Appendix B: Solutions Toolbox
TOOLBOX OF SOLUTIONS
Toolbox of Solutions

**Intersections**
- Signal Timing Optimization
- Signal Modifications
- Add Turn Lane
- Right In/Right Out
- Three Quarter
- Acceleration/Deceleration
- Roundabout
- Restricted Crossing U-Turn (RCUT)
- Median U-Turn
- Jughandle
- Displaced Left Turn
- Offset T
- Quadrant
- Green T

**Segments**
- Truck Climbing Lanes
- Shoulder Widening
- Passing Lanes
- Access Management
- 4 to 3-Lane Conversion
## Construction Cost Ranges

<table>
<thead>
<tr>
<th>Unconstrained</th>
<th>Constrained</th>
</tr>
</thead>
<tbody>
<tr>
<td>$</td>
<td>$</td>
</tr>
<tr>
<td>= 0 to 0.5 million</td>
<td>= 0 to 0.5 million</td>
</tr>
<tr>
<td>$$$</td>
<td>$$</td>
</tr>
<tr>
<td>= 0.5 to 2 million</td>
<td>= 0.5 to 3 million</td>
</tr>
<tr>
<td>$$$</td>
<td>$$$</td>
</tr>
<tr>
<td>= 2 to 4+ million</td>
<td>= 3 to 7+ million</td>
</tr>
</tbody>
</table>

**Unconstrained:** Adjacent land largely undeveloped, substantial existing R/W available

**Constrained:** Adjacent land largely developed, limited existing R/W
Signal Timing Optimization

Pros
• Reduce overall delay
• Improve coordination
• Low cost improvement
• No construction/modification

Cons
• Limited improvement
• Short term solution

Best Applied
• If timing has not changed in > 5 years
• Poorly operating intersections
• Time of day issues

Cost $
Signal Modifications

Pros
• Increase Safety
• Increase capacity
• Provide exclusive phases (protected/permitted/FYLA/overlap)

Cons
• Limited improvement

Best Applied
• Lacking protected phasing
• Lacking detection

Cost  $

FYLA

Video Detection

LEFT TURN YIELD ON GREEN

NO TURN ON RED

Video Detection

MINNESOTA

Video Detection

Video Detection
Add Turn Lane

Pros
• Improves safety
• Improves sight lines
• Reduces “weaving” near intersections

Cons
• Need adequate space
• Can requires signal modifications

Best Applied
• Intersections without turn lanes
• Where additional capacity is needed

Cost  $$

Source: Google Maps
Right In/ Right Out

**Pros**
- Eliminates crossing maneuvers
- Continuous flow on mainline
- Access to and from one direction

**Cons**
- Need alternative routes
- Reduce access

**Best Applied**
- High mainline traffic volumes
- When alternate routes are available

**Cost**  
$
# Three Quarter

## Pros
- Eliminates crossing maneuvers from side street
- Continuous flow on mainline
- Enables access from mainline

## Cons
- Need alternative routes
- Reduce access from side street

## Best Applied
- High mainline traffic volumes
- When alternate routes are available

## Cost
$
Acceleration/Deceleration Lanes

**Pros**
- Eliminates turns into mainline high speed traffic
- Allows vehicles to reach proper merging speed in separate lane
- Continuous flow on mainline

**Cons**
- Additional Pavement/Construction needs

**Best Applied**
- High mainline traffic volumes
- Proper distance between intersections
- Divided roads (for left turn acceleration lane)

**Cost**

$\$

Source: Google Maps

Hwy 5 and 101 in Chanhassen, MN
Roundabout

**Pros**
- Increase safety/reduces conflict points
- Minimizes serious/fatal injury crashes
- Improves delay/capacity
- Reduces lifecycle cost

**Cons**
- Initial Confusion
- Space requirements
- Not applicable to all intersections

**Best Applied**
- Proper traffic volumes for roundabout
- Presence of high severity crashes

**Cost**  $$

Source: Google Maps
Restricted Crossing U-Turn (RCUT)

**Pros**
- Eliminates left turns into high speed mainline traffic
- Continuous flow on mainline
- Eliminates need for traffic signal
- Beneficial for heavy vehicles on side street

**Cons**
- Initial Confusion
- Out of direction travel
- Reduce access from side street
- Requires wide median

**Best Applied**
- Rural 4-lane divided
- Low side street volume

**Cost** $\$\$

Source: Google Maps
Median U-Turn

**Pros**
- Increase green time for mainline
- Eliminate Left Turn Crashes
- Reduce conflict points at intersection

**Cons**
- Initial Confusion
- Typically require wider medians

**Best Applied**
- High capacity intersections

**Cost**  $$
Jug Handle

**Pros**
- Increase green time for mainline
- Eliminate Left Turn Crashes on mainline
- Reduce conflict points at intersection

**Cons**
- Initial Confusion
- Typically require additional ROW
- Longer travel time and more stops for left turning vehicles

**Best Applied**
- High mainline through movements

**Cost**  $$

Source: Google Maps
Displaced Left Turn

**Pros**
- Increase green time for mainline
- Increase throughput by 25-30%
- Reduce conflict points at intersection

**Cons**
- Initial Confusion
- Typically require additional ROW
- Pedestrian accommodations
- Construction Cost

**Best Applied**
- High volume intersection

**Cost** $$$
Offset T

Pros
• Eliminate intersection skew
• Spread out turning movements across multiple intersections

Cons
• Closely spaced intersections
• Potential weaving movement

Best Applied
• Skewed intersection
• Limited other options

Cost $$

Source: FHWA and IowaDOT
Quadrant

Pros
• Increase capacity
• Increase safety
• Removing turning traffic from primary intersection

Cons
• Initial Confusion
• Add traffic to “quadrant roadway”
• Out of direction travel
• Increase number of intersections

Best Applied
• Where quadrant street is already present
• Where there is adequate space for quadrant street

Cost  $$

Source: FHWA
Green T

**Pros**

- Eliminates left turns into high speed mainline traffic
- Continuous flow on mainline for *one* direction
- Can be fully or partially signalized if needed

**Cons**

- Initial Confusion
- Requires channelization

**Best Applied**

- 3-leg intersections
- High mainline and/or side street left turning volume

**Cost**  $$

Source: Google Maps
Shoulder Widening

**Pros**
- Reduces Run-of-Road crashes
- Can include rumble/mumble strips for increased safety
- Provide additional space for emergency stops

**Cons**
- Additional pavement to maintain

**Best Applied**
- Rural roadways without shoulders
- Rural roadways with gravel shoulders

**Cost** $\$\$ \text{(based on length)}

Source: Google Maps
Truck Climbing Lane

**Pros**
- Trucks do not impede on passenger cars traveling on inclines
- Avoids back-ups on highways

**Cons**
- Additional pavement to maintain

**Best Applied**
- Roadways with high truck volumes
- Areas with steep grade

**Cost**  $$  (based on length)

Source: Google Maps
Passing Lanes

Pros
• Slower traffic can be passed
• Avoids back-ups on highways

Cons
• Additional pavement to maintain

Best Applied
• Rural Roadways with high truck volumes

Cost $\$\$ \text{(based on length)}

Source: Google Maps
Access Management

**Pros**
- Reduces conflict points
- Can allow for smoother operations by minimizing acceleration/deceleration needs

**Cons**
- Can be controversial
- May need alternative routes

**Best Applied**
- Roadways with high access density

**Cost**  $$  (depends on extent)

Source: Google Maps
4 to 3-Lane Conversion

**Pros**
- Increase safety by providing dedicated area for left turns
- Can create easier/safer pedestrian crossings

**Cons**
- May need to widen for right turn lanes
- Potential for overlapping left turn movements

**Best Applied**
- 4-lane undivided roadways with locations of high turning traffic volumes

**Cost**  $$ (based on length)

Source: Google Maps