

Advanced Design Flexibility Pilot Workshop

Session 4

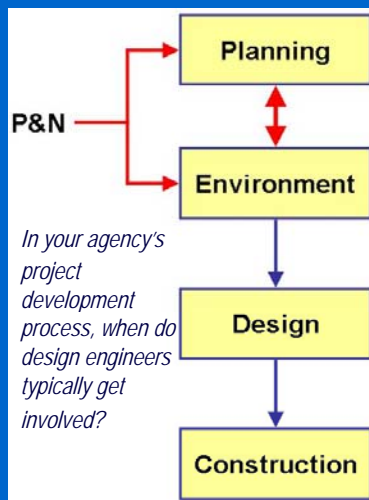
Jack Broz, PE, HR Green
May 5-6, 2010



Using Traffic Data



Defining “Purpose and Need”



“A key to context sensitive planning and design is developing a clear understanding during concept definition of the need for a project, which involves an understanding of the transportation problem and the context of the project area”

AASHTO: “A Guide for Achieving Flexibility in Highway Design” May 2004

Key Highway Design Controls

Which of these are selected or determined by designers and which factors are outside of our control?

- Functional Classification SELECTED
- Terrain
- Location **This Session!**
- Design Volume SELECTED
- Design Vehicle SELECTED
- Design Driver SELECTED
- Design Speed SELECTED

Design Volume

Typical practice is to establish a design hourly volume (DHV) upon which the operational and geometric design characteristics are based.

Establishing the DHV is typically based upon:

- Forecasting a “design year” volume
 - For new construction and major reconstruction a design period 20 years beyond the estimated year of completion is typical
- Selecting an appropriate hourly demand
 - Common practice is to choose the “30th highest” hourly volume for rural areas and the “100th highest” in urban areas

Forecasted Trip Generation Limitations

- Trip Generation
 - Linear analysis
 - Percentage based on historical trends (overpredicts)
 - ITE methodology
 - “Planned development”
 - Can easily over-estimate multiple land uses
 - TAZ modeling
 - Regional model predicts Regional trips
 - Regional model does not have local roads in the network and in urban areas does not predict trips accurately for local or internal trips within the TAZ

Basis of Design Volume

- Traffic forecasts represent an estimate
- Variability in actual future land use development and intensity, economic activity, future road network, transit service, and many other factors, can change significantly over time

“Design year forecasts should not be viewed as certain or precise”

p. 14 - AASHTO “A Guide for Achieving Flexibility in Highway Design”



Design Volume Risk

What are some example design decisions that are based upon the design volume?

- Pavement design
- Determining length of turn bays, number of turn lanes, number of through lanes, etc.
- Evaluating how well the project meets objectives for capacity, delay, and mainline or intersection level of service (LOS).
- Informed decision-making on project alternatives and trade-offs.

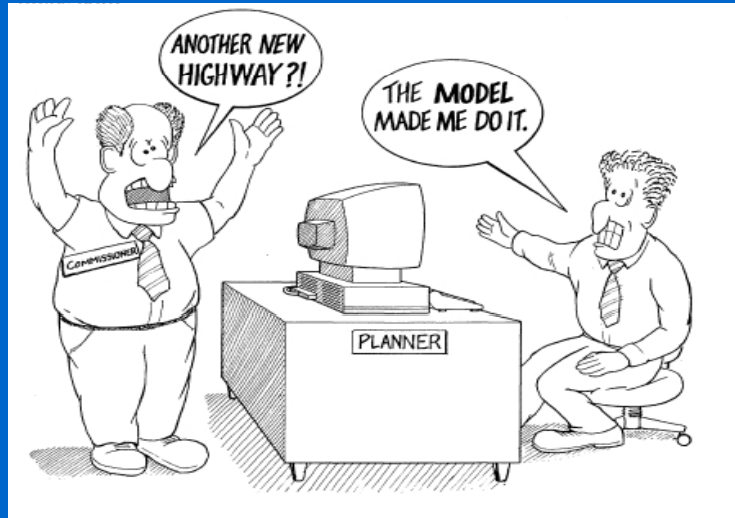
What are the adverse consequences (i.e. risks) if the actual volumes differ from the design volume?

Risk Management Approach

Minimize the risk by gaining confidence in the forecast:

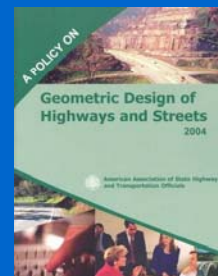
- Compare traffic data/counts to observations from field visits
- Investigate the model inputs (especially new or changing land uses)
- Lessons learned from other projects
- Consider a Sensitivity Analysis approach

Role of the Traffic Forecast



Selecting Operational Goals

- Measures of Effectiveness (MOE)
“Performance measures that can be estimated quantitatively”
- Level of Service (LOS)
“Choice of an appropriate LOS for design is properly left to the highway designer.”



Mobility vs. Speed

- Speed: Measurement of how fast you are moving
- Mobility: Measuring if you are moving
 - Travel: Movement from point A to point B, (such as a trip to work)
 - Circulating: Movement around a community (stopping for gas, banking and groceries)
 - Access: Movement into a destination (You park, get off the bus or park your bicycle and walk into your destination)

Other MOE's to Consider

In congested conditions, an array of MOEs may be necessary to assess operations and allow for effective decision-making.

- Corridor travel time
- Delay (variance from free flow travel time)
- Travel time index (typically a ratio of the observed VHT over the theoretical VHT at free flow speed and same VMT)
- Throughput (vehicles/hour or persons/hour)
- Peak period running speed
- Average travel speed through a segment
- Queue length
- Percent of segments in regular "breakdown" or "blocked" conditions

Chapter 3: Enhancement -- Level of Service is one Measure of Effectiveness

Transportation MOE's

(for all users)

- Condition of facilities
- Safety and comfort
- Mode choice
- Network connectivity
- User population
- Traditional LOS
 - Travel time
 - Congestion
 - Specific measures elsewhere

"Other" MOE's

- Environment preservation
- Cultural resource preservation
- Community enhancement
- Economic development
- Aesthetics
- Environmental justice/equity
- Impact mitigation
 - Noise
 - Air Quality
 - Wildlife Habitat

Vehicle Capacity of Street



People in Automobiles



Same People On Bus



Same People Walking/Biking



MOEs and Purpose and Need

- Project MOEs should be specific and measurable and tie directly to the desired project performance objectives identified in the Purpose and Need

Project Goals

- Reduce congestion
- Improve mobility
- Improve safety
- Minimize environmental impacts
- Provide multi-modal accommodations

Specific Objectives

- Improve mainline freeway operations during PM peak hour
- Reduce queue length
- Avoid encroachment into historic area
- Discourage use of neighborhood streets for through traffic

Operational Goal Setting

Functional class	Appropriate level of service for specified combinations of area and terrain type				Urban and suburban
	Rural level	Rural rolling	Rural mountainous		
Freeway	B	B	C	C	Urban E D D
Arterial	B	B	C	C	
Collector	C	C	D	D	
Local	D	D	D	D	

AASHTO Green Book Exhibit 2-32

Guidelines for Selection of Design Levels of Service

AASHTO Flexibility Guide:

“Note, however, that these are for guidance only.”

“Failure to achieve a level of service indicated does not constitute a non-standard design decision.”



Applying Flexibility to LOS

A flexible approach acknowledges the need to tailor the level of service to other design controls and constraints within the context of the project's purpose and need

p. 15 - AASHTO “A Guide for Achieving Flexibility in Highway Design”



Design LOS – Reality Check

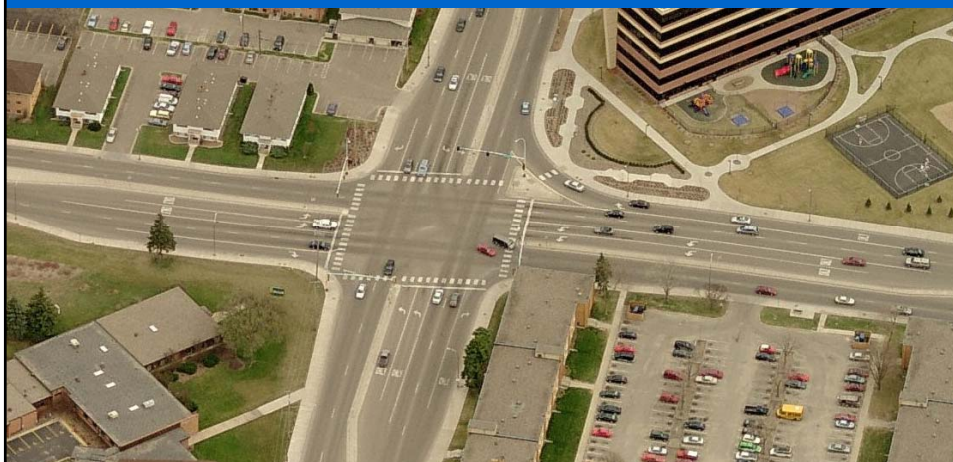
It may not be practicable to construct projects that fully accommodate a future design hour traffic demand (or even to fully address existing traffic congestion). Engineering judgment and consideration of relevant factors provides the flexibility in determining the best extent design year traffic can be accommodated.



“Think outside the peak hour”

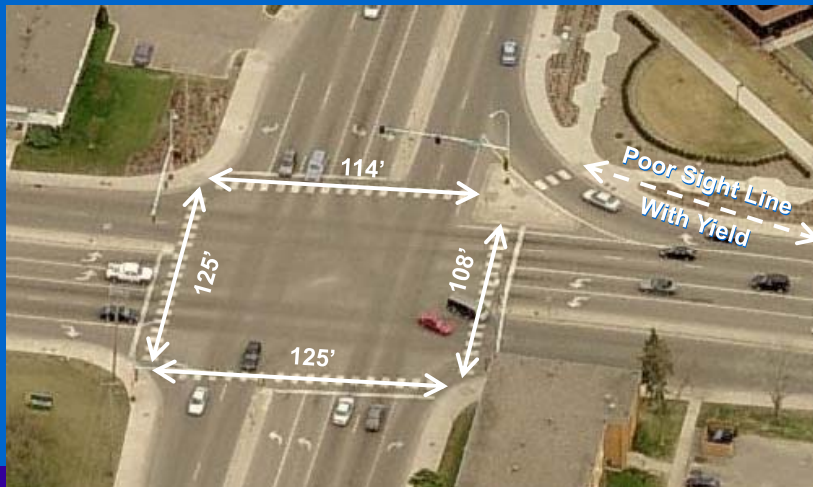
Peak Period Level of Service

Results in “open streets” for non-peak periods.



Peak Period Level of Service

Results in poor pedestrian crossings.



Peak Period Level of Service

Results in no room for bus stops.



Peak Period Level of Service

Results in no space allocated for bicycles.



LOS Example

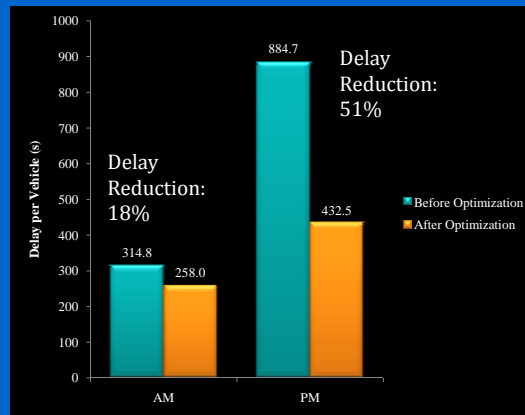


Signal Optimization (Delay MOE)

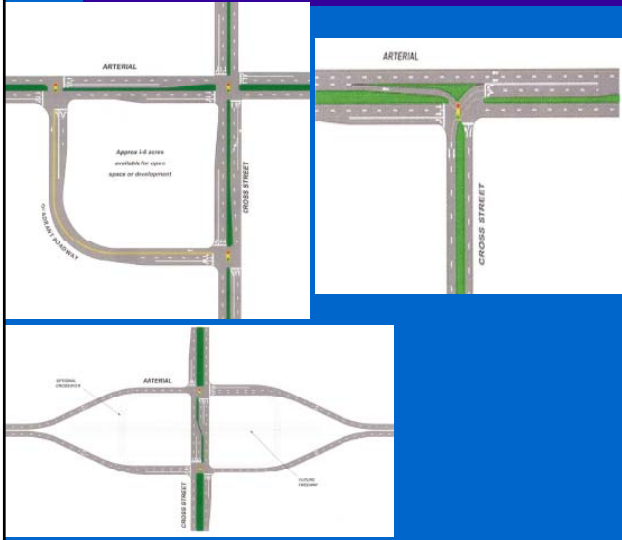


Signal Optimization

- Change in Signal Phasing
- Estimated Cost: \$80,000
- LOS F

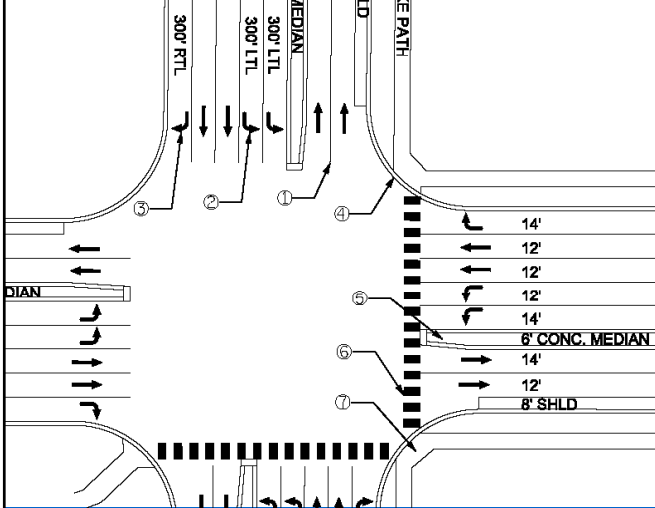


Intersection Design



- Quadrant Roadway
- Single Loop Interchange
- Median U-Turn
- Paired Intersections
- Jug Handle
- Echelon
- Continuous Green-T
- Center Turn Overpass
- Bowtie
- Superstreet
- Split Intersection

Intersection Design



What does each element of the intersection do?

Where is the flexibility?

Intersection Elements

Through Lanes = Capacity

This slide features an aerial photograph of a multi-lane intersection. Three callout boxes with teal arrows point to specific elements: 'Number of Lanes' points to the width of the intersection, 'Lane Widths (All the same? Always constant?)' points to the individual lanes, and 'Curb Reaction Width (Left or right side of the driver?)' points to the curb area on the right side of the road.

Intersection Elements

Left Turn Lanes = Major Cause of Problems

This slide features an aerial photograph of an intersection with a dedicated left-turn lane. Three callout boxes with teal arrows point to specific elements: 'Downstream opening Lane Balance' points to the intersection area, 'Permissive vs. Protected Phasing' points to the traffic light, and 'Double Lefts: Truck Lane/Car Lane Lane Widths Curb Reaction' points to the left-turn lane.

Intersection Elements

Right Turn Lanes = Efficiency/Convenience

Deceleration Lane

Merge

Turning Radius

"Free Right"

This slide features an aerial photograph of a complex intersection with multiple lanes and a roundabout. Four callout boxes with teal backgrounds and white text point to specific features: 'Deceleration Lane' points to a lane on the left side of the intersection; 'Merge' points to the area where lanes converge; 'Turning Radius' points to the curved path of a roundabout; and '"Free Right"' points to a right-turn lane on the right side of the intersection.

Intersection Elements

Cross Walk:
Width
Length
Time to cross
Time to wait

Median:
Painted
Mountable
Raised

Shoulder:
Width
On-street Bicycle
Lanes

Sidewalk/Trail:
Width
Boulevard
Truncated Domes

This slide uses the same aerial photograph as the first slide but highlights different intersection elements. Four callout boxes with teal backgrounds and white text point to these features: 'Cross Walk' points to a crosswalk with sub-points for Width, Length, Time to cross, and Time to wait; 'Median' points to a central road divider with sub-points for Painted, Mountable, and Raised; 'Shoulder' points to the edge of the road with sub-points for Width, On-street Bicycle Lanes; and 'Sidewalk/Trail' points to the pedestrian path with sub-points for Width, Boulevard, and Truncated Domes.

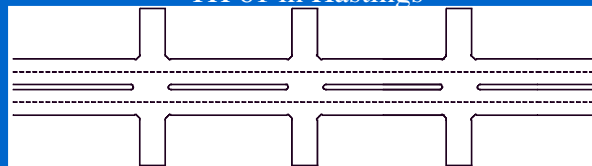
Geometric Design Guidelines

- Turn Lane Length
Guidance – 300 feet of full width and 180 feet of taper

Objective – Provide sufficient length to accommodate deceleration and storage.

Variance from Left Turn Lane and Taper Length

TH 61 in Hastings

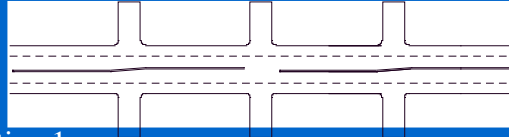


Before Condition

- 4-lane undivided
- High Crash Rate – 13.8 crashes/MVM
- High frequency of rear end (left turn) crashes

Variance from Left Turn Lane and Taper Length

TH 61 in Hastings

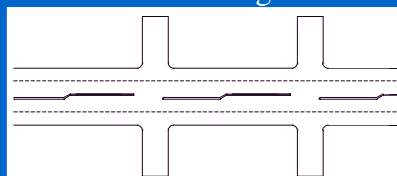


Alternative 1

- 4-lane Divided / Raised median
- 300 foot Left Turn Lanes & 180 foot Tapers
- Required closing access to every other city street
- This alternative was REJECTED and MnDOT asked to leave town

Variance from Left Turn Lane and Taper Length

TH 61 in Hastings



Alternative 2

- 4-lane Divided / Raised median
- 125 foot Left Turn Lanes & 60 foot Tapers
- All public street intersections remained open
- Project was APPROVED and constructed
- The raised median and exclusive Left Turn Lanes reduced crashes by 44%

Pedestrian Enhancements

- Sidewalk bump outs
- “Far Side” Bus Stops
- Set back Stop Lines
- Wide Medians
- Free Right Islands, (check sight lines!)
- Signal Control

Choosing Vehicles for Design

The design vehicle should be selected with knowledge of the trade-offs involved.

Design Vehicle

The vehicle that must be *regularly* accommodated

Control Vehicle

A vehicle that infrequently uses a facility and must be accommodated, but where encroachment or multiple-point turns may be acceptable

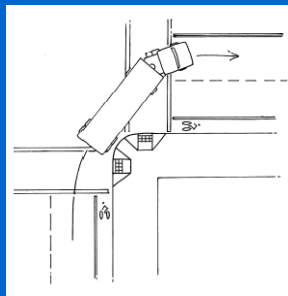


Data-driven Vehicle Choice

- Design vehicle should be based on:
 - Traffic count classification data
 - Largest vehicle class with regular use
 - “Regular” = measurable & reasonably predictable
 - Cost-effectiveness
 - Impacts to neighboring properties
 - Appropriate for context
 - Consideration of largest *legal* vehicle with allowable encroachment

Design Vehicle Trade-offs

What are some example trade-offs associated with selecting a design vehicle?



Turning radius at an intersection

Benefits of smaller radii:

- Decreased pedestrian crossing distances
- Slower speed of turning traffic
- Facilitates perpendicular curb ramps parallel to the crosswalk
- Less space available on corners for peds and utilities

Who is the “Design Driver”?

Profiles of possible design drivers:

<u>Category</u>	<u>Characteristics</u>
YOUNGER	
OLDER	
LOCAL/COMMUTER	
UNFAMILIAR	

Identifying the Design Users

- Highway design is generally based on the assumption that drivers are competent and capable
- Certain design criteria are based on human factors and are relatively conservative in assumptions regarding capability that the vast majority of users exceed
- Conservative assumptions better accommodate fatigued, inexperienced, and users with below average capabilities

