Freeway System Considerations

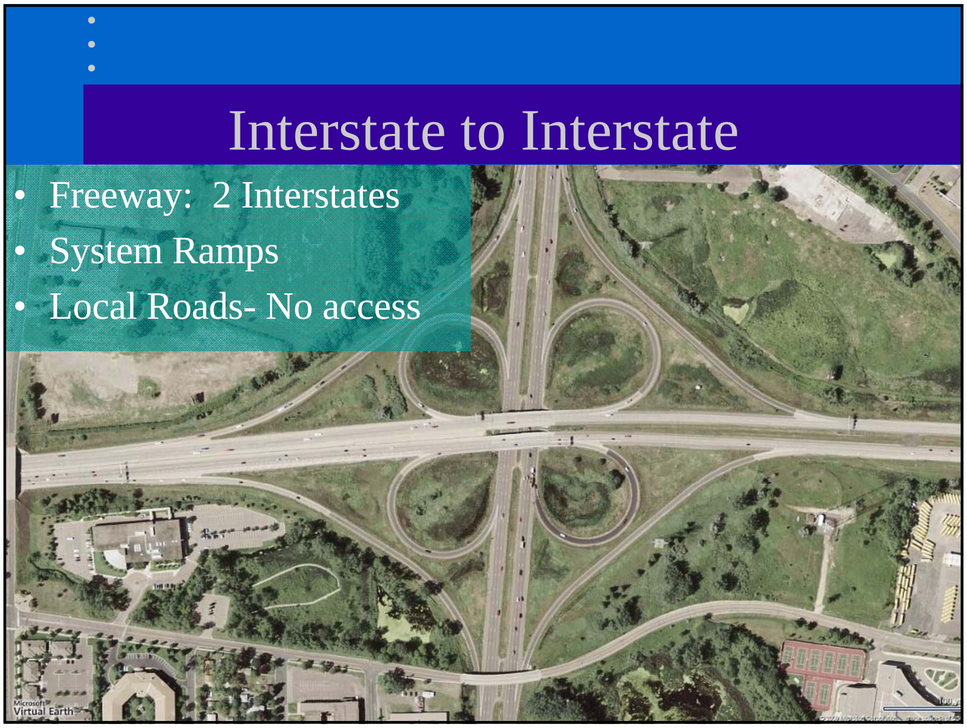
- Mainline
  - Transit: Shoulder Operations, BRT, Stations
  - HOV, HOT, UPA
- Interchanges
  - Exit Ramps
  - Entrance Ramps
  - Bridges
- Local Crossings
  - Modes

Mainline

- Consider appropriate Design Speed
- Shoulder width
- Shoulder Operations

Interchanges

- Interchanges fail more often than mainline operations
- Consider Roadway functions at interchange to find flexibility
  - Interstate to Interstate
  - Interstate to TH (System)
  - Interstate/TH (System) to Local
- Ramp terminal intersection operations can be the “weakest link”


Interstate to Interstate
• Freeway: 2 Interstates
• System Ramps
• Local Roads- No access

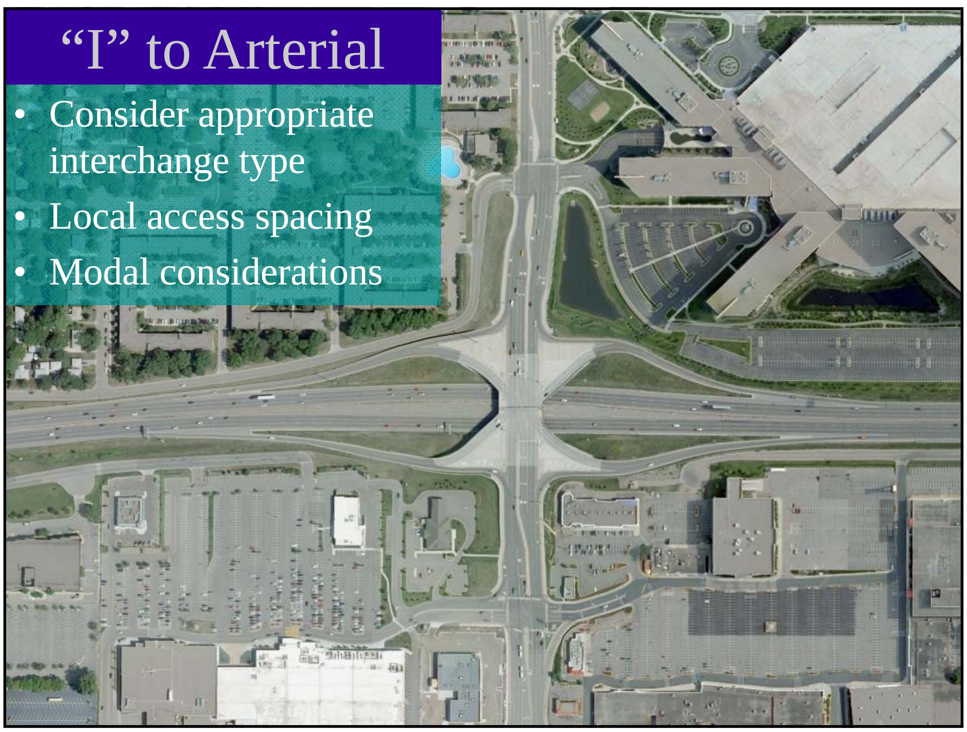

“I” to TH- Freeway
• System Ramps
• C-D Roadways
• Local Roads- No access

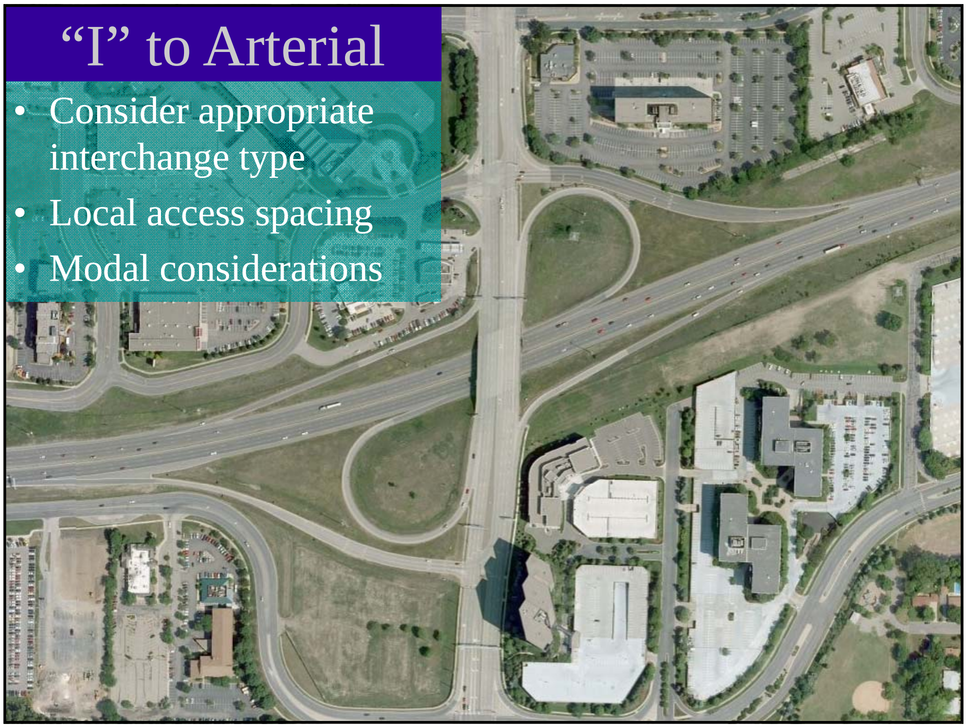
Interstate to Arterial

- Freeway: 1 Interstate
- Arterial
- Local Ramps
- Local Roads

"I" to Arterial

- Consider appropriate interchange type
- Local access spacing
- Modal considerations





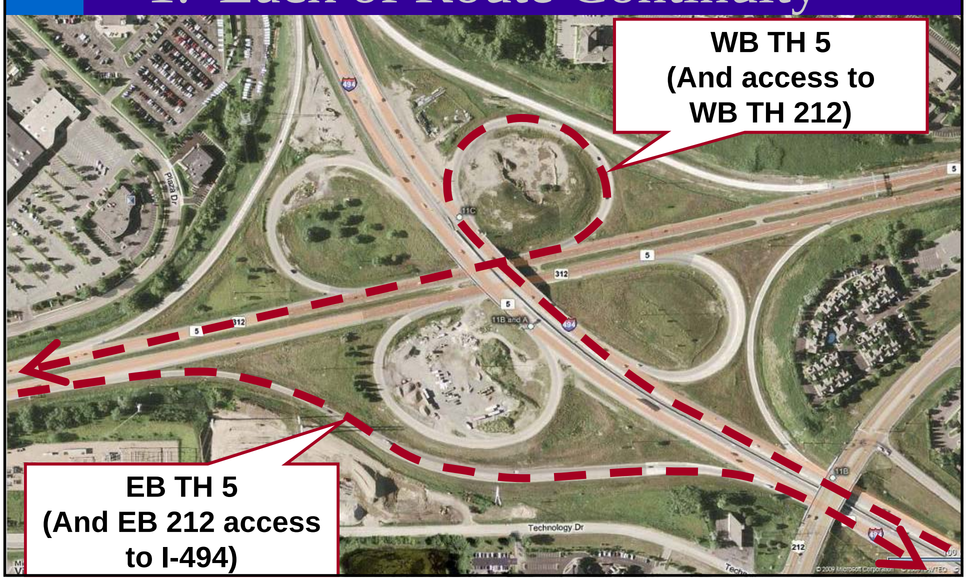
Interchange Design Components

- Mainline
  - Lanes
  - Shoulders
  - Median
  - Backslopes
- Exit Ramps
- Entrance Ramps
- Cross-Road
  - Turn Lanes
  - Medians
  - Signals
  - Sidewalks/Cross-walks
  - Bus Stops
  - Bicycle Lanes
- Local Streets
- Driveways

High Risk Design Elements

1. Lack of Route or Lane Continuity
2. Lane Geometry at Major Forks
3. Advance Guide Signing
4. Weaving on Mainline
5. Local Access at/near System Interchanges
6. Ramp Layout & Design
7. Lack of Necessary Sight Distance
8. Critical Combinations of Horizontal Curvature and Grade at Ramps
9. Vertical Clearance

1. Lack of Route Continuity



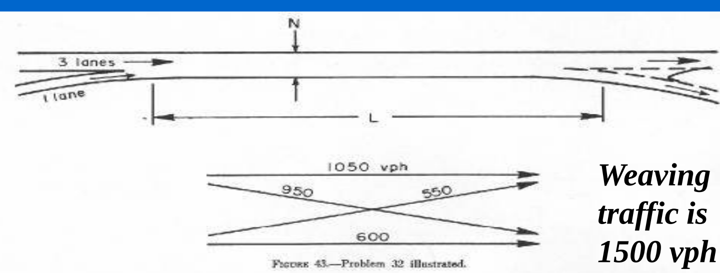
2. Major Fork Lane Geometry

"The design of major forks is subject to the same principles of lane balance as any other diverging area. The total number of lanes in the two roadways beyond the divergence should exceed the number of lanes approaching the diverging area by at least one. Operational difficulties invariably develop unless traffic in one of the interior lanes has an option of taking either of the diverging roadways."

(AASHTO – Geometric Design of Highways and Streets, Page 860)

AGREE OR DISAGREE?

4. Weaving along Mainline

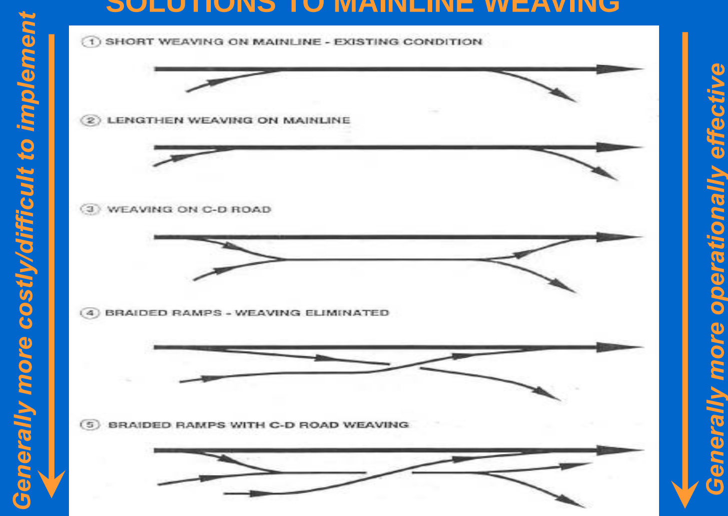


Weaving traffic is 1500 vph

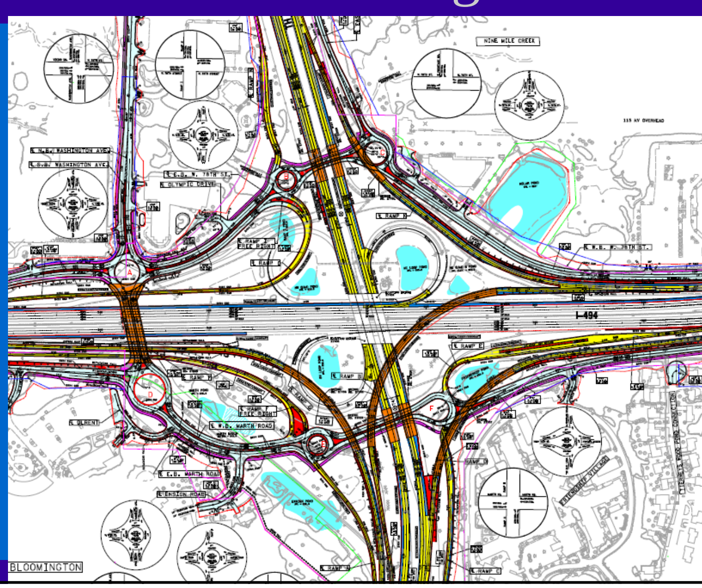
- Weaving is the crossing of conflicting traffic flows
- Key design elements include the length of weaving section (L), number of lanes (N) and volume of weaving traffic

4. Weaving along Mainline

SOLUTIONS TO MAINLINE WEAVING



5. Local access at or near System Interchanges



6. Ramp Layout & Design

- Insufficient Queue Storage
  - Ramp/crossroad intersection typically becomes the capacity and operational control point for the freeway/arterial network
  - Properly providing for adequate future traffic growth becomes the most critical at this "weakest link" in the system

6. Ramp Layout & Design

- Considerations for the Ramp Terminal Intersection
  - Appropriate intersection traffic control
  - Adequate number of lanes on each approach
  - Appropriate channelization for turning movements
  - Sufficient storage lengths for vehicles queued on ramps
  - Access management along crossroad
  - Preventing wrong-way entrances
  - Accommodating pedestrians, bicycles and transit users

6. Ramp Layout & Design

- Strategies for Reducing Queues at Exit Ramps
  - Change traffic control (signal, roundabout)
  - Modify signal timing plan
    - Allocate more green time to off-ramp traffic
    - Ramp queue length detectors and/or monitoring cameras to adjust signal timing to relieve queue
  - Intersection geometric improvements
    - Build additional lanes at the exit ramp (double or triple turn lanes)
    - Reassign lane usage
    - Improved channelization (provide free right turns)

6. Ramp Layout & Design

- Strategies for Reducing Queues at Exit Ramps
  - Access management along crossroad
    - Implement turn restrictions at nearby intersections
  - Alleviate arterial congestion
    - Improve signal coordination
    - Remove nearby signals on the arterial
    - Add lanes on arterials near interchange

7. Lack of Sight Distance

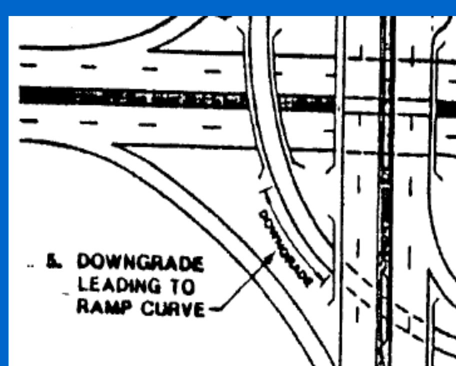
The exit diverge point is hidden by the horizontal curvature and roadside vegetation.

When the diverge point becomes visible, there is little time to adjust for speed and path change (further complicated by a taper style exit on horizontal curve).

It is desirable to provide Decision Sight Distance (DSD) values in advance of an exit ramp

8. Critical Geometric Combinations

- Substantial downgrades leading into a tight ramp curve

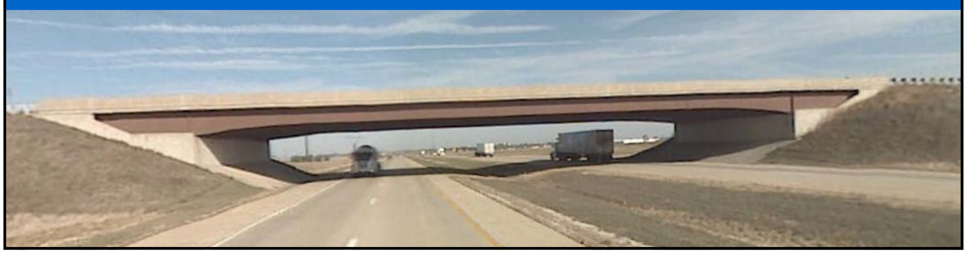


"downgrades should desirably be limited to 3 or 4 percent on ramps with sharp horizontal curvature and significant heavy truck or bus traffic."

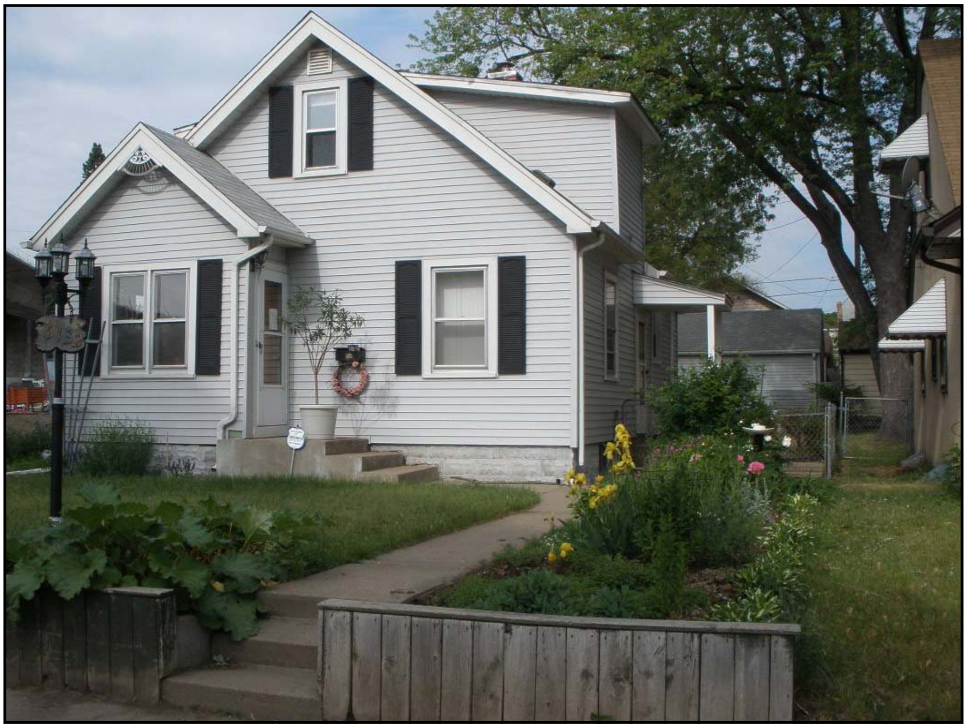
AASHTO Green Book (2004) page 829

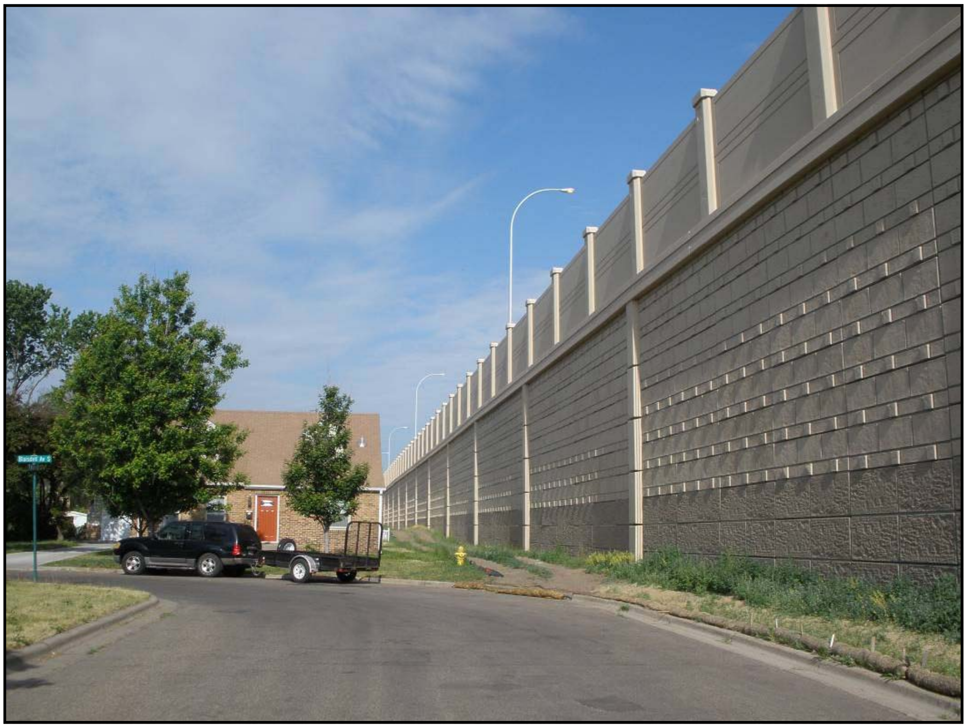
9. Vertical Clearance

- Interstate/military
- Highway
- Local Roads
- Bridge Types



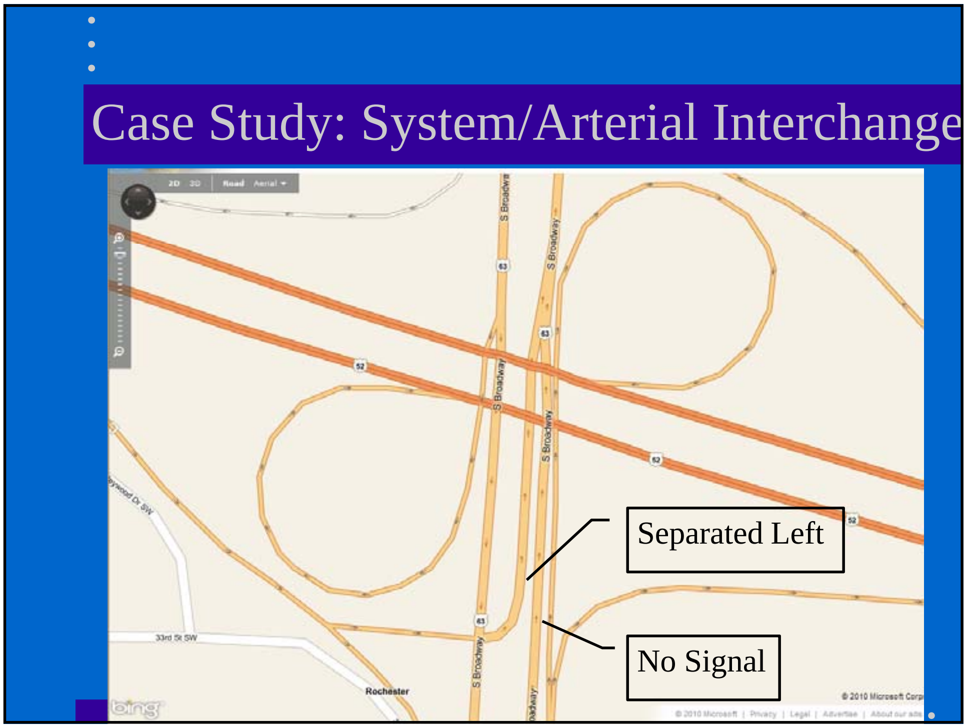
Other Design Considerations: Scale

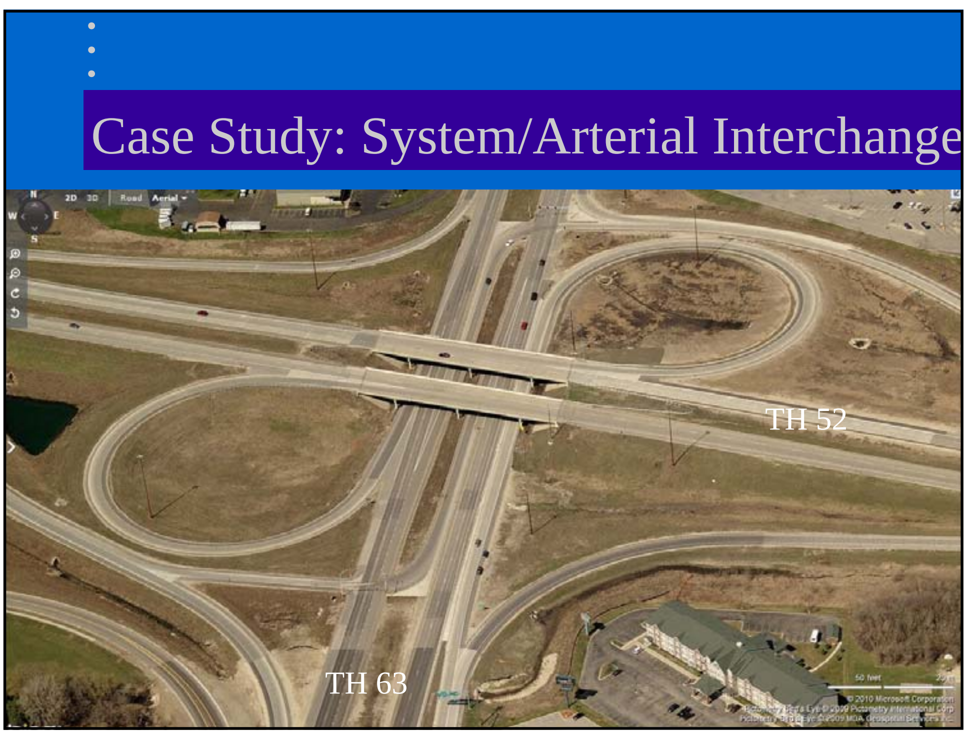




How have been Doing?

- Let’s Look at some Design Case Studies:
  - TH 52/63 in Rochester
  - TH 36 in North St Paul
- And some retro-fits:
  - I-94 in St Paul
  - TH 100 in St Louis Park


Case Study: System/Arterial Interchange
Separated Left
No Signal
S Broadway
33rd St SW
Rochester


Case Study: System/Arterial Interchange
TH 52
TH 63

Case Study: TH 36 in North St Paul

- Project Goal: Improve Safety and Access
- Exemplary cooperation
  - City of North St Paul
  - Ramsey County
  - MN DNR
  - Mn/DOT Metro
- Stakeholder coordinated Construction Staging
  - See "Open for Business" workbook
  - Significant Savings in Construction Costs
    - Used Full Closure and Detour
    - Reduced Construction to one season

Case Study: TH 36 in North St Paul

- Project Scope
  - Depressed TH 36 and created a freeway from an expressway
  - Grade separations
    - McKnight Road
    - Margaret Street
    - Pedestrian Bridge
  - Eliminated at-grade intersections at three other locations
  - Frontage roads

Case Study: TH 36 in North St Paul

- Managed critical views of the community

Case Study: TH 36 in North St Paul

- Architectural treatments developed with Stakeholders to reflect historic railroad details

Case Study: TH 36 in North St Paul

- Good example of "Outside-In"
  - Better connections for the community
  - Community driven staging
  - Effective Business communications
  - Visual Quality Management
    - Views of Community
    - Views of Highway
  - Highway fits under and through constraints

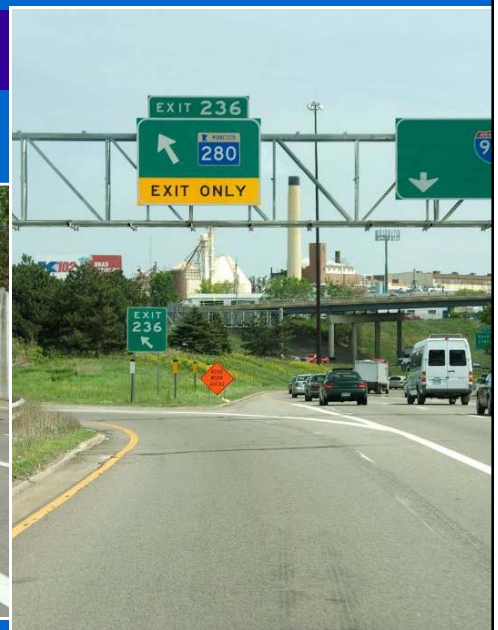
Retrofits

- Need
  - Safety
  - Capacity
  - EMS
- "Best Practices"
  - 2-Lane Exits
  - Diverging Diamonds
  - Auxiliary Lanes
  - Buffer Lanes
  - Separated Lefts
  - Continuous Flow

Or Do Nothing?

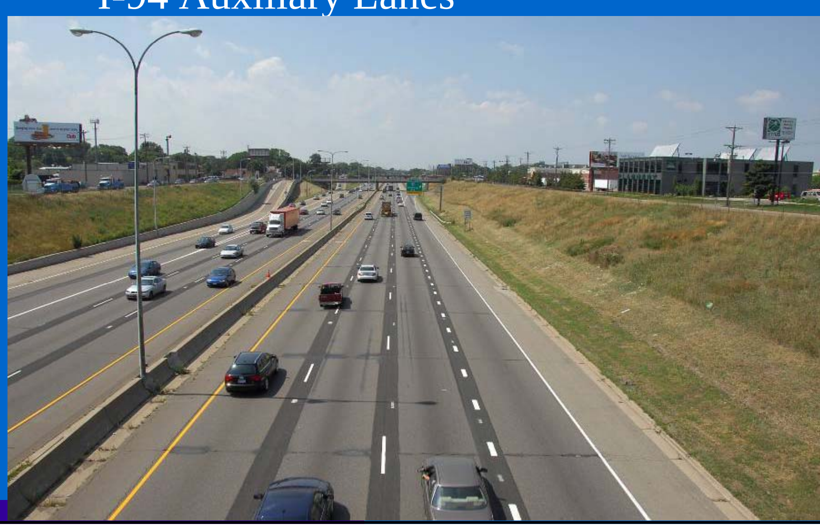
Retrofits

- I-94 Auxiliary Lanes



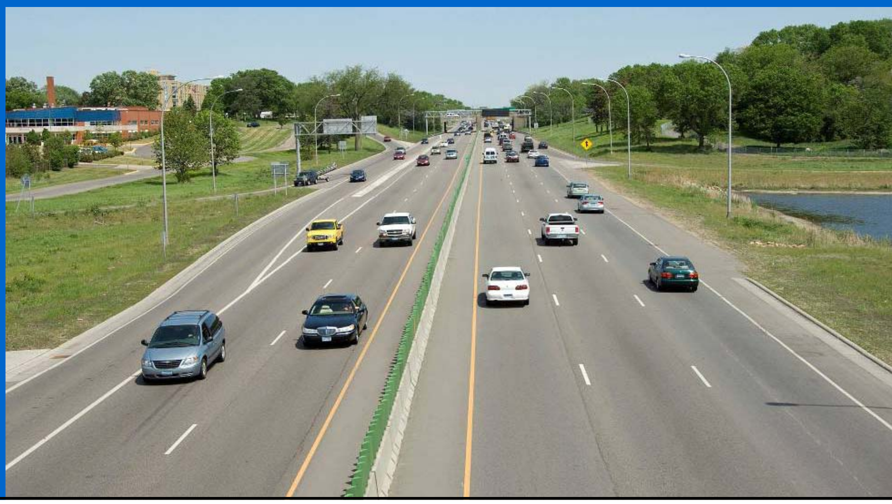
Retrofits

- I-94 Auxiliary Lanes



Retrofits

- TH 100 3rd Lane NB and C-D on SB



When you design "Outside-In"

- Balance point shifts from freeway to local
  - Bottleneck is majority of problem
  - Let local needs drive "outside" issues
  - Consider land-use
- More potential to address local issues which may create the problem on the highway system
  - Real problems solved for the locals
  - A "Win-Win" potential

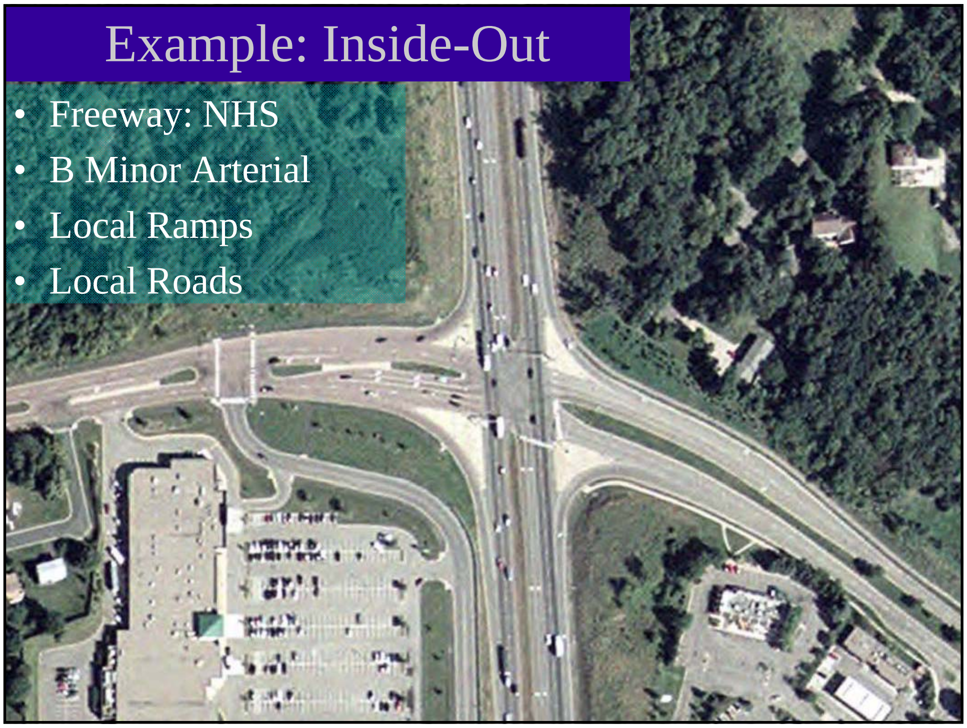
"Outside-In" Freeway Design

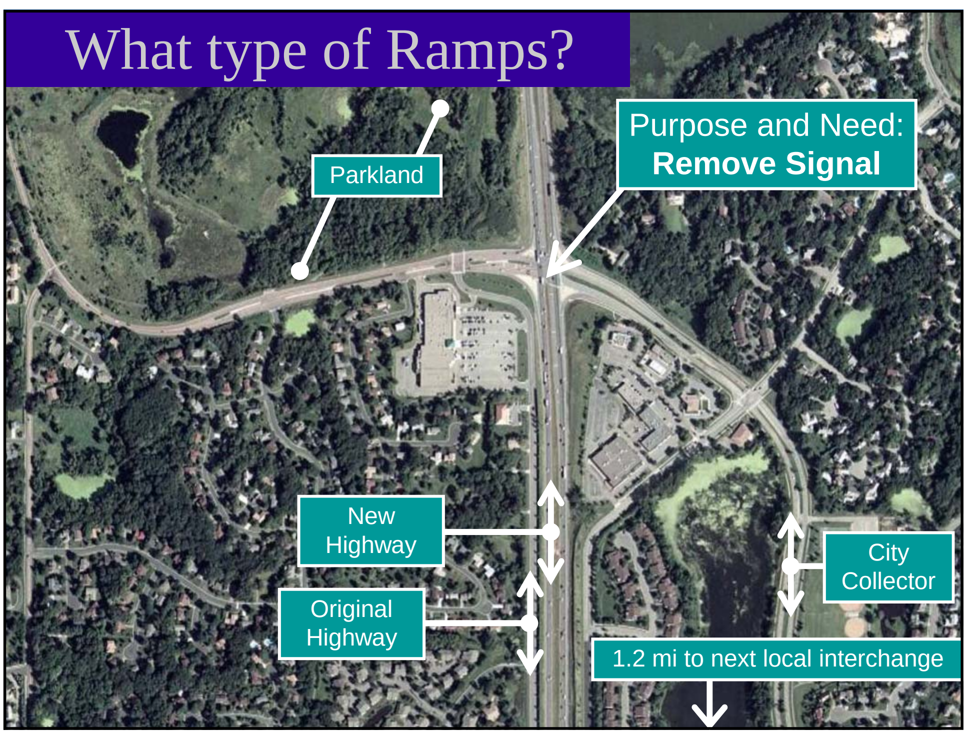
- Determine WHAT freeway "fix"
- Determine WHAT local needs
  - Land use
  - Local connections
  - Local circulation
- Determine HOW to build
- Design Local Roads to match local constraints
- Fit mainline and ramps into the "middle"

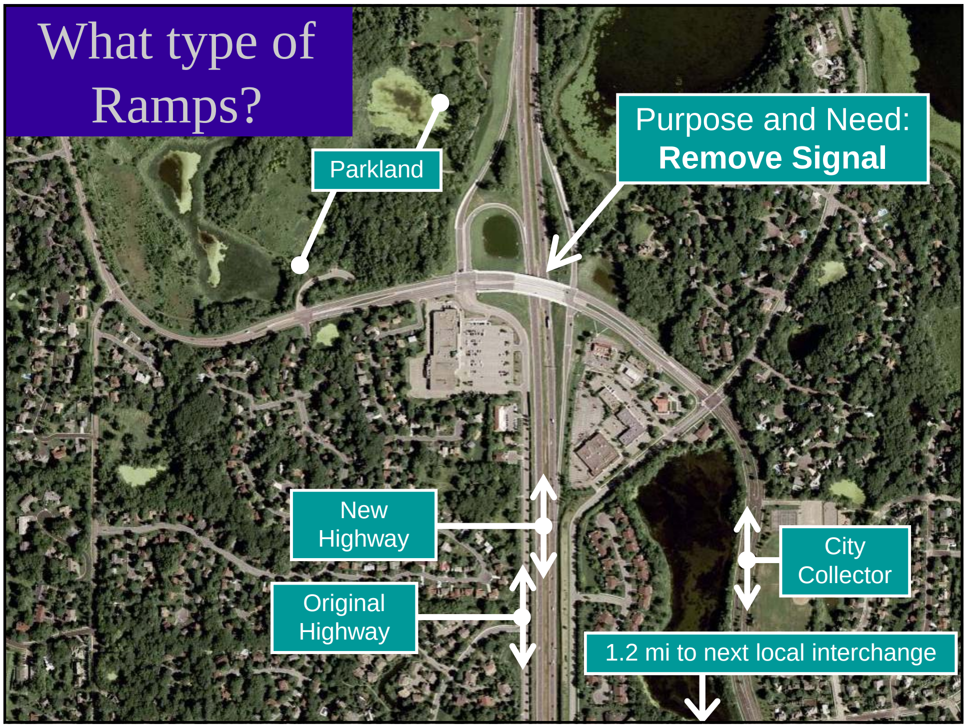
Let's take a closer look at… Table 3-3.02A

DEGREE OF CURVE (D)	RADIUS OF CURVE (R)	V=40 mph		V=45 mph		V=50 mph		V=55 mph		V=60 mph		V=65 mph		V=70 mph		V=75 mph	
		e	L	e	L	e	L	e	L	e	L	e	L	e	L	e	L
0°15'	22918	NC	0	NC	0	NC	0	NC	0	NC	0	NC	0	NC	0	NC	0
0°30'	11459	NC	0	NC	0	NC	0	NC	0	NC	0	RC	96.0	RC	96.0	RC	96.0
0°45'	7639	NC	0	NC	0	RC	96.0	RC	96.0	0.021	100.8	0.023	110.4	0.026	124.8	0.029	139.2
1°00'	5730	NC	0	RC	96.0	RC	96.0	0.023	110.4	0.027	129.6	0.030	144.0	0.033	158.4	0.037	177.6
1°15'	4584	RC	96.0	RC	96.0	0.024	115.2	0.028	134.4	0.032	153.6	0.036	172.8	0.040	192.0	0.044	211.2
1°30'	3820	RC	96.0	0.024	115.2	0.028	134.4	0.032	153.6	0.037	177.6	0.041	196.8	0.046	220.8	0.051	244.8
1°45'	3274	0.023	110.4	0.027	129.6	0.031	148.8	0.036	172.8	0.041	196.8	0.046	220.8	0.051	244.8	0.056	268.8
2°00'	2865	0.025	120.0	0.030	144.0	0.035	168.0	0.040	192.0	0.045	216.0	0.049	235.2	0.055	264.0	0.059	283.2
2°15'	2546	0.028	134.4	0.033	158.4	0.038	182.4	0.043	206.4	0.048	230.4	0.053	254.4	0.057	273.6	0.060	288.0
2°30'	2292	0.030	144.0	0.035	168.0	0.040	192.0	0.045	216.0	0.051	244.8	0.055	264.0	0.059	283.2	D_{max}=2°15'	

- Where is the Flexibility?


Example: Inside-Out
• Freeway: NHS
• B Minor Arterial
• Local Ramps
• Local Roads


What type of Ramps?
Parkland
Purpose and Need:
Remove Signal
New Highway
Original Highway
City Collector
1.2 mi to next local interchange


What type of Ramps?
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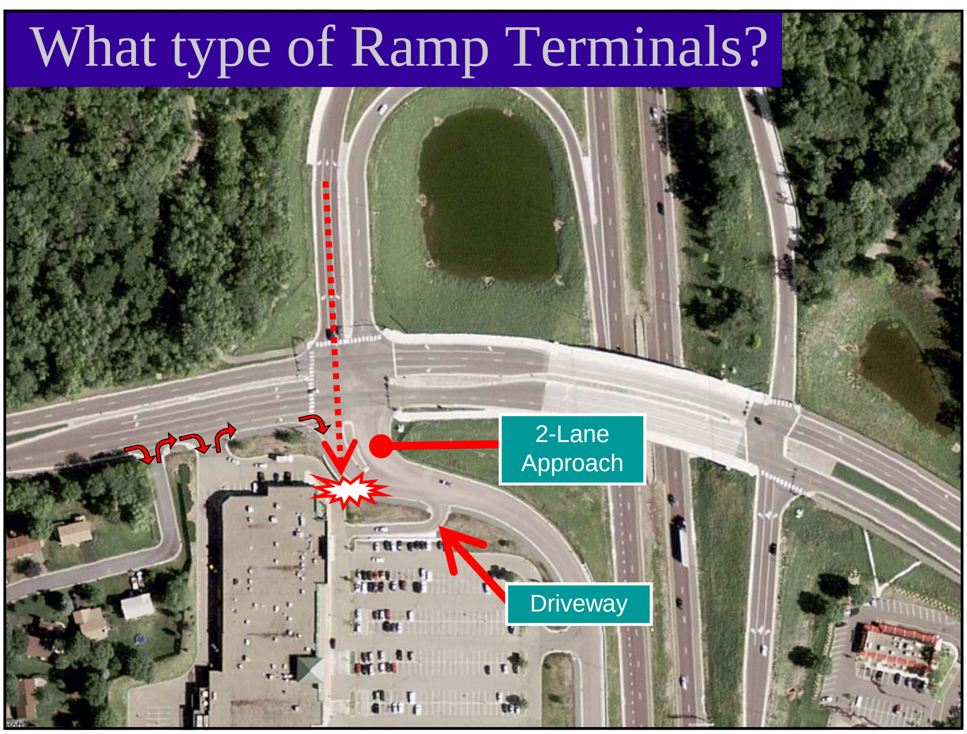
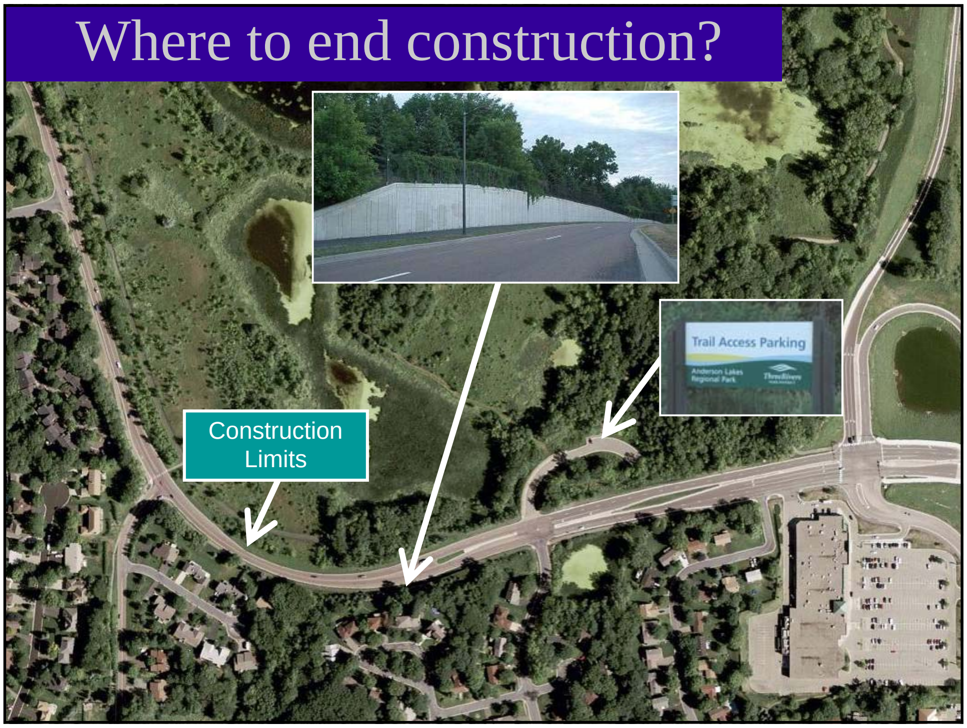
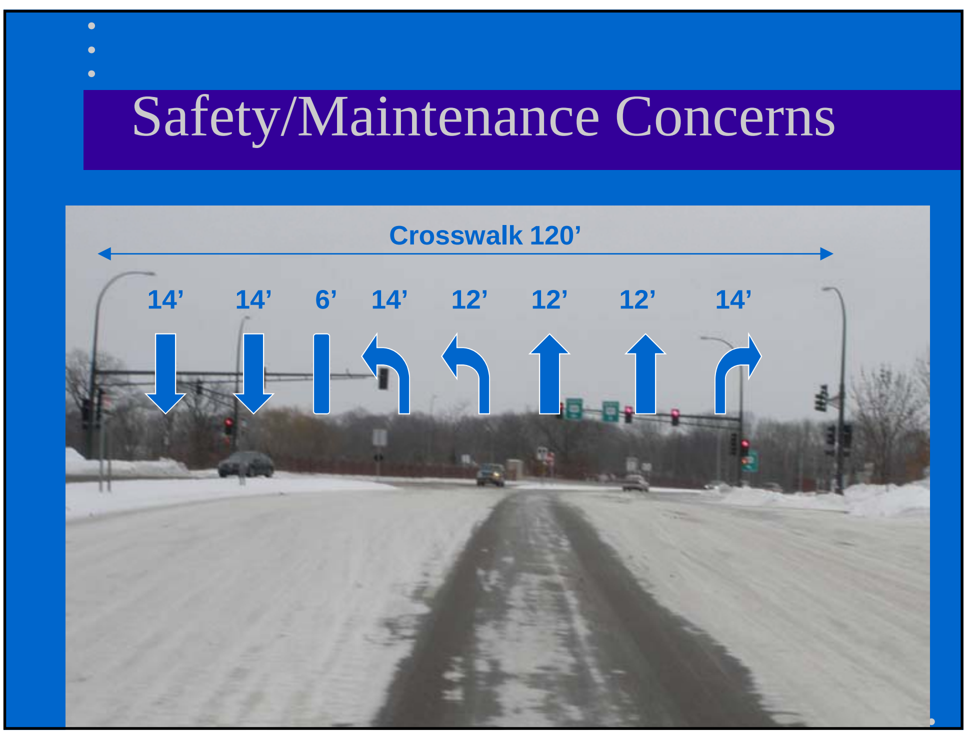

What type of Ramp Terminals?
2-Lane Approach
Driveway


Where to end construction?
Construction Limits
Trail Access Parking


Safety/Maintenance Concerns
Crosswalk 120’
14’ 14’ 6’ 14’ 12’ 12’ 12’ 14’

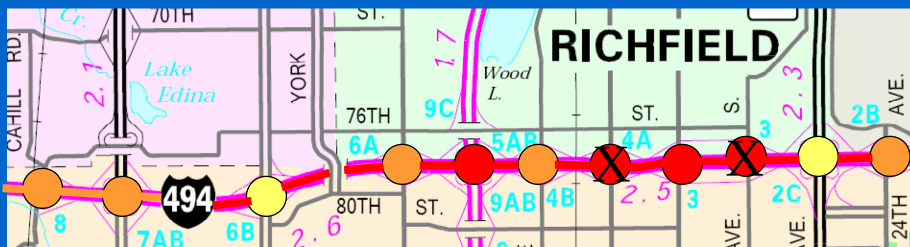
Balanced?

- Were the local impacts justified?
- Would a different ramp/frontage solution work “acceptably”?
- Where could we have applied flexibility?

So we have the Old Layout…

- Can we afford to build it?
- Does it have local support?
- Does it have any major opponents?
- Is it solving a REAL problem?
- If we make a major change, are we Backing up?
- How long will it take if we back up?

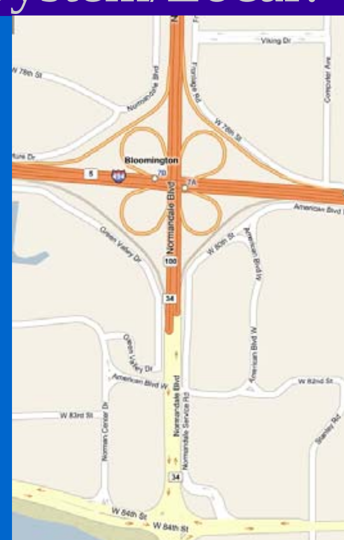
Example: I-494 Corridor

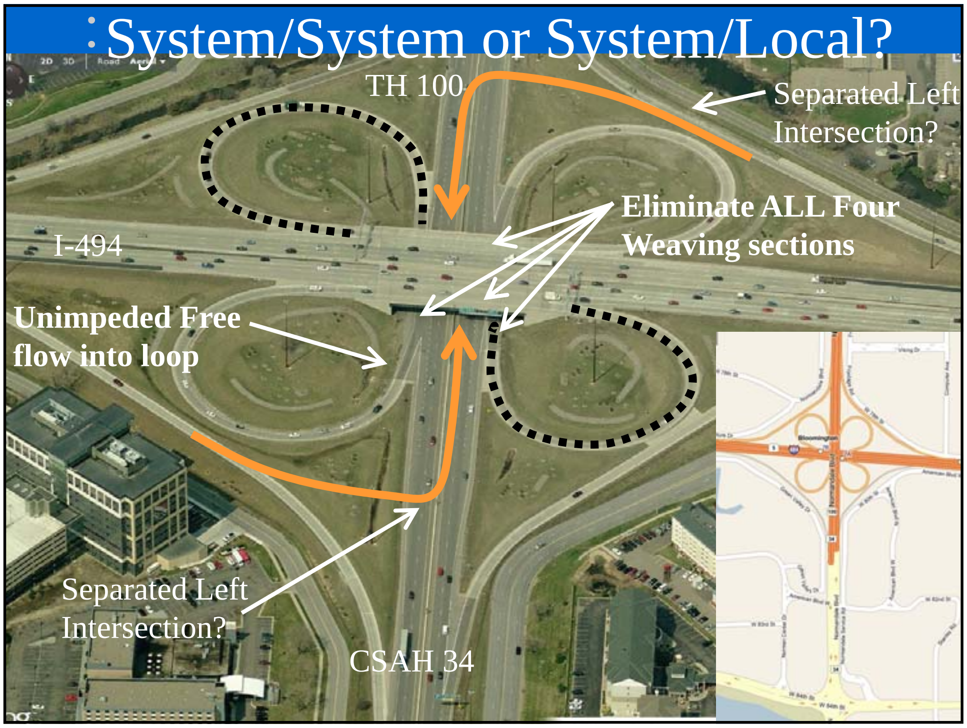


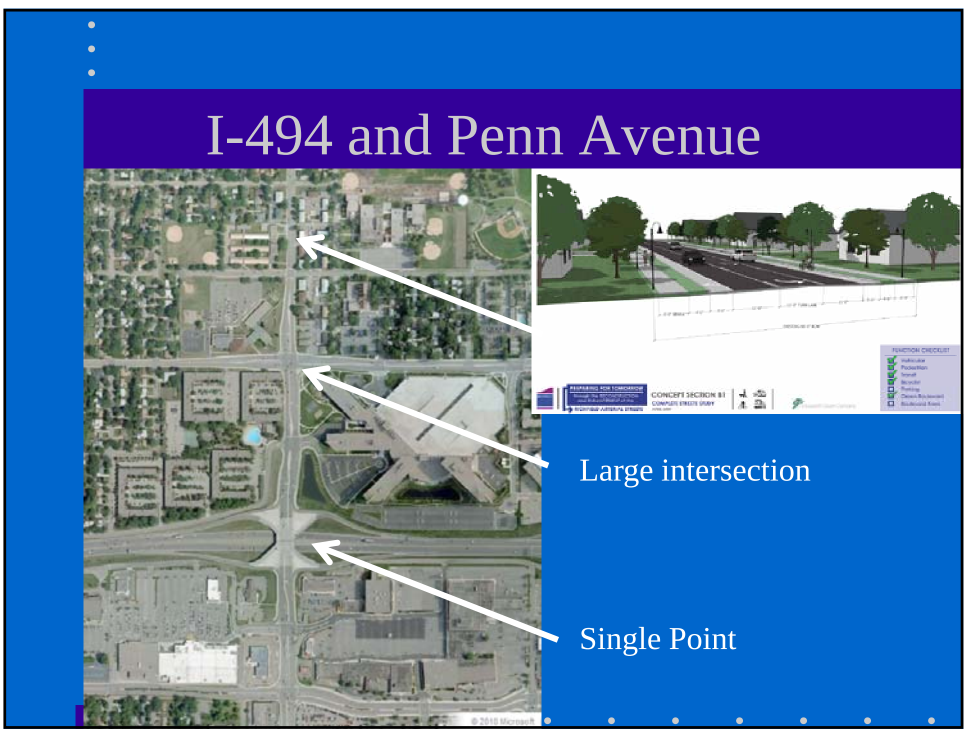
- Less than 10 years
- More than 10 years
- Original Design

System/System or System/Local?

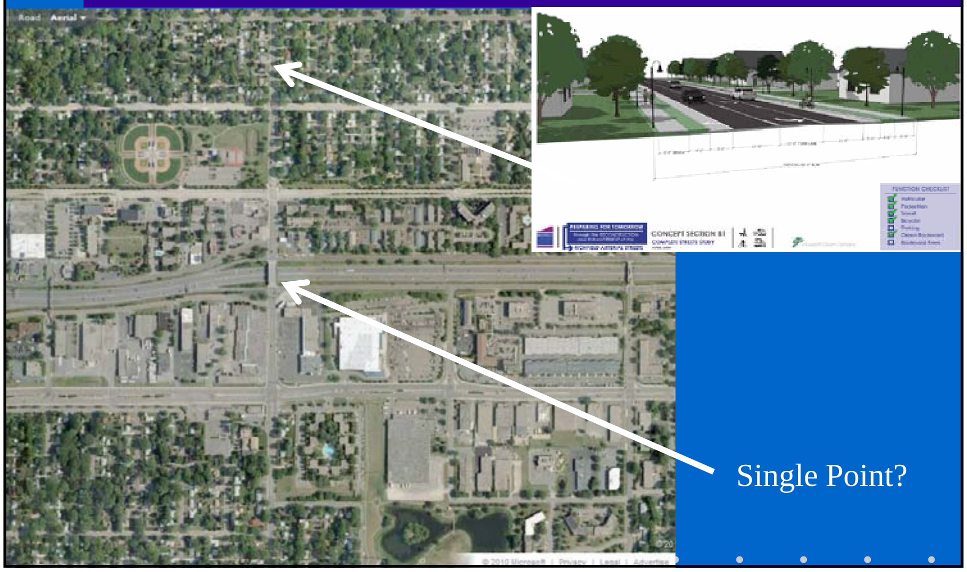
- I-494 at TH 100
- Or I-494 at CSAH 34?




System/System or System/Local?
TH 100
Separated Left Intersection?
Eliminate ALL Four Weaving sections
I-494
Unimpeded Free flow into loop
Separated Left Intersection?
CSAH 34


I-494 and Penn Avenue
Large intersection
Single Point

I-494 and Portland Ave



Outside-In Considerations

- Airport Noise impacted areas
- 77th Street underpass at TH 77
- Metro Transit bus facility
- Old Cedar Avenue Bike Route
- Three Rivers Regional Trail
- Local Landuse plans

Metro Highway System Investment Study

General Update
March 2010

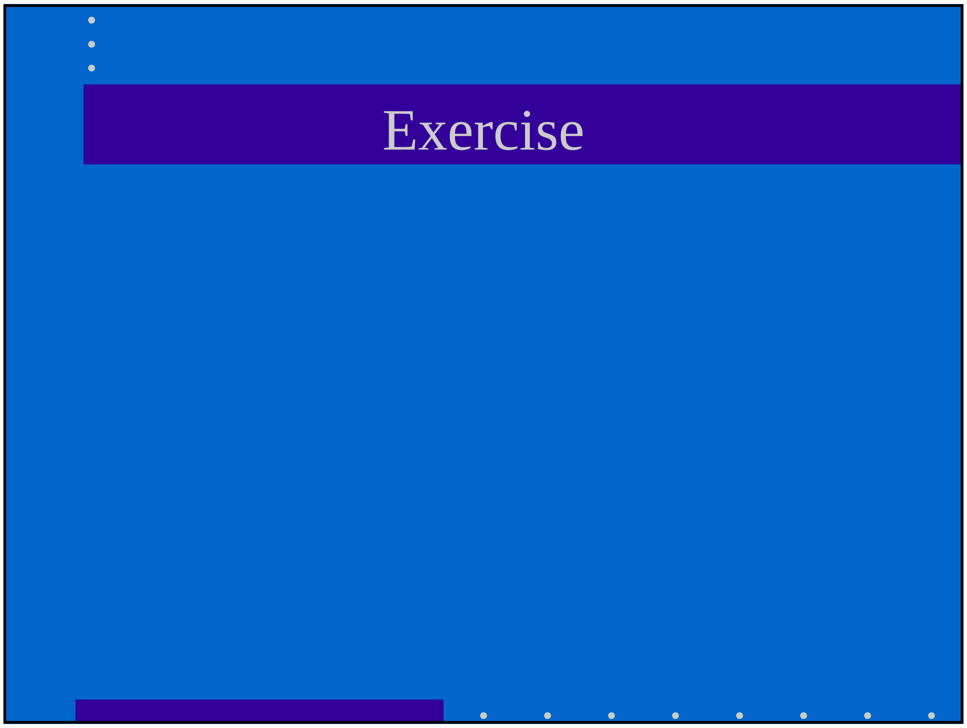
Metropolitan Council

A joint effort of the Metropolitan Council and Minnesota Department of Transportation

Region's congestion needs 21st century solution

- System-wide management
- Technology-based applications
- Multi-modal approach
- Strategic capacity expansions
- Fiscally-constrained approach

Metro Highway System Investment Study


Exercise