Design Traffic Volumes

• Need to figure out the appropriate hourly traffic volume to get a particular LOS
Definitions

• **Annual average daily traffic (AADT)**
  - Annual traffic averaged on a daily basis
  - Both directions

• **Design hourly volume (DHV)**
  - Traffic volume used for design calculations
  - Typically between the 10\(^{th}\) and 50\(^{th}\) highest volume hour of the year (30\(^{th}\) highest is most common)

• **K-factor**
  - Ratio between DHV and AADT

\[
K = \frac{DHV}{AADT}
\]
Definitions

• Directional distribution factor (D)
  – Factor reflecting the proportion of peak-hour traffic traveling in the peak direction
  – Often there is much more traffic in one direction than the other

• Directional design-hour volume (DDHV)

\[ DDHV = K \times D \times AADT \]
Typical Graph

Highest 100 Hourly Volumes Over a One-Year Period for a Typical Roadway

Number of hours (annually) with specified or greater volumes

Hourly volume as a proportion of AADT

$K_{30} = 0.12$
Is 2 lanes sufficient to ensure LOS C?

\[ DDHV = K \times D \times AADT \]

\[ v_p = \frac{PHF \times N \times f_{HV} \times f_p}{V} \]
Is 2 lanes sufficient to ensure LOS C?

• Use 30\textsuperscript{th} highest annual hourly volume
• Freeway, 2 lanes each direction
• Passenger car only facility
• AADT = 35,000 veh/day
• FFS = 70 mph
• Commuters
• D = 65% (PH traffic in peak dir.)
• PHF=0.85

\[ DDHV = K \times D \times AADT \]
Example

\[ v_p = \frac{V}{PHF \times N \times f_{HV} \times f_p} \]
Define Speed-Flow Curve

Select a Speed-Flow curve based on FFS

EXHIBIT 23-3. SPEED-FLOW CURVES AND LOS FOR BASIC FREEWAY SEGMENTS

From *Highway Capacity Manual*, 2000
Example

Determine the typical LOS for SR 520 eastbound near Microsoft (MP 10.25 – shown in the picture below) at 7 a.m. and 10 p.m.

Geometry
• 11 ft. lane width
• Left lateral clearance = 5 ft.
• Right lateral clearance = 4 ft.

Other
• 7 am PHF = 0.95
• 10 pm PHF = 0.99
• 2% trucks
• 3% buses

from WSDOT’s SRWeb
http://srview.wsdot.wa.gov/
<table>
<thead>
<tr>
<th>Lane Width (ft)</th>
<th>Reduction in Free-Flow Speed, $f_{LW}$ (mi/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>0.0</td>
</tr>
<tr>
<td>11</td>
<td>1.9</td>
</tr>
<tr>
<td>10</td>
<td>6.6</td>
</tr>
</tbody>
</table>
Determine FFS

### Exhibit 23-5. Adjustments for Right-Shoulder Lateral Clearance

<table>
<thead>
<tr>
<th>Right-Shoulder Lateral Clearance (ft)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>≥ 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 6</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>5</td>
<td>0.6</td>
<td>0.4</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>4</td>
<td>1.2</td>
<td>0.8</td>
<td>0.4</td>
<td>0.2</td>
</tr>
<tr>
<td>3</td>
<td>1.8</td>
<td>1.2</td>
<td>0.6</td>
<td>0.3</td>
</tr>
<tr>
<td>2</td>
<td>2.4</td>
<td>1.6</td>
<td>0.8</td>
<td>0.4</td>
</tr>
<tr>
<td>1</td>
<td>3.0</td>
<td>2.0</td>
<td>1.0</td>
<td>0.5</td>
</tr>
<tr>
<td>0</td>
<td>3.6</td>
<td>2.4</td>
<td>1.2</td>
<td>0.6</td>
</tr>
</tbody>
</table>

### Exhibit 23-6. Adjustments for Number of Lanes

<table>
<thead>
<tr>
<th>Number of Lanes (One Direction)</th>
<th>Reduction in Free-Flow Speed, f_L (mi/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 5</td>
<td>0.0</td>
</tr>
<tr>
<td>4</td>
<td>1.5</td>
</tr>
<tr>
<td>3</td>
<td>3.0</td>
</tr>
<tr>
<td>2</td>
<td>4.5</td>
</tr>
</tbody>
</table>

Note: For all rural freeway segments, f_L is 0.0.
Determine FFS

In a 6-mile stretch from I-405 to Redmond there are 5 interchanges

<table>
<thead>
<tr>
<th>Interchanges per Mile</th>
<th>Reduction in Free-Flow Speed, $f_{ID}$ (mi/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.50</td>
<td>0.0</td>
</tr>
<tr>
<td>0.75</td>
<td>1.3</td>
</tr>
<tr>
<td>1.00</td>
<td>2.5</td>
</tr>
<tr>
<td>1.25</td>
<td>3.7</td>
</tr>
<tr>
<td>1.50</td>
<td>5.0</td>
</tr>
<tr>
<td>1.75</td>
<td>6.3</td>
</tr>
<tr>
<td>2.00</td>
<td>7.5</td>
</tr>
</tbody>
</table>
Determine $F_{ID}$

Interchanges per mile vs. $F_{ID}$
Determine Flow Rate ($v_p$)

Recall there are 2 lanes

At 7am the $\frac{1}{2}$ hour volume is about 4000 veh/hr
At 10 pm the $\frac{1}{2}$ hour volume is about 1700 veh/hr

Graph from the Puget Sound Regional Council’s *Puget Sound Trends*, No. T6, July 1997
Determine Flow Rate ($v_p$)

\[
f_{HV} = \frac{1}{1 + P_T (E_T - 1) + P_R (E_R - 1)}
\]

**Exhibit 23-8. Passenger-Car Equivalents on Extended Freeway Segments**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Level</th>
<th>Rolling</th>
<th>Mountainous</th>
</tr>
</thead>
<tbody>
<tr>
<td>$E_T$ (trucks and buses)</td>
<td>1.5</td>
<td>2.5</td>
<td>4.5</td>
</tr>
<tr>
<td>$E_R$ (RVs)</td>
<td>1.2</td>
<td>2.0</td>
<td>4.0</td>
</tr>
</tbody>
</table>
\[ v_p = \frac{V}{PHF \times N \times f_{HV} \times f_p} \]
Determine LOS, speed

EXHIBIT 23-3. SPEED-FLOW CURVES AND LOS FOR BASIC FREEWAY SEGMENTS
What is LOS at 10:00 pm?

\[ v_p = \frac{V}{PHF \times N \times f_{HV} \times f_p} \]