain infrastructure of particular importance, extraordinary expense, life span expectancy beyond 20 years, or where travel demand will likely always exceed transportation system capacity constraints, give consideration to the concept of facility capacity balancing within the context of the larger transportation system.

This approach needs to demonstrate that the maximum amount of upstream traffic flowing into a project, as well as all project-area traffic flowing into downstream sections, can be handled acceptably. This does not require traditional travel demand forecasting, which has a limitation of about 20 years. Instead, it requires a sensitivity approach where maximum up- and downstream flows are used to right-size the project area's proposed improvements. The simplest example is the SR 520 Floating Bridge: constraints on either end of the bridge limit the usefulness of adding more lanes on the bridge.

TIAs and ARRs (see Chapter 550) shall clearly describe the methodology and process used to develop forecasts in support of a proposed project's analysis. For example, include only those projects that:

- Are on the six-year Transportation Improvement Plan.
- Are fully funded.
- Have entered the environmental review process.

320.05 Traffic Impact Analysis (TIA)

TIA is a term used for all analyses that are not structured ARRs (see Chapter 550) or planning-level efforts like corridor studies. The quality and level of service[4] for state-owned and state-interest facilities shall be based upon MOEs that support the project purpose and need. They shall also be developed and presented in accordance with the latest versions of the *Highway Capacity Manual* (HCM), FHWA Traffic Analysis Toolbox, and WSDOT modeling software protocols.

For some example MOEs, see the FHWA MOE List, which describes measures typically used for analyzing state and local agency facilities such as freeway segments, signalized intersections, ramp terminals/junctions, sidewalks, and transit services.

Depending on the facility and when HCM Level of Service MOE is used, WSDOT thresholds are "C" for rural and "D" for urban non-NHS facilities, unless a WSDOT region specifies otherwise for specific route segments. (See each WSDOT region for details.) Refer to the WSDOT State Highway Log for a determination of existing route segment definitions for urban or rural status.

Depending on the project type and purpose, multimodal MOEs may be employed.

The final TIA needs to be included in the project's Design Documentation Package (DDP). (See DDP check lists) When filing TIAs in DDPs, ensure accompanying documentation is included. Examples include but are not limited to traffic counts and other base data used as inputs, calibration information, relevant traffic model outputs, and any data visualizations used in evaluation.

Models developed as part of the analysis need not be included in the DDP but can optionally be included in the project file.

[4] WSDOT sets level of service (LOS) standards for state highways and ferry routes of statewide significance (HSS) based on RCW 47.06.140(2). Regional transportation planning organizations (RTPOs) and WSDOT jointly develop and RTPOs establish LOS standards for regionally significant state highways and ferry routes (non-HSS) based on RCW 47.80.030(1)(c).

320.05(1) Updating an Existing TIA

TIAs require either updating or a sensitivity analysis if they become more than 3 years old; however, a TIA will require updating sooner in rapidly developing areas. TIAs can avoid such update efforts in slowly developing areas. To determine if an update is required, an assessment of critical infrastructure functionality must be documented.

If the amount or character of traffic in the study area is significantly different from an earlier analysis, an update will be required. The definition of significant is 10% (volume, flow rate, travel time, delay, density, or other key MOEs) where existing operations are currently acceptable. If they are not currently acceptable, the threshold is reduced to 5%. In cases where greater than 10% change or failed MOEs have been found, consultation and concurrence with WSDOT Transportation Operations Office of purview is required to avoid a full ARRs or TIA update.

Developer-initiated TIAs are typically valid for 5 or 6 years, as that is the window provided under the Growth Management Act for concurrency. The Development Services Office should be consulted regarding the need for updates to TIAs for developer, tribal, and local agency projects.

320.06 TIA Scope

To establish the appropriate scope, consultation between the lead agency, WSDOT, and those preparing the TIA is encouraged before beginning work. A summary of typical TIA contents is listed in Section 320.10. Note: For developer-initiated TIAs, the local agency may prescribe the scope of the TIA per the local agency's adopted standards.

320.06(1) TIA Boundaries

The traffic impacts of local streets and roads can impact intersections on state highway facilities. In these cases, include in the TIA an analysis of adjacent local facilities (driveways, intersections, main lines, and interchanges) upstream and downstream of the intersection with the state highway. A "lesser analysis" may include obtaining traffic counts, preparing signal warrants, or a focused TIA. For developer projects, the boundaries of the analysis (such as the city limits) may be determined in consultation with local agencies and WSDOT.

320.06(2) Traffic Analysis Scenarios

WSDOT must understand the effects of plan updates and amendments, as well as the effects of specific project elements (including site plans, conditional use permits, subdivisions, and rezoning) that have the potential to impact state facilities. Consultation between the lead agency, WSDOT, and those preparing the TIA is essential early in the process to help determine appropriate scenario analyses and goals. For further guidance, consult Chapter 1130.

Depending on the type of work being analyzed, required TIA scenarios can range from simple "existing conditions with and without project," to more complex analyses where TIA scenarios could include: existing; opening year with and without project; interim years with and without project; and design year with and without project. If developed with WSDOT, and if following ARR guidance, pre-ARR work such as Area Study TIAs can be used in future ARRs.

The appropriate and necessary scenarios shall be agreed upon by the TIA study team and documented in the TIA Methods and Assumptions (M&A) Document.

For existing networks, calibrate models to existing conditions.

If a near-term baseline network is required, only funding-secured projects should be added to the existing network. This is typical of opening year models that are a few years beyond existing year.

For interim scenario networks, include only projects or developments within the forecasting process that have the highest probability within the 10-year horizon. For example, include projects that are fully funded or have a construction phase in the six-year Transportation Improvement Plan.

For scenarios with phases beyond 10 years, TIA or ARR teams should discuss and document the merits of including other potential projects. For example:

- Projects on current long-range regional transportation plans (or the locally-adopted transportation plan, if the TIA is not on a regionally-significant facility)
- Projects on the HSP or MTP

All other potential influences with lower probability should not be allowed to affect travel or trip demand forecast results—with one exception: TIAs and ARRs may include multiple scenarios for the design year. For example, if a major assumption for unfunded additional lanes "feeding traffic into" or "allowing traffic from" the project is desired for the design year to allow for a better understanding of expensive infrastructure sizing (such as ultimate bridge widths), ensure a constrained design year scenario is included so that proper funding-based phasing solutions are communicated.

320.07 TIA Methods and Assumptions Document

The TIA M&A is similar to an ARR M&A in that it documents the "who, what, where, when, how, and why" items associated with the traffic analysis portion of a project.

Prior to any substantial fieldwork or traffic/facility data collection, consultation between the lead agency, WSDOT, and those preparing the TIA is encouraged to help reach and document consensus on study data needs and assumptions. These and other items should be documented and the M&A signed by all lead staff that conduct work in association with the TIA M&A document. For further guidance, consult Chapter 1130.

320.08 TIA Methodologies

The FHWA Traffic Analysis Toolbox, Volume 2, provides a methodology for selecting traffic analysis tools. However, in general, traffic analysis methodologies for those facility types indicated below are used by WSDOT and will be accepted if agreed upon by those who sign TIA or ARR M&A Documents.

- **Freeway Segments:** *Highway Capacity Manual*/Software (HCM/S); operational and design analysis; macroscopic, mesoscopic, and microsimulation
- **Weaving Areas:** *Design Manual* (DM); HCM/S; operational and design analysis; microsimulation
- **Ramps and Ramp Terminals:** HCM/S; operational and design analysis; DM; microsimulation
- **Multilane Highways:** HCM/S; operational and design analysis; macroscopic, mesoscopic, and microsimulation
- **Two-Lane Highways:** HCM/S; operational and design analysis
- **Intersection, Signalized:** Sidra; Synchro; SimTraffic; HCM/S; Vissim,
- **Intersection, Roundabout:** Sidra; Rodel; HCM; Vissim
- **Corridors:** Sidra; Synchro; SimTraffic; HCM; Vissim
- **Stop-Controlled Intersections:** HCM/S for capacity; Design Manual Chapter 1330 and the MUTCD for signal warrants (if a signal is being considered)
- **Transit:** HCM/S; operational and design analysis; *Traffic Manual*
- Pedestrians: HCM/S

- Bicycles: HCM/S
- **WSDOT Criteria/Warrants:** MUTCD (signals, stop signs); *Traffic Manual* (school crossings); Design Manual Chapter 1040 (freeway lighting, conventional highway lighting)
- Channelization: Design Manual

The procedures in the *Highway Capacity Manual* do not explicitly address operations of closely spaced signalized intersections, nor does WSDOT currently endorse microsimulation or roundabout guidance as noted in the HCM/S. Under such conditions, several unique characteristics must be considered, including spill-back potential from the downstream intersection to the upstream intersection; effects of downstream queues on upstream saturation flow rates; and unusual platoon dispersion or compression between intersections. An example of such closely spaced operations is signalized ramp terminals at urban interchanges. Queue interactions between closely spaced intersections can seriously distort the results of analyses that follow the procedures in the HCM.

Other analysis methods may be accepted; however, consultation between the lead agency, region or HQ Transportation Operations, and those preparing the TIA is encouraged to reach consensus on the data necessary for the analysis if meso- or microsimulation is employed. When a state highway has saturated flows, the use of a meso- or microsimulation models can provide additional understanding.

Note, however, that the simulation model must be calibrated and validated for reliable results and is intended for near-term operational analyses.

Operational MOEs for simulation models based on long-term forecasts should be used primarily to determine which scenarios are better than others. The models can only do so if the resultant MOEs demonstrate significant differentiation between scenarios. TIA or ARR teams will determine what is considered significant and will document those findings in the study. However, at a minimum, significant must be greater than the expected error band of the models used. For example, if Vissim is considered to be calibrated to a given MOE within 15% of existing conditions (a very wide band), the scenarios need to show greater than 15% differentiation between each other to be significant.

320.09 TIA Mitigation Measures

Consultation between the lead agency, WSDOT, and the responsible parties preparing the TIA is recommended in order to reach consensus on the project mitigation measures. Mitigation measures, if applicable, need to be included in the TIA to determine whether a project's impacts can be eliminated or reduced to a level of insignificance. Eliminating or reducing impacts to a level of insignificance is the standard pursuant to the State Environmental Policy Act (SEPA) and National Environmental Policy Act (NEPA). The lead agency is responsible for administering the SEPA and/or NEPA review process. WSDOT is responsible for reviewing the TIA for impacts that pertain to state highway facilities. However, the authority vested in the lead agency under SEPA/ NEPA does not take precedence over other authorities in law.

Development work in the state highway right of way requires a WSDOT permit or agreement. Normally, this work is coordinated by the region Development Services Office.

Mitigation measures may take the following forms:

- Channelization such as turn lanes or raised islands
- Installation of a roundabout or, if necessary, a traffic signal (signal warrant analysis per MUTCD is required)
- Frontage improvements
- Donation of right of way
- Addressing any design or operational deficiencies created by the proposal

- Possible restrictions of turning movements
- Sight distance enhancements
- Traffic mitigation payment (pro rata share contribution) to a programmed WSDOT project (consult Chapter 1130)
- Satisfaction of local agency guidelines and interlocal agreements

320.10 TIA Report

320.10(1) TIA Minimum Contents

Below is a typical outline of a TIA report; however, the depth and detail of content under each element varies in relation to the scale and complexity of the project. For further guidance, contact the region or HQ Transportation Operations Division.

a) Executive Summary
b) Table of Contents
    1. List of Exhibits (Maps)
    2. List of Tables
c) Introduction
    1. Description of the proposed project with purpose and need.
    2. Traffic Impact Analysis Methods and Assumptions summary.
    3. Map of project location.
    4. Site plan, including all access to state highways (site plan, map).
    5. Circulation network, including all access to state highways (vicinity map).
    6. Land use and zoning.
    7. Phasing plan, including proposed dates of project (phase) completion.
    8. Project sponsor and contact person(s).
    9. References to other traffic impact studies.
    10. Other mitigation measures considered
d) Traffic Analysis
    1. TIA M&A.
    2. Existing and projected conditions of the site: posted speed; traffic counts (to include turning movements); sight distance; channelization; design analyses; pedestrian and bicycle facilities; design vehicle; and traffic controls, including signal phasing and multi-signal progression where appropriate (exhibit(s)).
    3. DHV and ADT; project trip generation and distribution map, including references and a detailed description of the process involved in forecasting the projected trips, including tables.
    4. Project-related transportation mode split, with a detailed description of the process involved in determining transportation mode split.
    5. Project-generated trip distribution and assignment with a detailed description of the process involved in distributing and assigning the generated traffic, including exhibit(s).
    6. If intersection control additions are employed and traffic signals are assumed, include functionality and warrant analyses. With roundabouts or signals, include existing conditions, cumulative conditions, and full-build of plan conditions with and without project.
    7. Safety performance analysis (see Chapter 321).
e) Conclusions and Recommendations
    1. Quantified or qualified LOS, QOS, and other appropriate MOEs of impacted facilities with and without mitigation measures.
    2. Predicted safety performance with and without mitigation measures.
    3. Mitigation phasing plan with dates of proposed mitigation measures.
    4. Defined responsibilities for implementing mitigation measures.
    5. Cost estimates for mitigation measures and financing plan.

f) Appendices
   1. Description of traffic data and how data was collected and manipulated.
   2. Description of methodologies and assumptions used in analyses.
   3. Worksheets used in analyses. For example, signal warrants, LOS, QOS, and traffic count information.
   4. If microsimulation is used, provide a copy of the Confidence and Calibration Report.

320.11 References

320.11(1) Federal/State Laws and Codes

42 United States Code 4321, National Environmental Policy Act (NEPA) of 1969

Revised Code of Washington (RCW) 43.21C, State environmental policy (Chapter 197-11 WAC and Chapter 468-12 WAC)

RCW 36.70a, Growth Management Act

RCW 36.70A.070, Comprehensive plans – Mandatory elements

RCW 47.06.140, Transportation facilities and services of statewide significance – Level of service standards

Washington Administrative Code (WAC) 365-196-430, Transportation elements of comprehensive plans

Manual on Uniform Traffic Control Devices for Streets and Highways, USDOT, FHWA; as adopted and modified by Chapter 468-95 WAC "Manual on uniform traffic control devices for streets and highways" (MUTCD)

320.11(2) Design Guidance

Design Manual, Chapter 321, for sustainable safety

Design Manual, Chapter 550, for Access Revision Report guidelines

Design Manual, Chapter 1130, Development Services

Design Manual, Chapter 1300, for selecting intersection control type

Design Manual, Chapter 1310, for intersection guidelines

Design Manual, Chapter 1320, for roundabout guidelines

Federal-Aid Highway Program Stewardship and Oversight Agreement:
www.fhwa.dot.gov/federalaid/stewardship/agreements/wa.pdf

Highway Capacity Manual (HCM), latest edition, Transportation Research Board, National Research Council

Level of Service Standards for Washington State Highways

Roadside Design Guide and *A Policy on Geometric Design of Highways and Streets,* latest editions, American Association of State Highway and Transportation Officials (AASHTO)

Standard Plans for Road, Bridge, and Municipal Construction (Standard Plans), M 21-01, WSDOT

WSDOT Traffic Analysis web page:

https://wsdot.wa.gov/engineering-standards/design-topics/traffic-analysis

320.11(3) Supporting Information

FHWA Traffic Analysis Toolbox:
https://ops.fhwa.dot.gov/trafficanalysistools/index.htm

Traffic Manual, M 51-02, WSDOT

"Trip Generation," Institute of Transportation Engineers (ITE)

WSDOT's Highway Segment Analysis Program

WSDOT's Planning Level Cost Estimation (PLCE) Tool