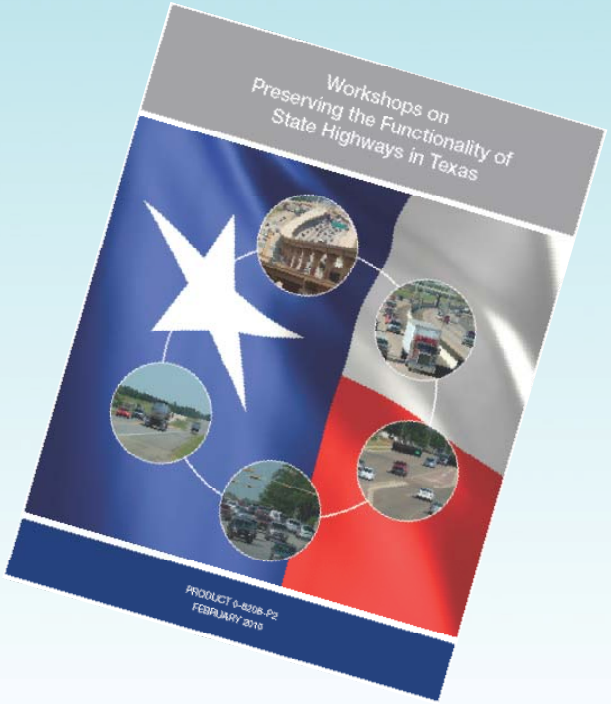
Preserving and Enhancing the Functionality of Highways in Texas

Workshop

_____ District Office

(date) _____



TxDOT Research Project 0-6208-P2

Texas Transportation Institute

Welcome and Introductions

- Instructors

Ed Hard

Brian Bochner

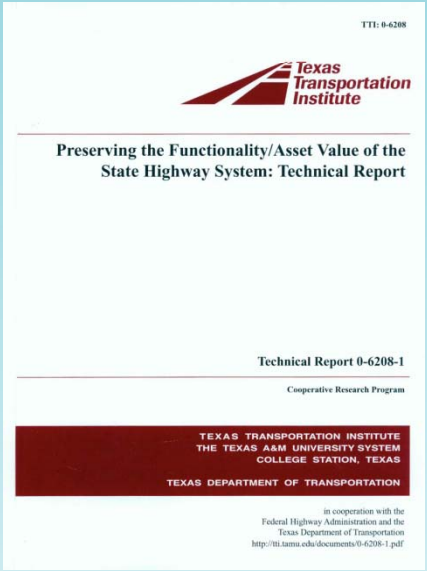
- Participants
  - What is your name?
  - Who are you with?
  - What you do?

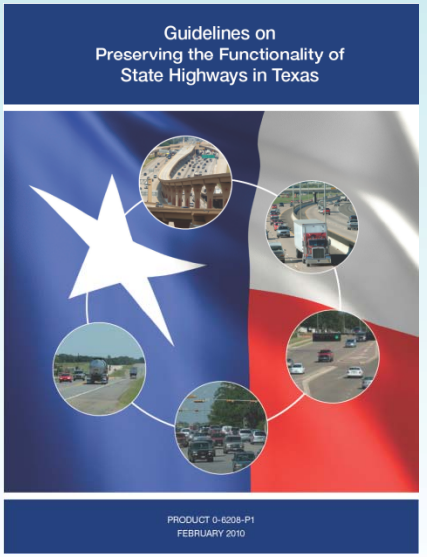
Before We Get Started….

- Basis for Workshop
- Objectives
- What is Functionality?

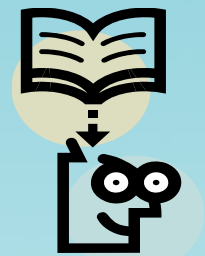
Basis for Workshop

- 2009 RMC Project 0-6208
  - Report 0-6208-1, Preserving the Functionality/Asset Value of the State Highway System
  - 0-6208-P1, Guidelines on Preserving the Functionality of State Highways in Texas
  - 0-6208-S, Summary Report
- Workshop is a Research Implementation project





What the 0-6208 Research Covered



- Losses to highway functionality over time
  - Sources/causes of deterioration
  - Performance measures
  - Counter measures to address
- Reviewed practices and policies in five areas
- Benefits and consequences
- Case studies, lessons learned

Workshop Objectives

- To promote the importance of Highway Functionality
- To review functionality in highway lifecycle
- To provide ‘how to’ materials to preserve, maintain, and enhance functionality
- To promote coordination between TxDOT and its local partners
- To get your input and feedback

What is Functionality?

Definition: Facility effectiveness at providing mobility and accessibility in a safe and efficient manner

Attributes:

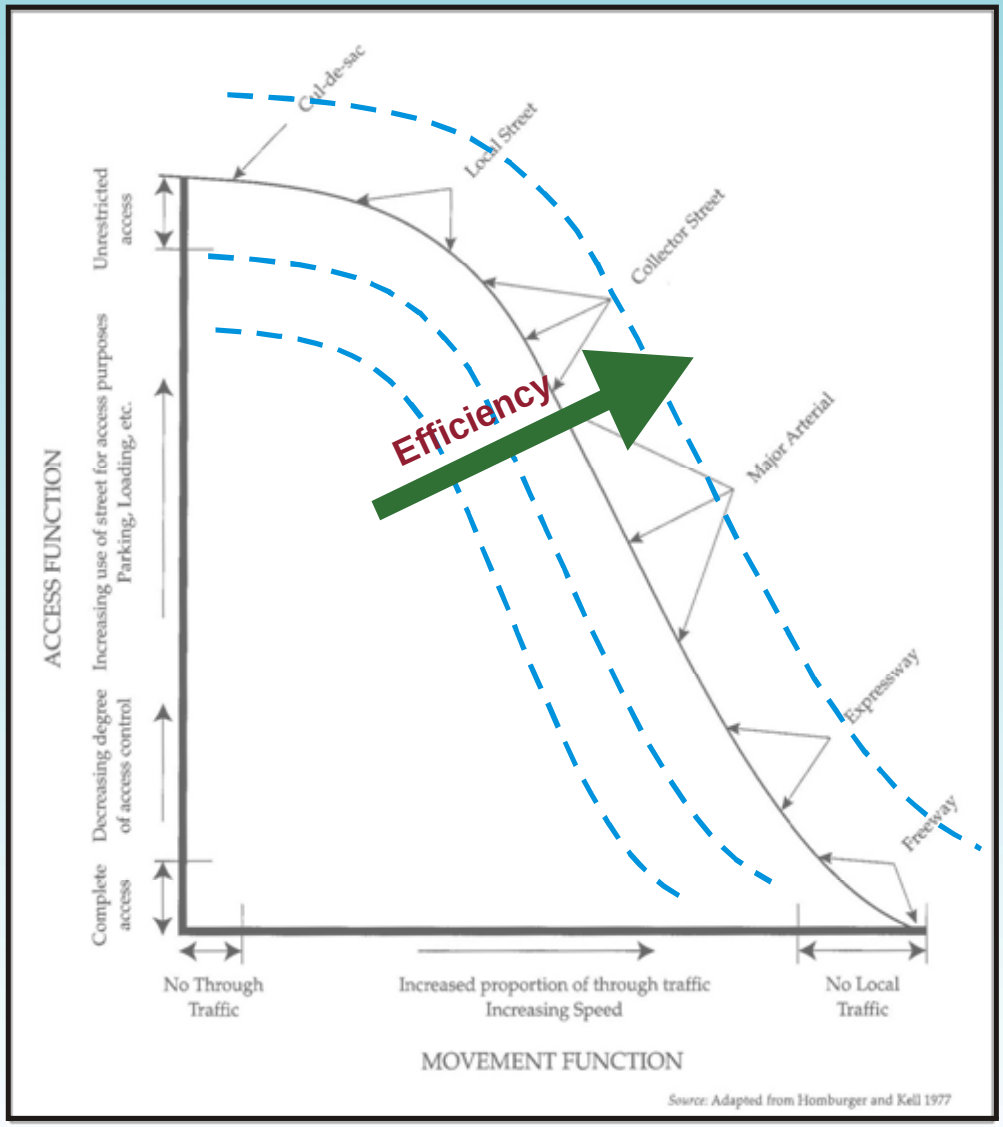
- Core concept of a transportation system/plan
- Provides network organization through classification
- Establishes priority of mobility vs. access

✓ Establishes differing roles for streets/highways

✓ Determines how well/poorly highways perform

Key Aspects of Functionality

- System balance
- Transitioning
- Integration
- Criteria

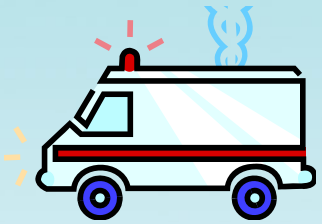


Five Areas Affecting Functionality

Planning and Land Development	Operations and Capacity	Right of Way	Infrastructure and Maintenance	Safety
• TxDOT • TxDOT/local coordination • MPO/regional • City/comprehensive • Development review • County transportation • AM, CM, CP	• Signal coordination and optimization • Facility design • Rehabilitations and Retrofits • Minor enhancements • Traffic control, management • TSM, TDM, and ITS • Network enhancements	• Preservation/ protection • Acquisition • Protection • Utility location and maintenance • Coordination with stakeholders	• Maintenance Practice • Work zone traffic management • Contracting strategies • Life cycle cost decision making • Sustainable materials, equipment, designs • Low maintenance infrastructure components	• Road safety audits • Operational assessments • Crash assessments • Sight distance • Sign assessments and maintenance • Lighting • Traffic Control

Role and Importance of Functionality

- Systemic concept
- Maintain capacity, efficiency, safety
  - Reduce potential for congestion
  - Reduce pollution, maintenance
- Protect value of public investment
- Reduce need for further/unplanned improvements



Agenda Overview

Turn to the First Page of Your Workbook

Preserving and Enhancing the Functionality of Highways in Texas

August 24, 2010
8:30 a.m. – 4:00 p.m.
Waco District Office
100 S. Loop Drive, Waco, Texas

Module	TOPICS
Opening 8:30- 8:45	Welcome and Introductions • Basis for Workshop • Functionality Definition and Components
1 8:45-10:00	Functionality in Planning and Land Development • MPO and Statewide • TxDOT Planning and Design Practices • District Involvement in Local Planning • SH 105 Case Study
Break 10:00 – 10:15	
2a 10:15-11:30	Operational Functionality • Operational Practices • Operations Performance Measures • Causes of Operational Deterioration • Countermeasures
LUNCH 11:30 – 1:00 (on your own)	
2a 1:00-2:15	• Operational Functionality Program • Countermeasure Examples • Exercise
Break 2:15-2:30	
3 2:30–3:15	Functionality Considerations in Right of Way and Utilities • Right-of-Way Acquisition • Right-of-Way Protection • Utility Accommodations • IH-10 Katy Freeway Case Study
4 3:15-3:45	Safety and Functionality • Safety Performance Measures • Causes of Safety Deterioration • Countermeasures for Safety • Road Safety Audits
Closing 3:45-4:00	Participant Feedback

Texas Transportation Institute

MODULE 1

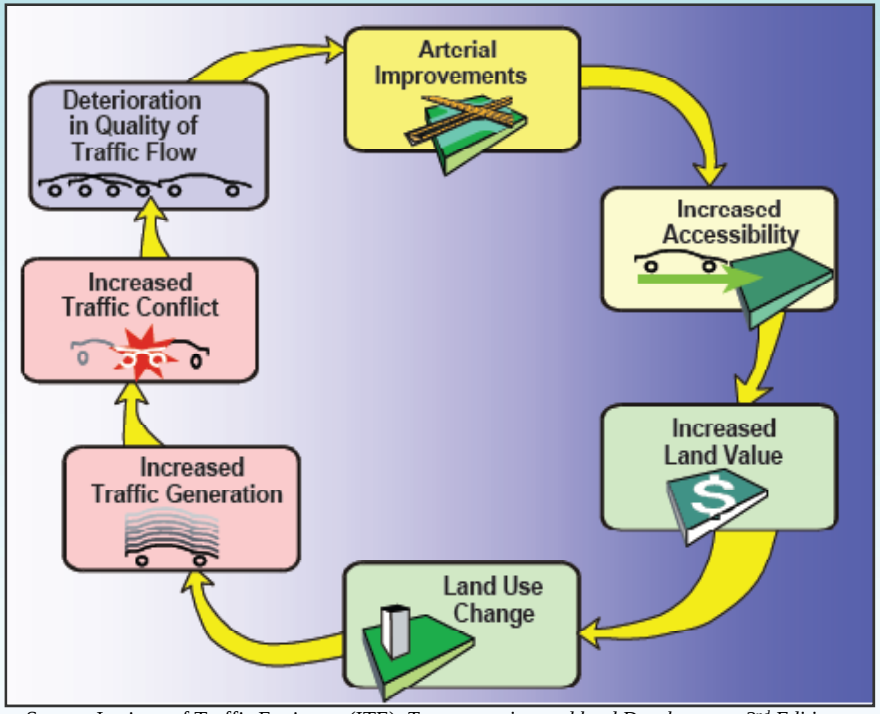
Functionality in Planning and Land Development

What Makes a Highway Function Well?

- Continuity/connectivity
- Capacity
- Operations/efficiency
- Context
- Support system

Planning Functionality Cycle

- Functionality is not a constant
- Changes over time
- Decline in Level of Service
- Improvements Needed
- Akin to Transportation Land Use Cycle



Source: Institute of Traffic Engineers (ITE), *Transportation and land Development, 2nd Edition*

Functionality in Planning and Land Development

Policies, practices, and actions that help preserve or enhance functionality

- MPO and statewide
  - Statewide Transportation Plan
  - MTPs and UPWPs
  - Congestion Management Programs
- TxDOT planning/design practices

Statewide Transportation Planning

- Develop STP and TPs by TxDOT district
  - Map with functional categories
  - Existing and planned facilities
  - Goals, policies, and criteria to support
- Coordinate functionality on district plans with STP
- Statewide Analysis Model (SAM)

MPO MTPs and UPWPs

- Coordinate functionality of MTPs and local T-fare plans
- Include goals, policies, and initiatives on:
  - Adherence to functional criteria in plan document
  - TSM, TDM, and ITS programs, initiatives
- Use UPWP as mechanism to address functionality
- TIPs: include functionality enhancement as factor in project selection

Other MPO Roles/Practices

- Monitor system effectiveness
- Assist in finding/distributing federal funds (e.g., CMAQ, safety, PL 112)
- Facilitate interagency coordination
- Travel demand modeling
- Education and outreach

Functionality in the Statewide and MPO Planning Process

Plan or Program	Agency	Examples of Means to Address Functionality
UPWP	**MPO**	- Studies on system functionality, CM/CP, and AM - Special studies to ID and prioritize corridors needing functional enhancement or preservation - Education/outreach to policy boards, public, and stakeholders on importance and benefits
STP and MTP	**MPO**	- Development of the plans illustrating existing and future thoroughfares by functional category - Include goals and policies related to adherence to functional criteria, AM, CM/CP, and other initiatives that enhance or preserve functionality
STIP and TIP	**MPO**	- Include benefits to functionality enhancement or preservation as a factor in project selection

Congestion Management Process (CMP) in Planning

- Required of MPOs in TMAs (>200,000 pop)
- Addresses functionality by:
  - Identifying system-wide locations of congestion
  - Determining the causes of congestion
  - Developing, implementing, and evaluating different congestion mitigation strategies
- Includes travel demand reduction and operational management strategies
- CMAQ funds used for studies, implementation projects

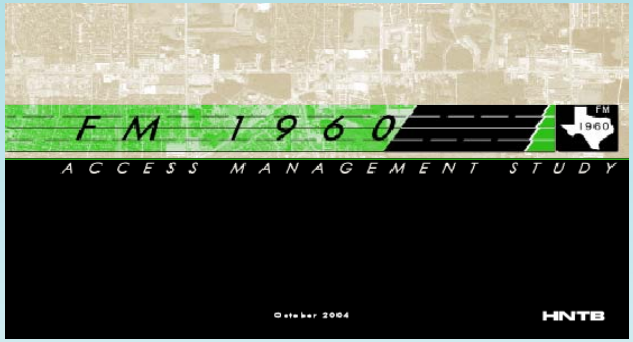
Houston/HGAC Examples

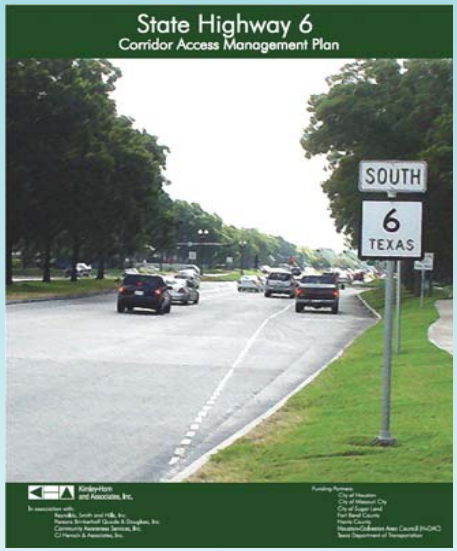
Programs/Initiatives to Enhance Functionality

- Corridor AM studies with follow-up Implementation projects
- Subregional planning initiative
- Safety program

Houston/HGAC Examples

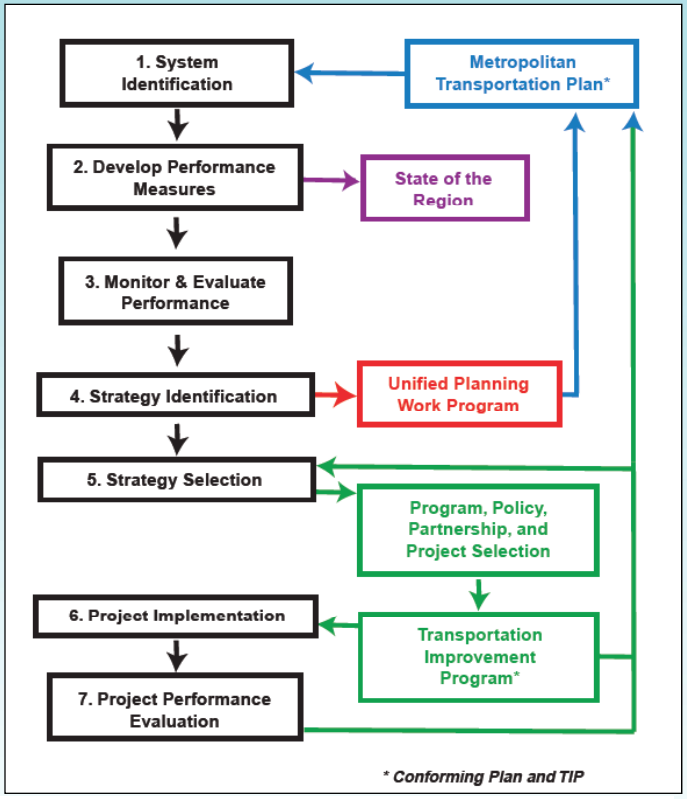
Programs that Enhance Functionality





http://www.h-gac.com/taq/plans_programs/mobility/default.aspx

NCTCOG Congestion Management



Source: NCTCOG. Regional Mobility Initiatives, Vol. XII, No.1. April 2008

NCTCOG North Central Texas Council of Governments

- Integrated into Planning, Programming Process
- 7 Components
- Shows Roles of MTP, UPWP, TIP

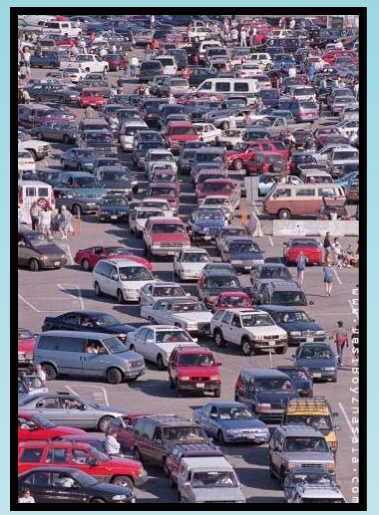
Sample Congestion Management Strategies

Transportation Systems Management (TSM)	Travel Demand Management (TDM)	Intelligent Transportation Systems (ITS)
Signal retiming, upgrades, interconnections, demand-response	Car/van pooling, transit, alternative work schedules, park and ride	Public transportation tracking, fare management/policies
Intersection and street improvements	Congestion pricing, parking mgmt. telecommuting	Traffic surveillance, incident management, electronic tolling
Bottleneck removal	TOD, land use/density controls, in-fill policies, utility extensions	Commercial vehicle electronic clearance, weigh-in-motion, HAZMAT mgmt.
Access and corridor management	Context sensitive design, car-free planning	Maintenance/construction work zone mgmt.
Special event management	TDM marketing education	Emergency management routing, traveler info

TxDOT Planning Practices Impacting Functionality

- System and facility planning
- Access management
- Monitoring operation, safety, and maintenance
- Facility design
- Involvement in local planning and development review
- Frontage road and bypass practices

Access Management

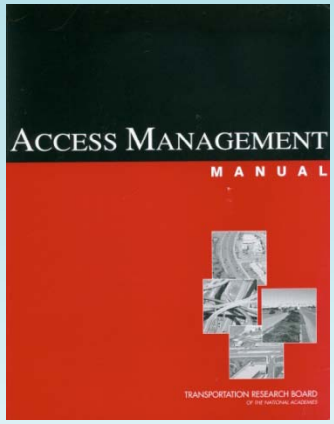


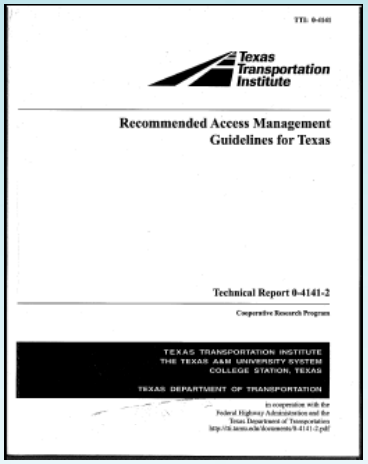
- Apply TxDOT AM Manual on upgrades, rehabs, site plans, plats
- Partner to use local powers
- Provide support, lessons learned to rural areas
- Involve senior local staff in development of TxDOT design schematics
- Other AM actions through ROW, project development, facility design

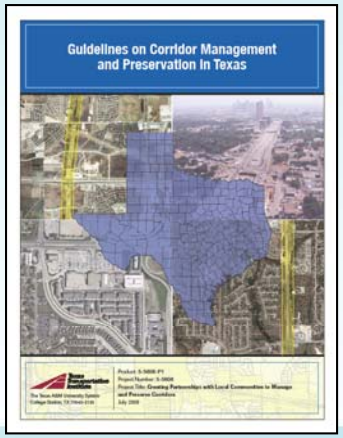
Access Management

Resources

- Guidelines on Corridor Management and Preservation for Texas, 0-5606-P1, 2008
- Texas Access Management Outreach Materials, TTI Report 5-4221-01-P1, 2008
- Recommended Access Management Guidelines for Texas, TTI Report 0-4142-2, 2006
- TxDOT Access Manual, 2003
- Access Management Manual, TRB, 2003
- A Guidebook for Including Access Management in Transportation Planning, NCHRP Report 548
- Guidelines and Recommendations for TxDOT Involvement in Local Development Review, TTI Report 0-4429-P1, 2004



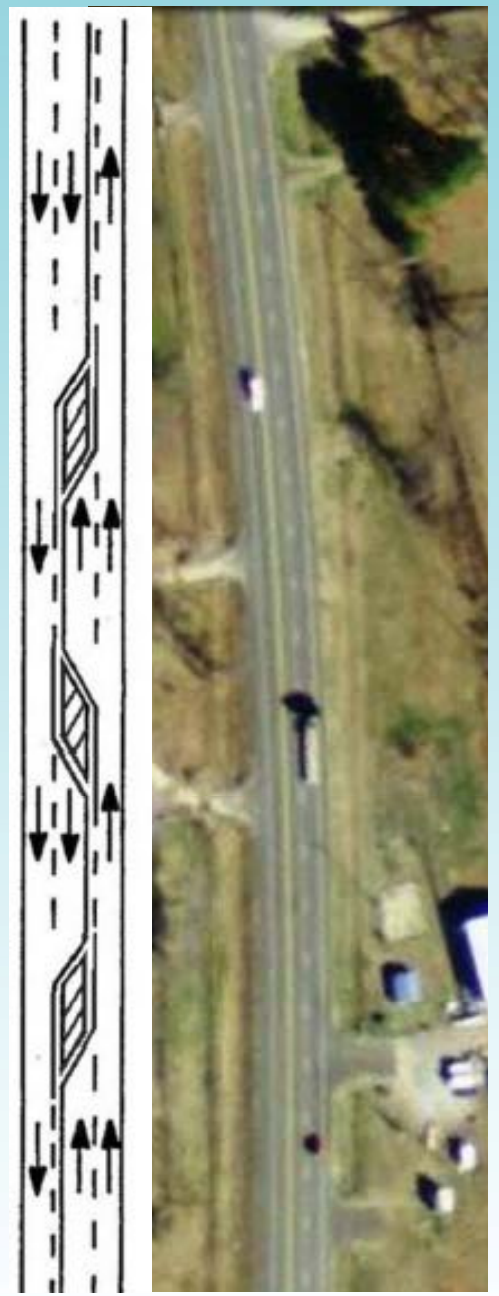




Facility Design

Actions to Enhance Functionality

- Continue 4-lane major links with divided highway sections
- Use minor geometric and operational enhancements.
- Enhance 2-lane highways to ‘Super 2s’
- Increase use of expressway and super arterial designs.
- Uphold intended function of loops and bypasses



SH 19 south of Paris, TX - 2+1 in mile increments

Super 2 Designs

- Modify 2-lane highways to remove turning conflicts and/or adding passing lanes
- Includes all/some of these additions
  - Shoulders
  - Turn-lanes at key intersection
  - Passing lanes
- Low cost or interim option
- RMC 0-4064-S or 1, Design Guidelines for Passing Lanes on Two-Lane Roadways, 2001

Uphold Function of Community Loops and Bypasses

- Plan and design new community loops/bypasses as controlled access facilities
  - If designed as surface arterial, should include NTM with 1-mile signal spacing
- No longer fund or permit upgrades to surface arterial loops that
  - Do not include NTMs or
  - Are not conversions to controlled access

Source: Tyler District, R. Redmond

Establish Statewide Policy on Non-Traversable Medians (NTMs)

- All designs with 3 or more dedicated thru lanes should contain a NTM
- All designs should include NTM when existing/projected ADT is ≥ 25,000
- Design for rehab projects should comply with TxDOT access guidelines
- TTI 0-4221-2 and 0-3904, NCHRP 420, and NCHRP 395

Median Studies

- TTI Report 0-3904 - medians have no direct affect on retail sales. Price, quality, service more important.

TTI Report 0-4421-2

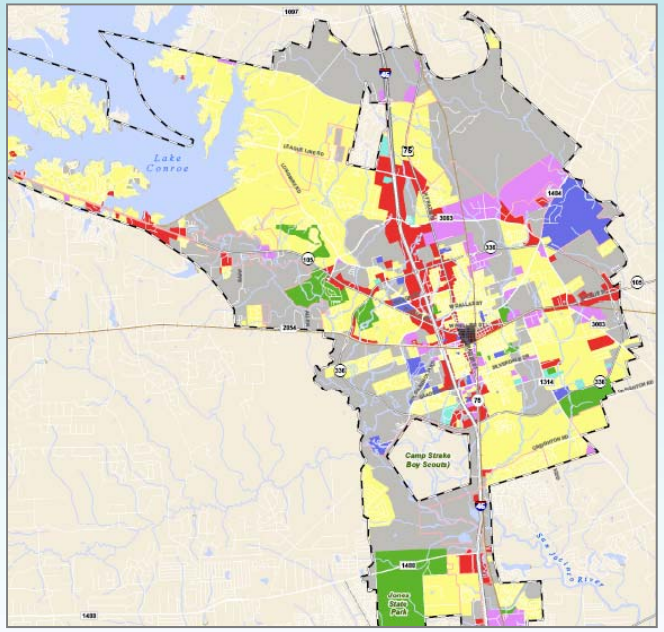
NCHRP 420

Representative Crash Rates (Crashes per Million VMT) by Type of Median – Urban and Suburban Areas			
	Median Type		
Total Access Points per Mile	Undivided	Two-Way Left-Turn Lane	Non Traversable Median
<20	3.8	3.4	2.9
20.01-40	7.3	5.9	5.1
40.01-60	9.4	7.9	6.8
>60	10.6	9.2	8.3
Average Rate	**9.0**	**6.9**	**5.6**

Corridor	ADT	"Before" Median Type	Crash Rate		
			"Before" Condition	Raised Median	Percent Difference
College Station (Texas Avenue)	41,000	TWLTL	4.3	1.8	**-58**
Longview (Loop 281)	23,500	TWLTL	5.2	4.3	**-17**
Tulsa (west) (71st Street)	30,500	Undivided	3.8	2.5	**-34**
Tulsa (west-central) (71st Street)	29,500	Undivided	3.8	1.8	**-53**
Odessa (US 385)	10,600	Undivided	19.6	15.4	**-21**
All Remaining	30,600	Varies	7.0	4.8	**-31**

District Involvement in Local Planning/Development

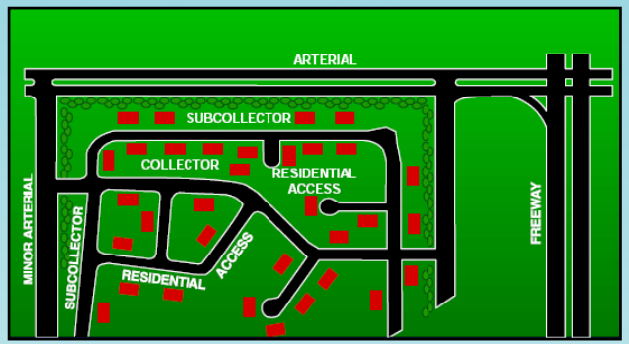
- Comprehensive planning
- Thoroughfare planning
- Development review
- Corridor management



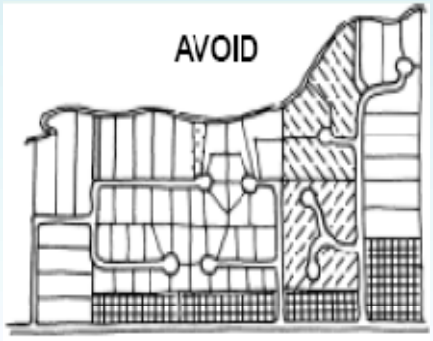
Local Comprehensive Plans (LCPs)

- LCPs impact direction of growth and utilities impacting functionality
- Districts should be involved in LCPs to:
  - Promote policies that protect or enhance functionality
  - Have input on direction of future growth, utility extensions
  - Promote activity-based over strip development along TxDOT corridors
  - Encourage city use of development policies in ETJs

Local Thoroughfare Plans

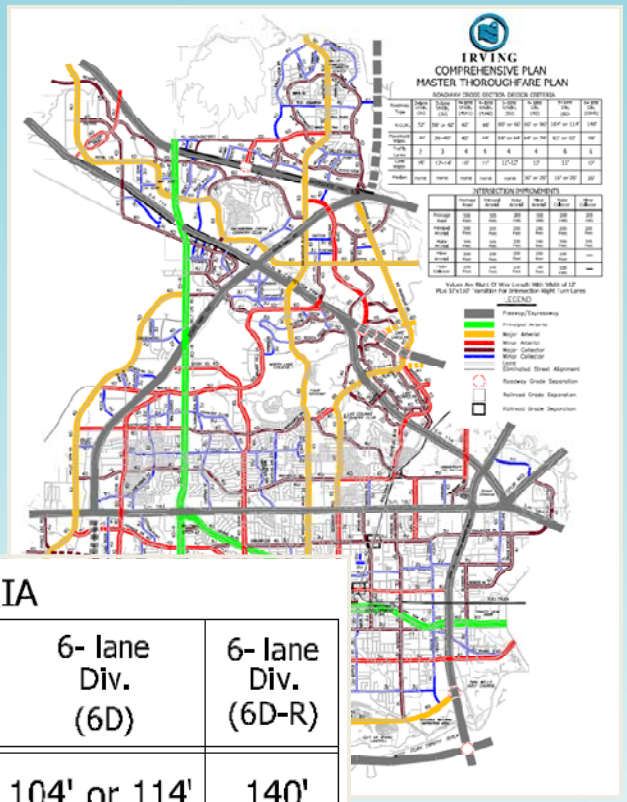


- Review layouts of plans/subdivisions to
  - Limit/avoid minor street connections to state roads
  - Encourage connections between neighborhoods
- Coordinate local T-fare design criteria and ROW standards
- ✓ Get on advisory panels for new plans or plan updates



Source: A Guide to Land Use and Public Transportation, Volume 2 , Snohomish County Transportation Authority

Thoroughfare Spacing and Design Criteria



ROADWAY CROSS-SECTION DESIGN CRITERIA

Roadway Type	2- lane Undiv. (2U)	3- lane Undiv. (3U)	4- lane Undiv. (4U-1)	4- lane Undiv. (4U-2)	5- lane Undiv. (5U)	4- lane Div. (4D)	6- lane Div. (6D)	6- lane Div. (6D-R)
R.O.W.	52'	58' or 62'	62'	66'	80' or 86'	86' or 96'	104' or 114'	140'
Pavement Width	30'	36'-40'	40'	44'	58' or 64'	64' or 74'	82' or 92'	98'
Traffic Lanes	2	3	4	4	4	4	6	6
Lane Width	15'	12'-14'	10'	11'	11'-12'	12'	11'	12'
Median	none	none	none	none	none	16' or 26'	16' or 26'	26'

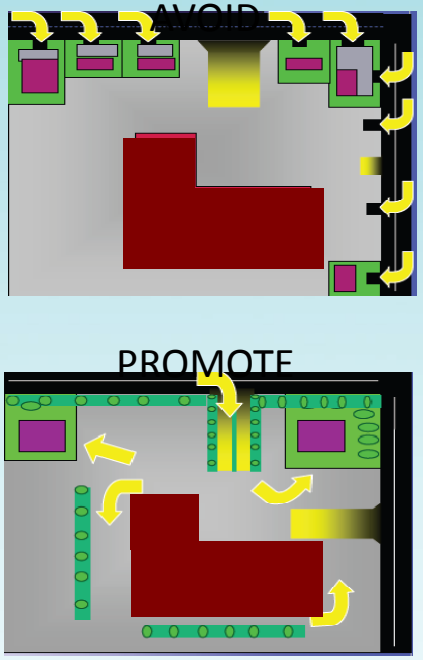
Thoroughfare Spacing and Design Criteria

Characteristic	Arterial	Collector	Local Street
Street Spacing	1 mile	¼ mile	300 ft.
Length	Continuous	½ mile	500 ft.
Lanes	4-6	2	2
Minimum Pavement	64 ft.	36 ft.	32 ft.
Access Spacing	1,300 ft.	300 ft.	60 ft.
Volume	30,000 vehicles per day	5,000 vehicles per day	200 vehicles per day
Striping	Center and lanes	Center	None
Driveway Design	Curb return	Curb return	Dustpan
Parking	Prohibited	Allowed	Encouraged
Median	Yes	No	No
Turn Lane	Yes	No	No
Traffic Signals	Yes	No	No
Residential Access	Prohibited	Indirect	Direct
Maximum Grade	6%	8%	10%
Minimum Radius	1,150 ft.	350 ft.	170 ft.
Pedestrian Crossing	Signalized Intersection	Intersection	Unrestricted
Pedestrians	Few	Many	Frequent
Speed	40 mph	30 mph	20 mph
Building Setback	Considerable	Moderate	Minimum

Source: Marks, H. *Traffic Circulation Planning for Communities*. Gruen Associates, Los Angeles, 1974.

Local Development Review

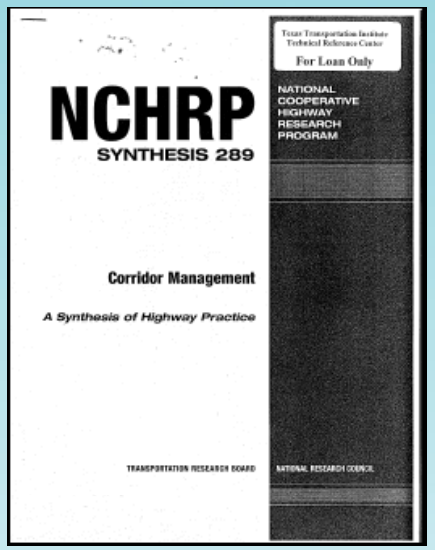
- TxDOT should be involve in the earliest stages
- Routinely review plats and site plans impacting state roads to:
  - Implement access guidelines
  - Prevent narrow lots
  - Encourage on-site connectivity between developments
  - Protect/preserve needed TxDOT ROW

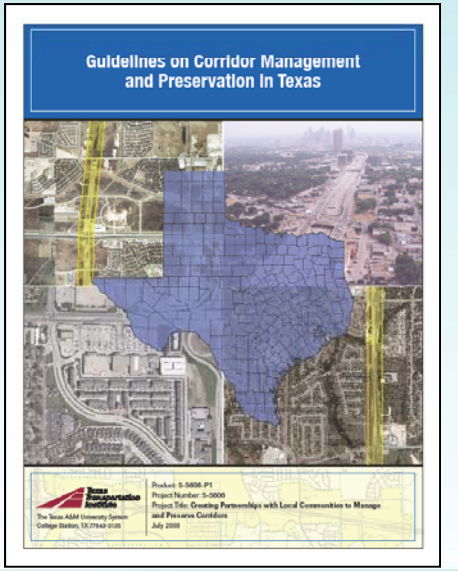


Source: K. Williams, Land Development Regulations That Support Access Management, CUTR, 2002

Corridor Management Plans

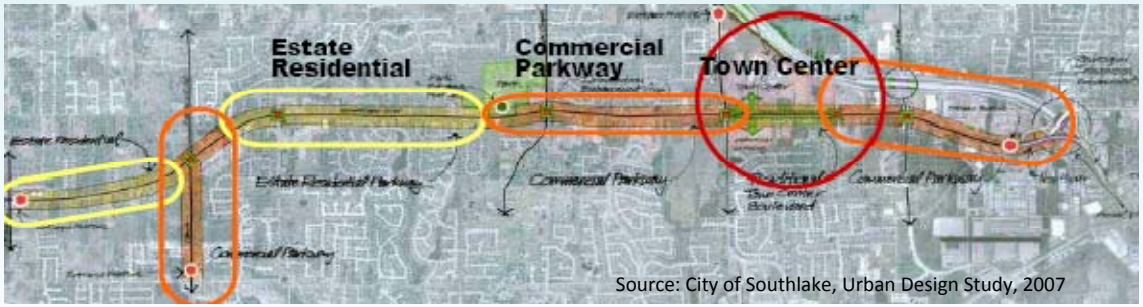
- Long-range comp. Ppan for a corridor
- Coordinates roadway design and function with land use and development
- Combination ‘roadway improvement/land development policy guide’
- Corridor-wide, not piecemeal
- Different types, shapes sizes
- TxDOT project 0-5606





Corridor Management Plans

- Districts should advocate CM plans on TxDOT corridors
- Adopt CM plans with NTMs, signal spacing thresholds, connectivity between developments
- Advocate CM plans in local comp. plans and MPO UPWPs

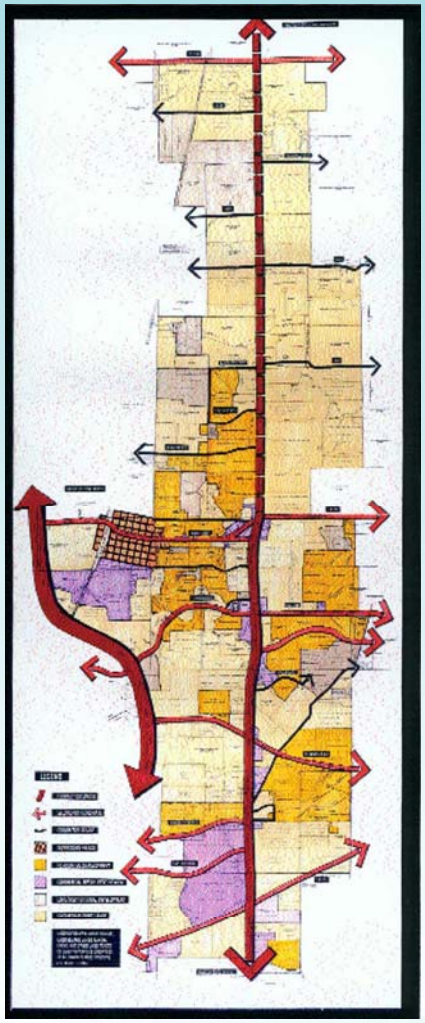


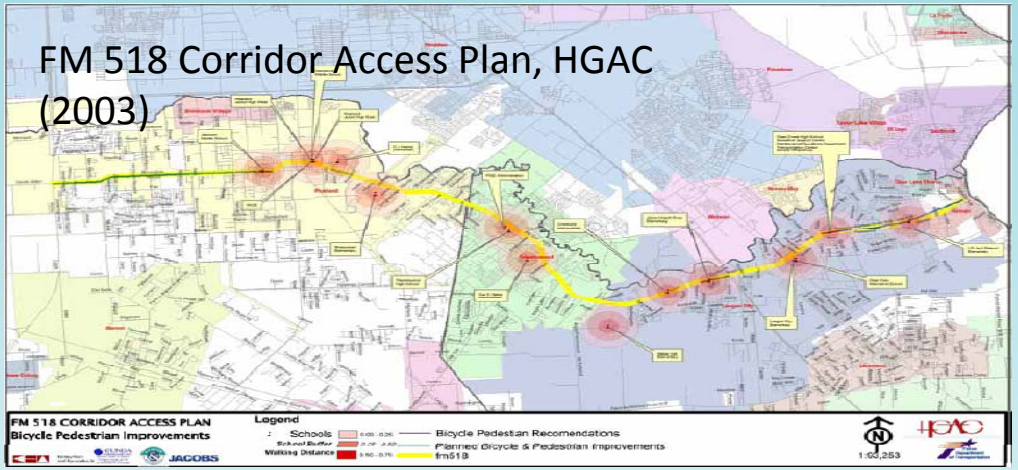
Source: City of Southlake, Urban Design Study, 2007

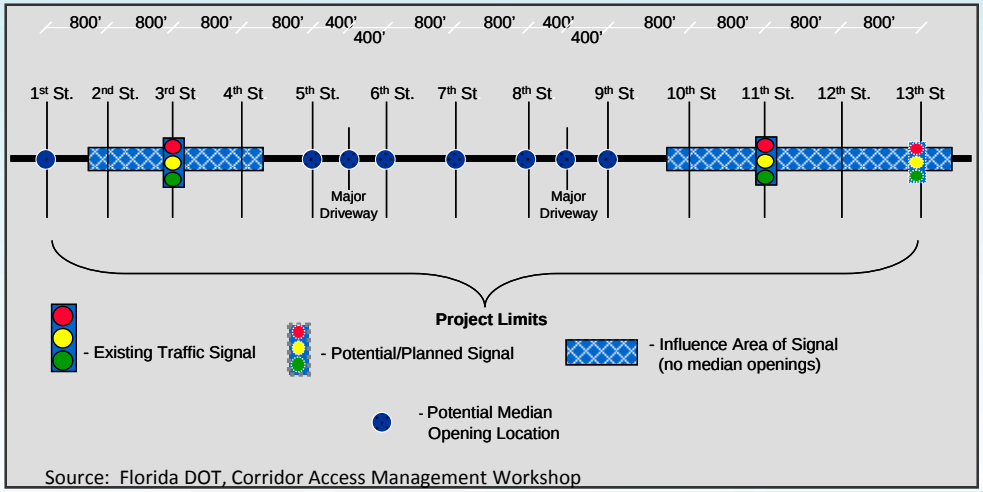
CM Tools

	CM Tool or Technique	City	ETJ	County
Access Management	Driveway Spacing	✓	limited	limited
	Non-Traversable Medians	✓	✓	✓
	Signalized Intersection Spacing	✓	✓	limited
	Arterial Frontage and Backage Roads	✓	limited	
	Acquisition of Access Rights	✓	✓	✓
Zoning and Development Regs	Site Plan review	✓	limited	
	Land Use/Density Controls	✓	limited	v. limited
	Building and Parking Setbacks	✓	v. limited	v. limited
	Corridor Zoning Overlays	✓		
	Driveway Throat Length	✓	limited	
Subdivision Regulations	ROW Dedication Through Platting	✓	✓	v. limited
	ROW Reservations Through Platting	✓	✓	v.limited
	Access Easements	✓	limited	limited
	Minimum Lot Size	✓	limited	limited
	Minimum Lot Width	✓	limited	limited

CM Plan Examples







Sources of Deterioration

Planning/Land Development

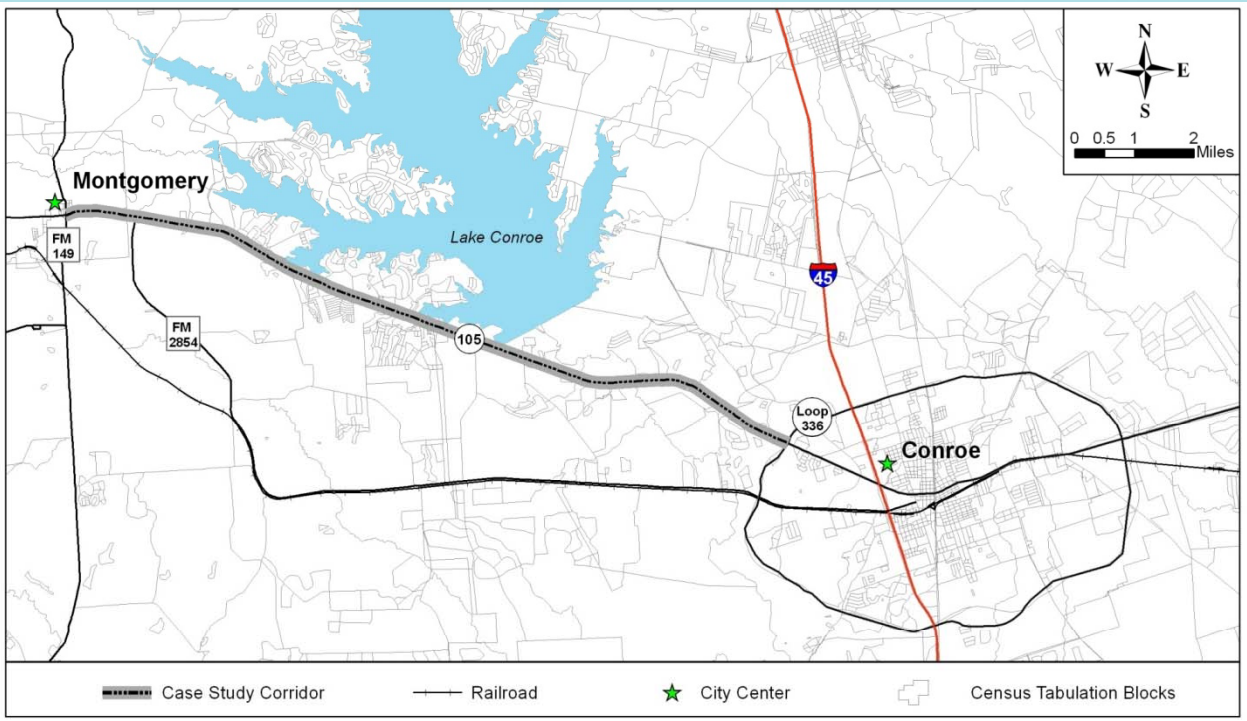
- Challenge in coordinating transportation and land use
- Sprawl, decentralized development patterns
- Rampant closely spaced driveways
- Lack of connectivity between developments, parcels
- Challenges in multi-jurisdictional coordination
- Lack of development reg., transportation plans in counties
- ROW encroachments
- Narrow, haphazard property splits along TxDOT ROW
- Roadway designs conducive to strip development

Countermeasures
Planning/Land Development

- TxDOT involvement EARLY in development process
- Corridor management/preservation
- Continue to practice, promote access management
  - Non-traversable medians ahead of development
  - Limit/disallow minor street connections
  - Internal connections between adjacent parcels
- TxDOT – local coordination in project development
- Early ROW acquisition by all means possible
- Policies, initiatives, and programs in MTPs, UPWPs, and local plans
- Activity center in lieu of strip development
- Require/encourage connections between adjacent local streets and neighborhoods
- Internal and external education, outreach on importance, benefits

Functionality Case Study

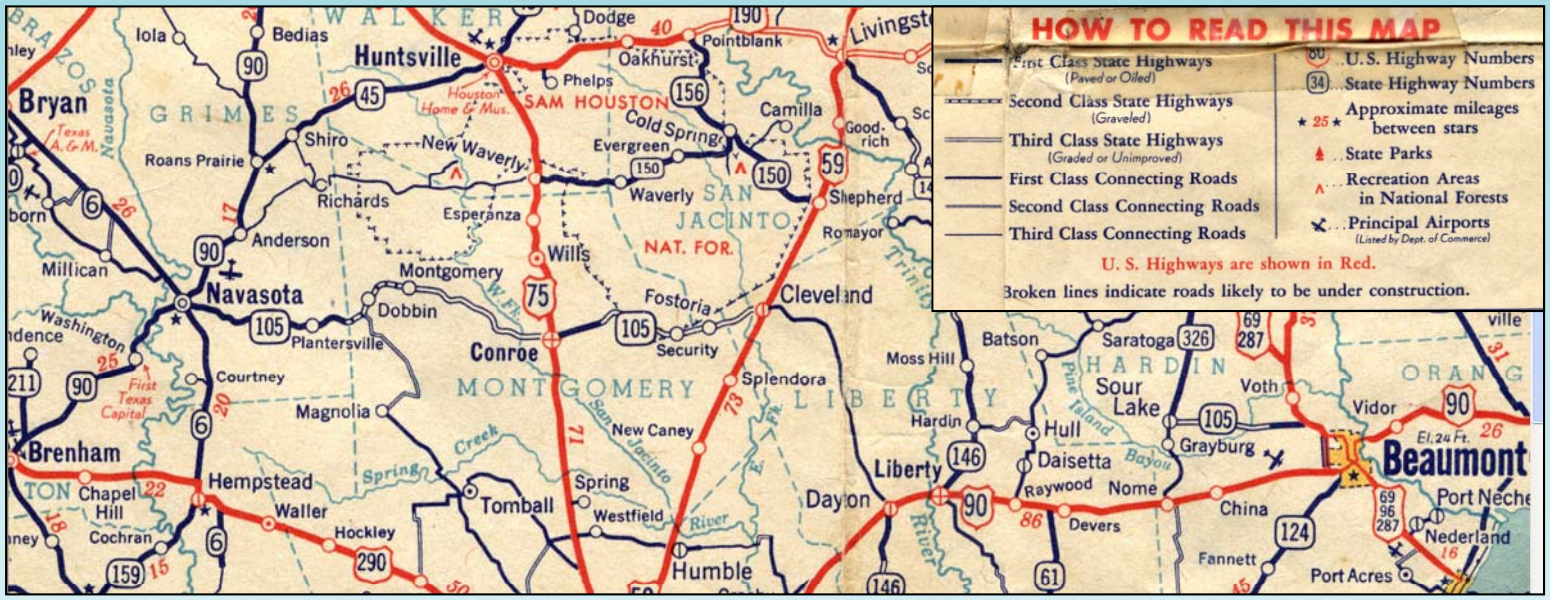
SH 105, Montgomery County, TX



Limits: FM 149 in Montgomery to Loop 336 in Conroe

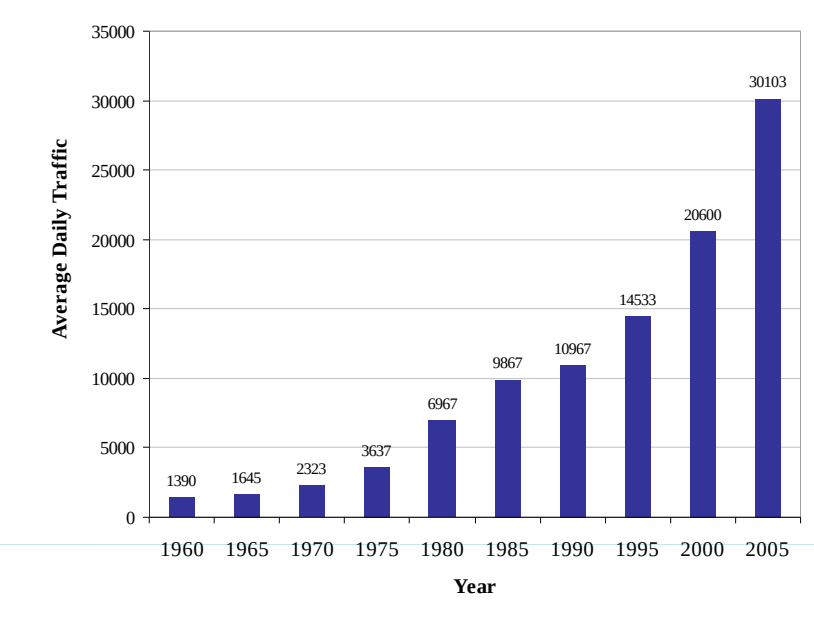
Length: 12.9 miles

SH 105 History



- Rural E-W highway between Brenham and Beaumont
- Proposed in 1930s, Navasota to Moss Hill
- Began with paved, graded, and gravel sections
- Section by Lake Conroe, greatest change

Land Development History



- Lake developed/filled in 1970-73
- Proximity to Houston, recreational and residential attraction spurred rampant growth
- Rapid change from rural character to suburban residential, retail/service commercial
- Need for added capacity rose quickly

Rural Highway to Suburban Arterial

Prior to Existing Cross-section

- Rural 2-lane undivided section, 8-12 ft. unpaved shoulders
- Early 1970s after lake, addition of signals, flashers

Early 1990s Widening/Upgrade

- 4-lane w/TWLTL, 10 ft. shoulder, open ditch – FM 149 - Old River Rd.
- 6-lane w/TWLTL, 10 ft. shoulder, open ditch – Old River – Loop 336
- Included several new signal installations
- Post widening: installation of advanced signal warning flashers

Widening of 4-lane section to 6-lanes in design

Current SH 105 Cross-Sections

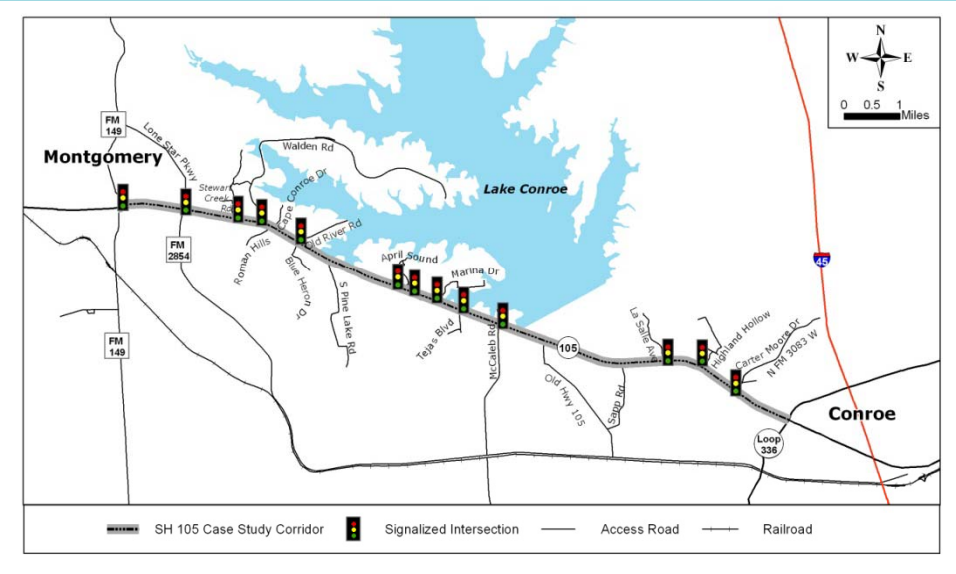
7-lane section, east side of corridor study area

5-lane section, west side of corridor study area

Texas Transportation Institute

Signal Locations and Spacing

- 12 signalized intersections
- All use span wire mounting
- Most have advanced warning beacons
- Spacing: not uniform, some too close



Unsignalized Access

- Current design in place before TxDOT AM guidelines
  - Few access consolidations
  - Few access connections between developments
- 300 access points, average 25/mile
- 39 access points/mile in some segments
- Key source of functionality loss

Regulatory Jurisdictions and Agency Responsibility

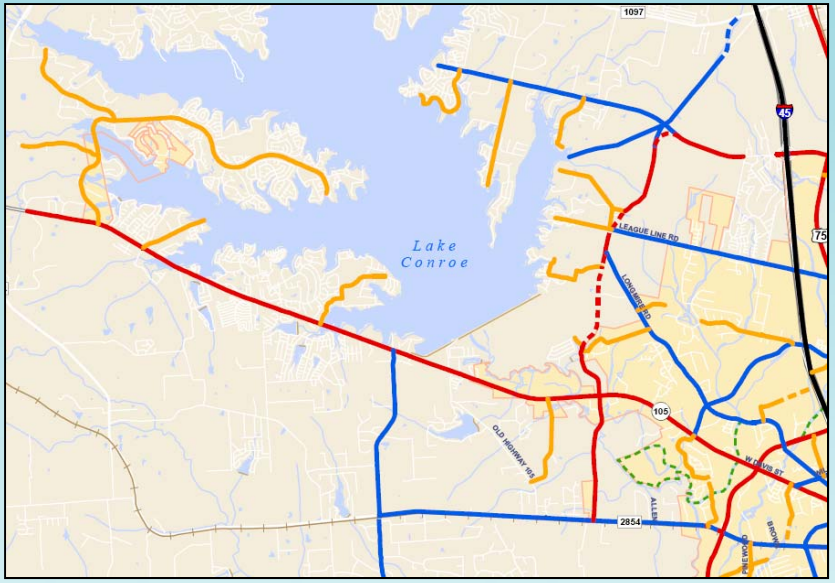
Area	Plats	Site Plans	Building Permits
Conroe City Limits	city	city	city
Conroe Planning Area	city	city	county
ETJ	county	county	county

Development Regulations in Corridor

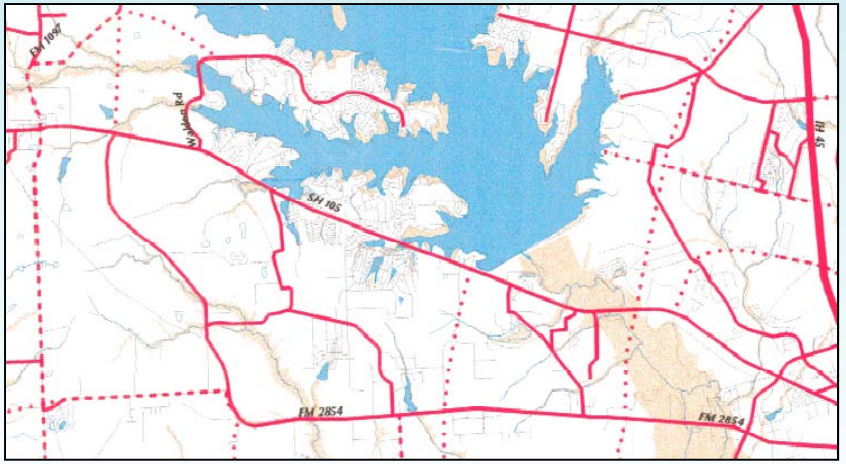
- Have/Use
  - Form based codes (recently)
  - Building setbacks, parking requirements
  - TxDOT Access Guidelines (since 2004)
  - FEMA floodplain compliance, drainage regs
- Don't Have/Use
  - Zoning/land use controls
  - Local access ordinance requirements
  - Access easements/coordination

Thoroughfare Plans Covering Area

City of Conroe
Thoroughfare Plan (2006)



Montgomery County/HGAC
Transportation Plan (1998)



SH 105 Crash History/Safety

Year	Total Crashes	Fatalities
2003	101	0
2004	100	3
2005	115	4
2006	99	1
2007	101	2
2008	109	4
2009 (part)	54	2 (+3?)
Total	679	**16**

Contributors to SH 105 Functionality Loss

- Frequent and closely spaced non-signalized access points
- Lack of vehicular connections between developments
- Facility design: continuous TWLTLs
- Lack of a supporting local street network, neighborhood connectivity
- Signal location and spacing

SH 105 Observations

- Age-old local access vs. regional mobility issue
- SH 105 serves competing dual functions
  - Regional arterial highway
  - Local urban arterial
- Combination of many factors have led to for functionality loss

8. SH 105 from Loop 336 to FM 149

Contributors to SH 105 Functionality Loss

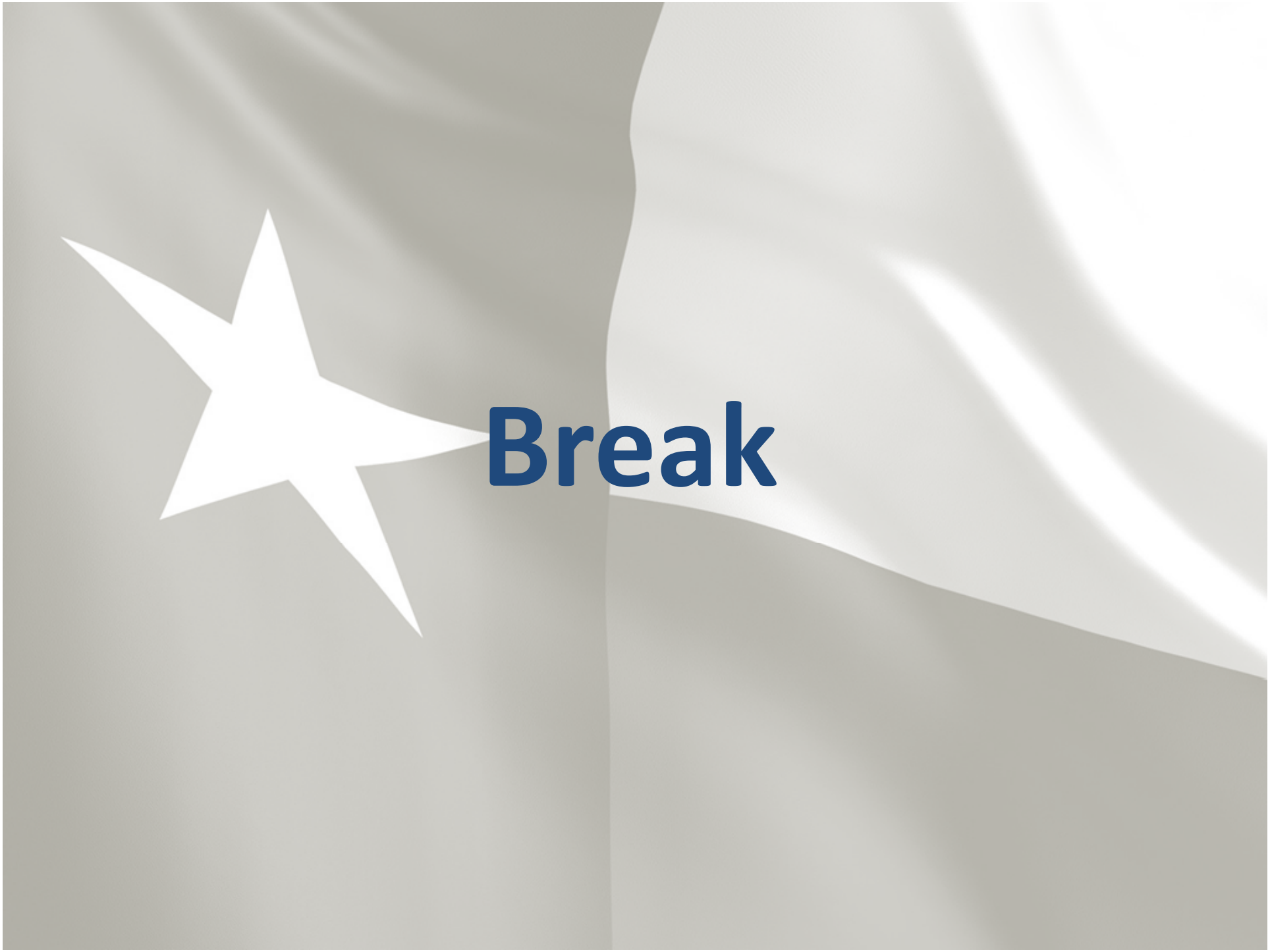
Unincorporated area

+ rampant growth
+ absence of planning
+ no land use controls
+ minimal development regulations
+ little local/TxDOT coordination
+ facility design with no access management provisions
+ business friendly development climate

= Unsustainability, reduced service life, need for rehabs sooner, increased safety and operational problems, higher costs, etc…..

SH 105 Discussion

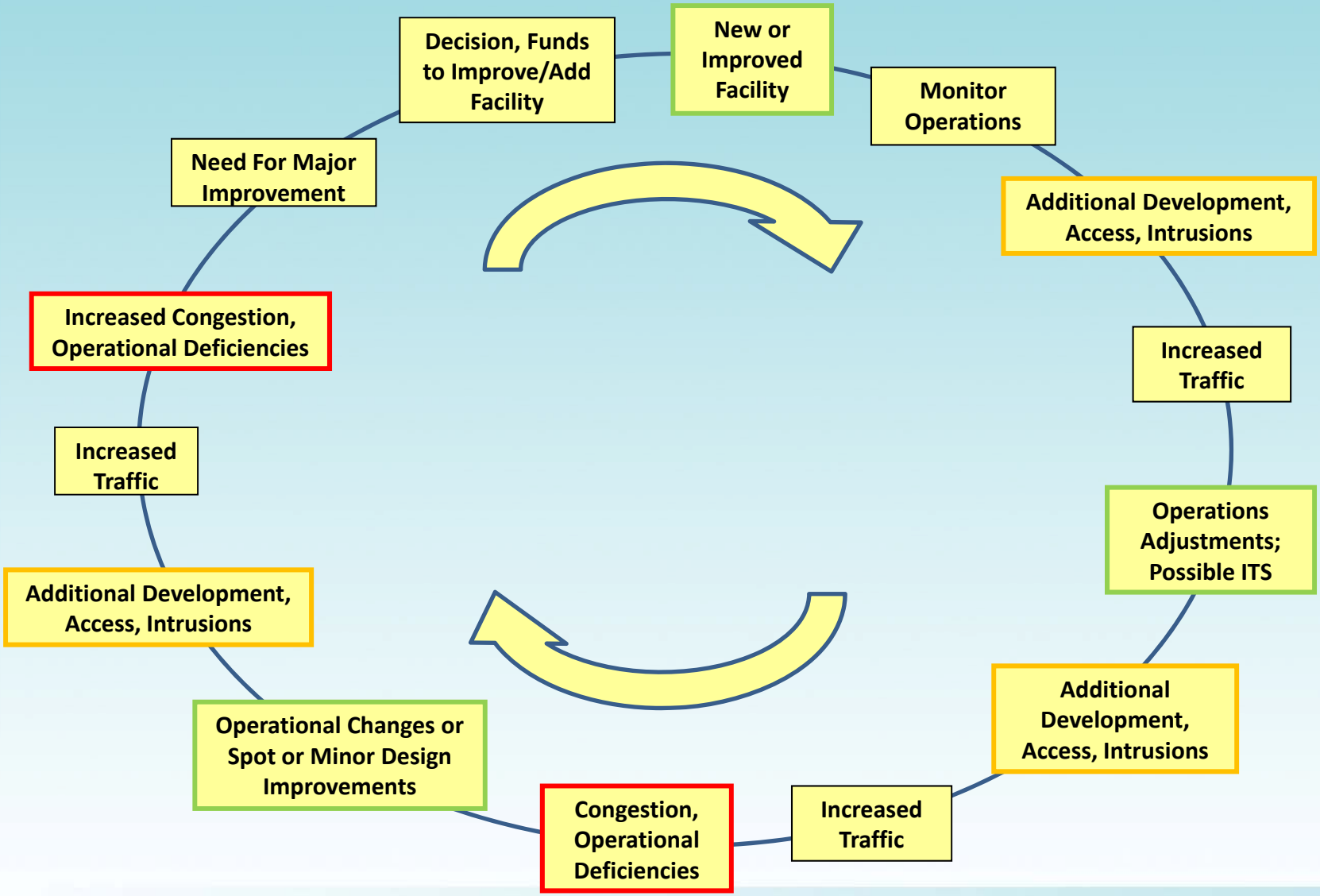
- Is there anything the City of Conroe or Montgomery Co. could or should have done in decades past to prepare for Lake Conroe's development?
- Has the way SH 105 has evolved affected business development and sustainability? Has it affected land values?
- How can safety be improved?
- How would this corridor be different if a corridor management plan had been adopted 20-30 years ago?
- So what's next for this section of SH 105?


Break

MODULE 2a

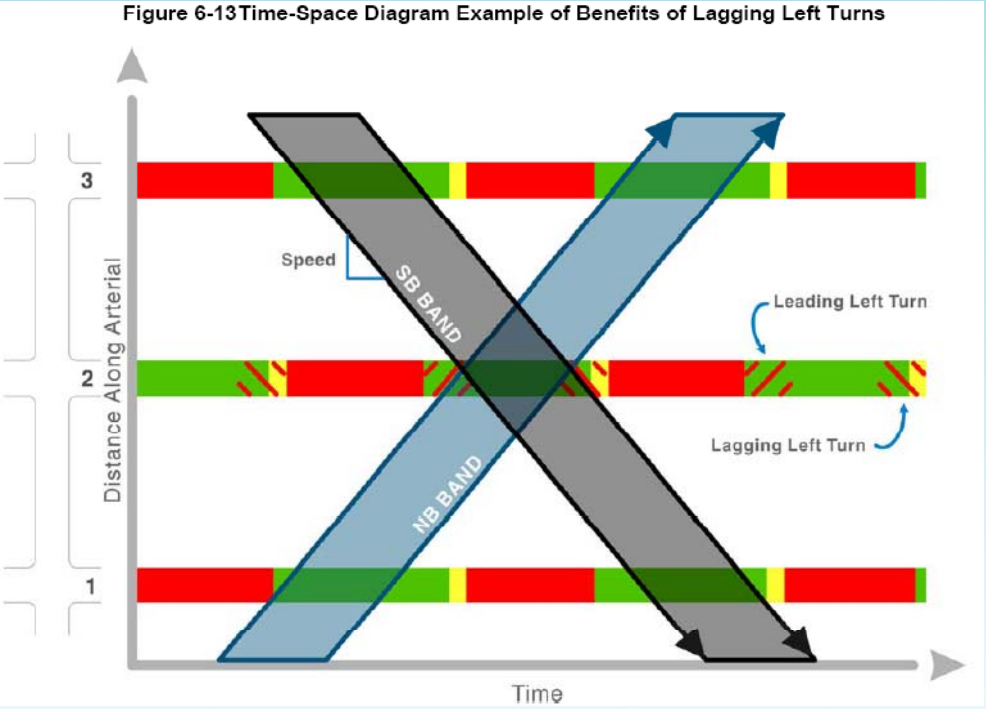
Operational Functionality

Operational Functionality Cycle



Categories of Practices Affecting Operations

- Traffic control and management
  - Traffic control
  - Incident management
  - ITS
  - Special use
    - HOV, HOT, toll, etc.
- Signal optimization and coordination
- Facility design and enhancement



Keeping Up with Operational Changes

- Performance measures
- Requests
  - Agencies
  - Businesses
  - Associations
- Complaints

Operations Performance Categories

- Capacity
  - Throughput
- Efficiency
  - Stops, delays, travel time
- Reliability
  - Travel time consistency
- Accommodating temporary conditions
  - Incidents, emergencies
  - Maintenance
  - Construction

Operations Performance Measures

- Level of Service
  - Segment, intersection
  - VMT within LOS ranges
  - Lane miles within LOS ranges
  - Many similar variations

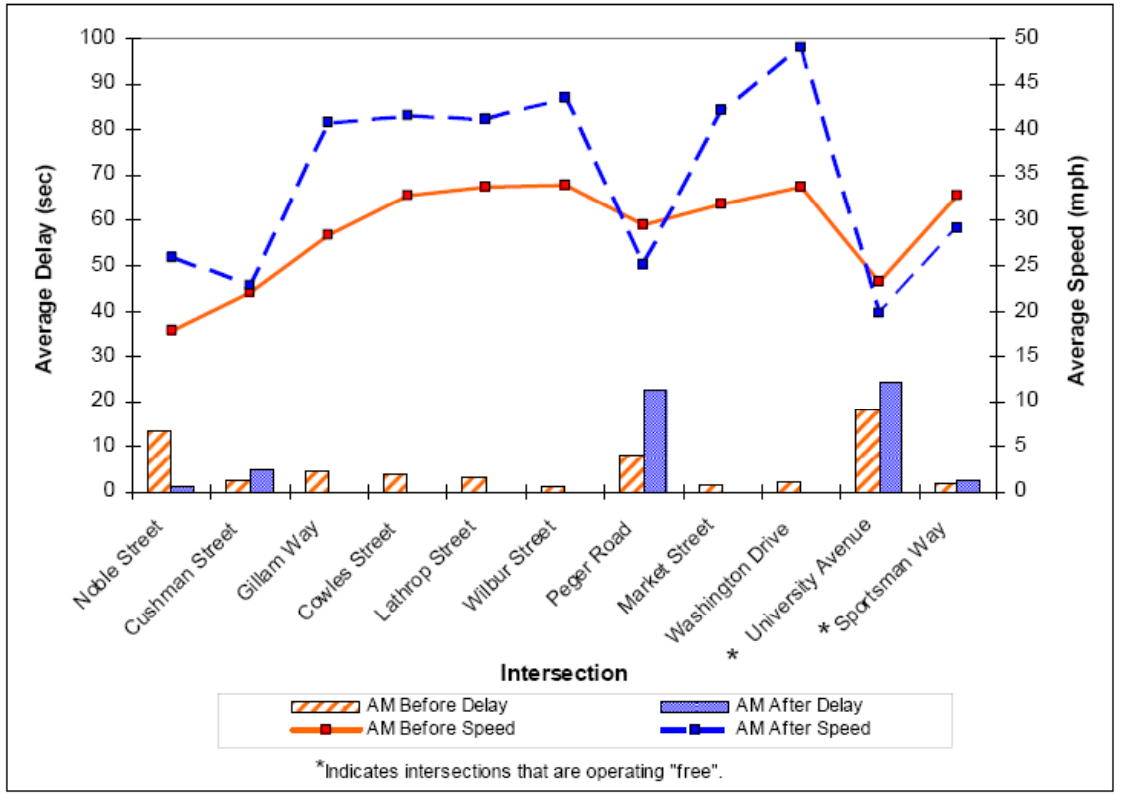
Operations Performance Measures

- Travel time
  - Segment
  - Reliability
- Travel speed
  - Average running speed (by segment)
  - Speed variability
  - VMT within speed ranges
  - Lane miles within speed ranges

Operations Performance Measures

- Delays
- Stops or stopped time
- VMT
- Trends
  - Travel time
  - Running speeds
  - Delays

Figure 3-6 Sample travel time run result graph

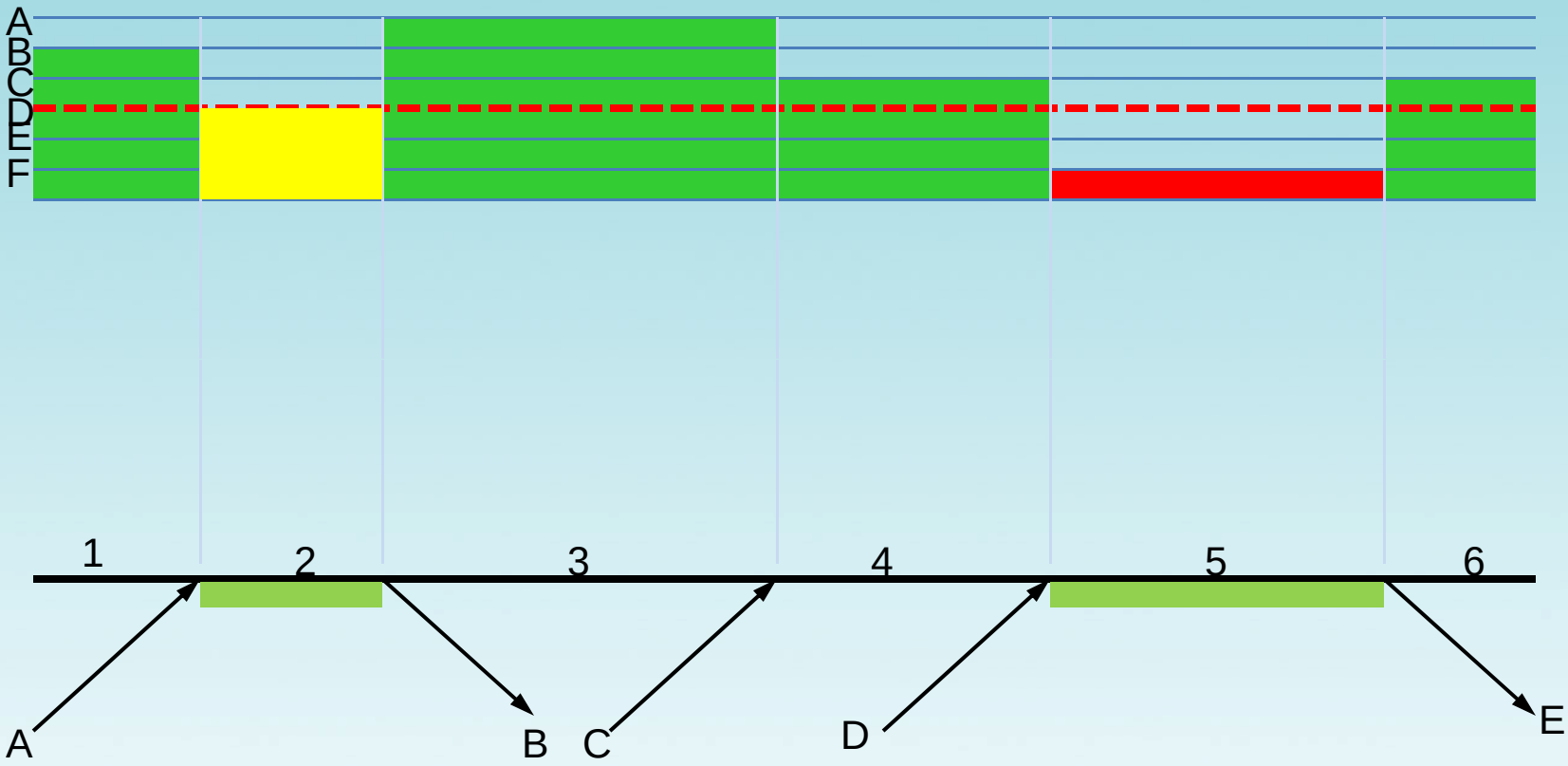


Operations Performance Measures

Use

- Performance measures that:
  - Evaluate desired performance
    - Area or agency goals
    - Local issue areas

Example – LOS Consistency Analysis



Some solutions

- Auxiliary lane
- Braid ramps A-B, D-E
- Reverse ramps A-B or D-E
- Combine C and D access to Ramp C
- Reroute traffic away from Ramps A and/or D
- Meter ramps A, C, and/or D
- Relocate ramps A and/or E to lengthen weaves

Data Sources for Performance Measures

- TxDOT Transportation Planning and Programming Division (TPP)
- TxDOT districts
- MPOs (where existing)
- TxDOT traffic maps
  - http://www.txdot.gov/travel/traffic_maps.htm
- Cities, urban counties
- Traffic management centers

Data for Performance Measures

Data

- Speeds
- Acceleration, deceleration
- Travel times
- Volumes
- Vehicle classifications
- Delays
- Occupancy
- Queues
- Density

Sources

- Traffic management center
- TxDOT counters
- Traffic control systems
- Automated vehicle locators (AVL)
- Closed circuit TV (CCTV)
- Road weather information system

Causes of Operational Deterioration

Types

- Recurring
- Occasional/ temporary
- Infrastructure

Causes of Operational Deterioration

Recurring

- Volume increase
  - Total
  - Merge, weave
  - Trucks, transit
- Travel pattern changes
  - Development, major schedule changes, etc.
    - Local
    - Area
- Road access changes
- Traffic control

Causes of Operational Deterioration

Recurring (cont.)

- Road access changes
  - Ramps
  - Cross streets
  - Driveways, medians
- Traffic control
  - Not up to warrant levels
  - Signals not retimed
  - Signals not coordinated
  - Suboptimal lane use

Causes of Operational Deterioration

Occasional/temporary

- Incidents
  - Crashes
  - Weather
  - Damage from incidents
- Maintenance
  - Short term
  - Long term
- Construction
- Special events
  - Recurring
  - One time

Causes of Operational Deterioration

Infrastructure

- Pavement condition
- Traffic control device deterioration
- Other maintenance items

Results from Operational Deterioration

- Congestion
  - Longer travel times
  - Longer goods delivery times
  - Emergency service delays
  - Increased cut through traffic
  - Higher travel costs
  - Excessive fuel use, pollution
  - Vehicle wear, breakdowns
  - Motorist frustration, stress
- More crashes
  - Aggressive driving
  - Increased traffic violations

Countermeasure Types

1. Operational
2. Infrastructure
3. Financial/pricing

Probably in order of preference

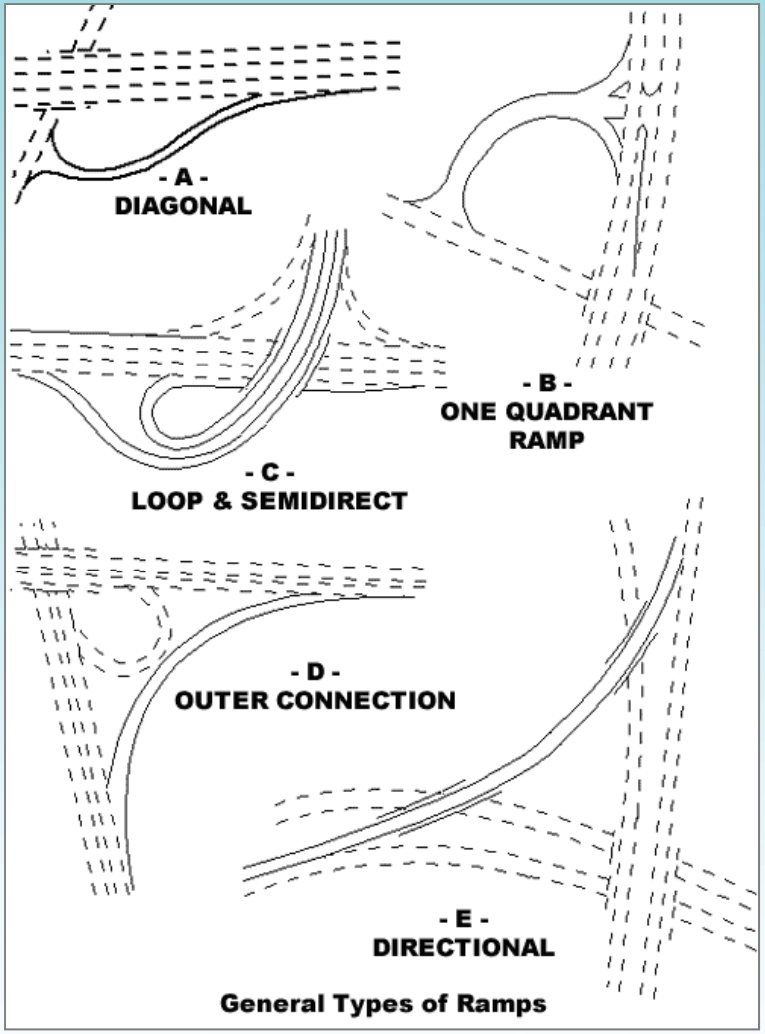
- Cost
- Implementation time
- Ease of implementation

Countermeasure Types

1. Operational
   - Intelligent transportation systems (ITS)
   - Incident management
   - Lane use changes
   - Signal timing, coordination
   - Shoulder use
   - Travel demand management (not covered here)

Countermeasure Types

2. Infrastructure
   - Add lanes
   - Add new facilities
   - Modify, reconfigure design
   - Add HOV, HOT, express, truck, other lanes



Countermeasure Types

3. Financial/pricing
   - Tolls
     - Fixed
     - Variable
   - Permits
     - HOV, HOT lanes
   - Parking

Operational Functionality Program

Corridor, area, or regional program

- Work zone management*
- Incident management*
- Special events management*
- Emergency preparedness*
- Facility upgrades, additions*
- Daily recurring operations*
- Signal coordination**

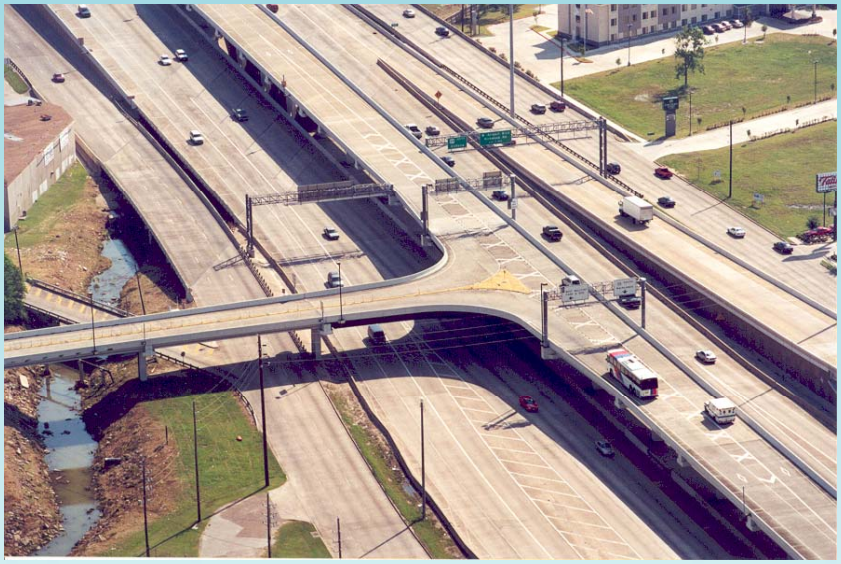
* Coordinate freeway and arterial management

** Coordinate arterials and interchanges/frontage roads

Countermeasures – A Few Sources

- FHWA *Freeway Management and Operations Handbook*
- FHWA *Coordinated Freeway and Arterial Management Handbook*
- FHWA *Incident Management Handbook*
- TxDOT *Traffic Signals Manual*
- ITE *Toolbox for Alleviating Traffic Congestion and Enhancing Mobility*
- ITE *Traffic Signal Timing Manual*

Countermeasures - Freeway



Widening

- Auxiliary lanes
- Speed change lanes
- Climbing lanes
- Use of shoulder lanes
- Separate roadways
  - Express
  - Trucks
  - HOV, HOT

Countermeasures - Freeway

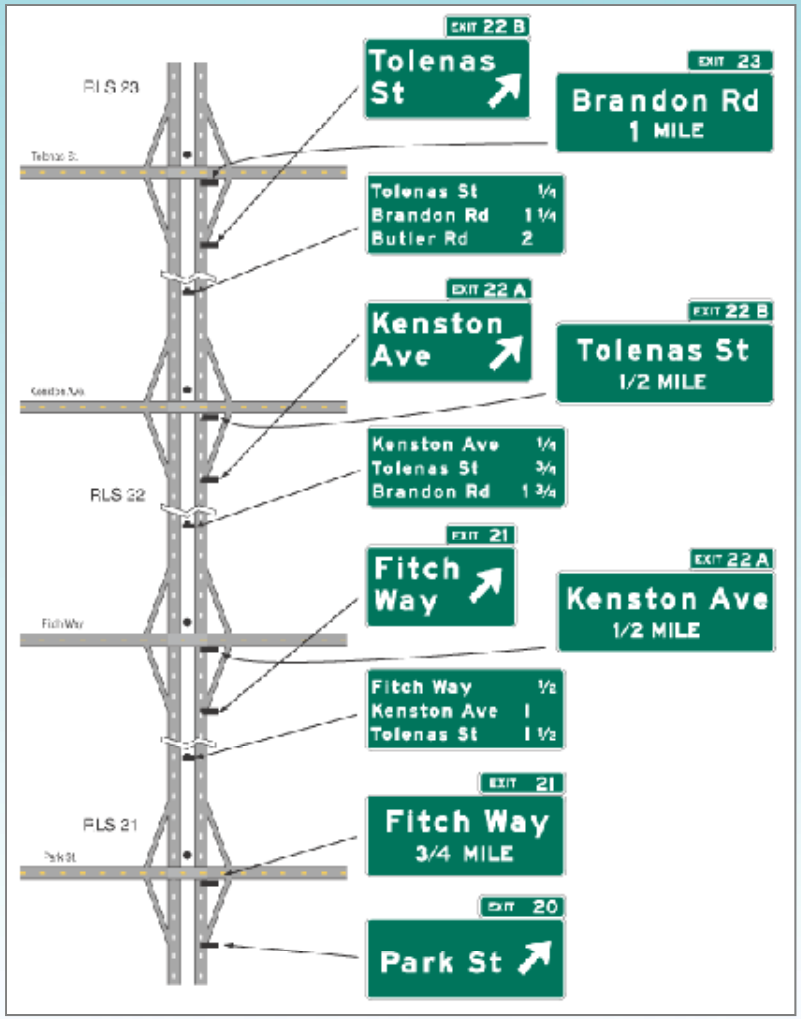
Interchanges

- Weaving sections
- Ramps
  - Added
  - Widened
  - Reconfigured
- Ramp location
  - Separation from intersections, driveways
- Bypass lanes
- CD roads

Countermeasures - Freeway

Signing

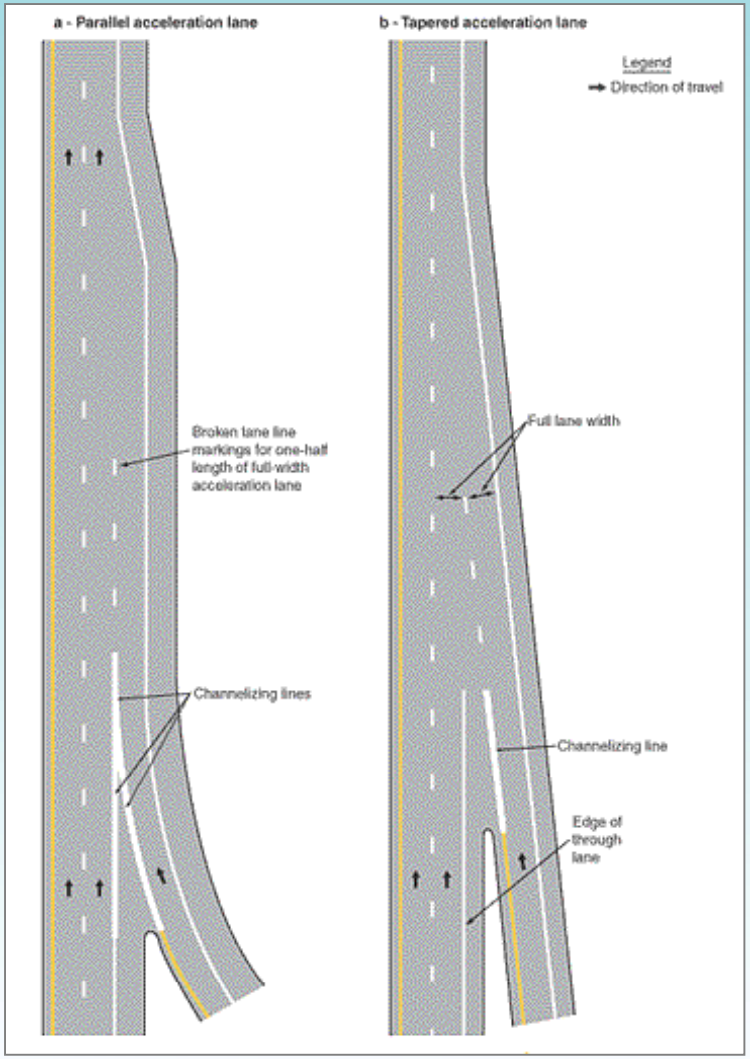
- Directional/guide
- Lane use
- Location, size



Countermeasures - Freeway

Markings

- Merge
- Transitions
- Narrower lanes



Countermeasures - Freeway

Ramp management

- Metering
- Closure
  - Special events
  - Peaks
- Special use
  - HOV, emergency bypass
- Terminal treatment
  - Widening
  - Channelization
  - Traffic control

Countermeasures - Freeway

Managed lanes

- HOV
- HOT, express
- Trucks
- Contraflow/reversible
- Toll
- Pricing – variable toll
- Shoulder use
- Work zone
  - Short, long term

Countermeasures - Freeway

Transportation management center (TMC)

- Traffic surveillance and monitoring
  - Real time
  - Trends
- Incident detection and response
- Traveler information
- Alternate route planning
- Traffic control coordination
- Emergency management
- Interagency coordination
- Other

Should extend to include arterials

Countermeasures - Freeway

Incident management

- Surveillance, detection
- Alternate route plans
- Response
- Clearance, recovery
- Motorist information

Countermeasures - Freeway

Special events

- Emergency
  - Floods
  - Hurricanes
  - Fires
  - Homeland security
- Scheduled
  - Sport
  - Entertainment
  - Security (President)

Countermeasures - Arterials

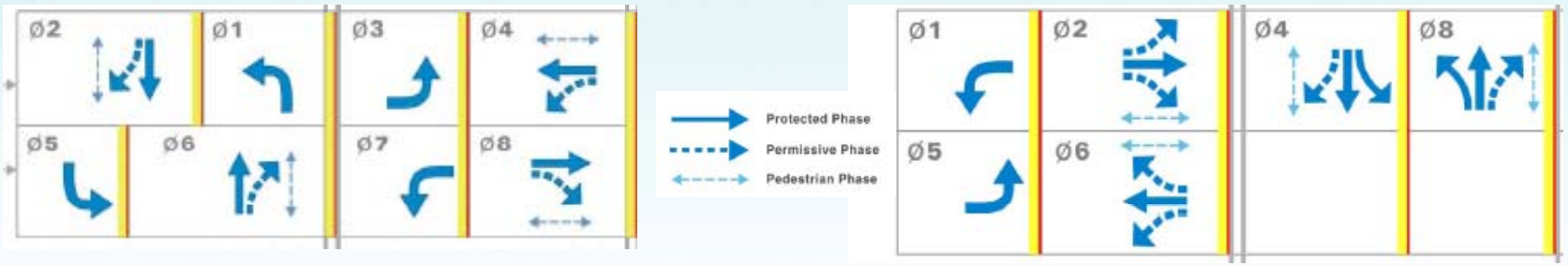
Intersections

- Single or double turn lanes
- Right turn lanes
- Turn restrictions
- Modified lane use
- Time managed lane use
- Queue jumpers
- Grade separations
- Additional through lanes at intersections
- Advance signing to improve circulation
- Pedestrian refuge islands to permit shorter ped phases

Countermeasures - Arterials

Traffic signals

- Traffic signal system audit (TSSA)
- Traffic signal retiming
- Traffic signal system coordination
- Remove unwarranted signals
- Upgrade signal hardware, software
- Install additional signals
- Relocate signals for coordination



Lead-lag (left) and split phasing (right) examples

Countermeasures - Arterials

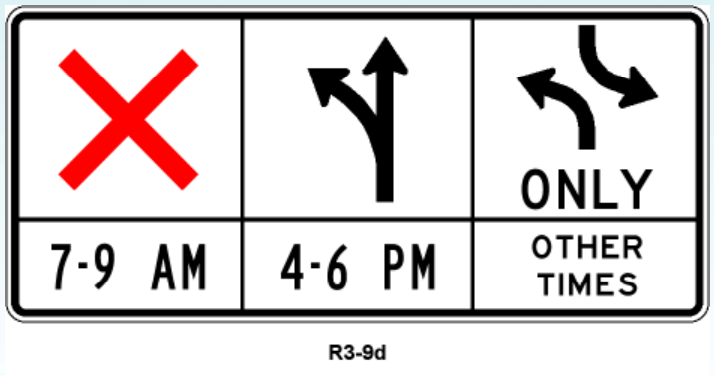
Design improvements

- Increased sight distance
- Improved geometrics
- “Super 2” sections
- Non-traversable medians
- Bus, HOV lanes
- Narrowed lanes to permit more lanes
- Upgrade arterials to expressways
- Add pedestrian/bike facilities
- Access management

Countermeasures - Arterials

Other traffic management

- Traveler information system
- Arterial traffic management system (ATMS)
- Parking restrictions
- Relocate bus stops
- Truck restrictions



LUNCH
11:30-1:00

MODULE 2b

Operational Functionality

Developing Your Operational Functionality Program

1. Assemble collaborating agencies, stakeholders
2. Establish objectives
3. Develop corridor concept of operation
4. Agree on concept
5. Develop operating plan
6. Identify improvements, resources
7. Develop implementation strategy
   - Responsibilities
   - Priorities
   - Public information program

Sample Operations Concepts

- Time managed operation
- Area or corridor signal coordination
- Through traffic priority
- Long distance travel priority
- Person movement priority
- Maintain travel times/speeds on selected facilities
- Evacuate high intensity trip generator

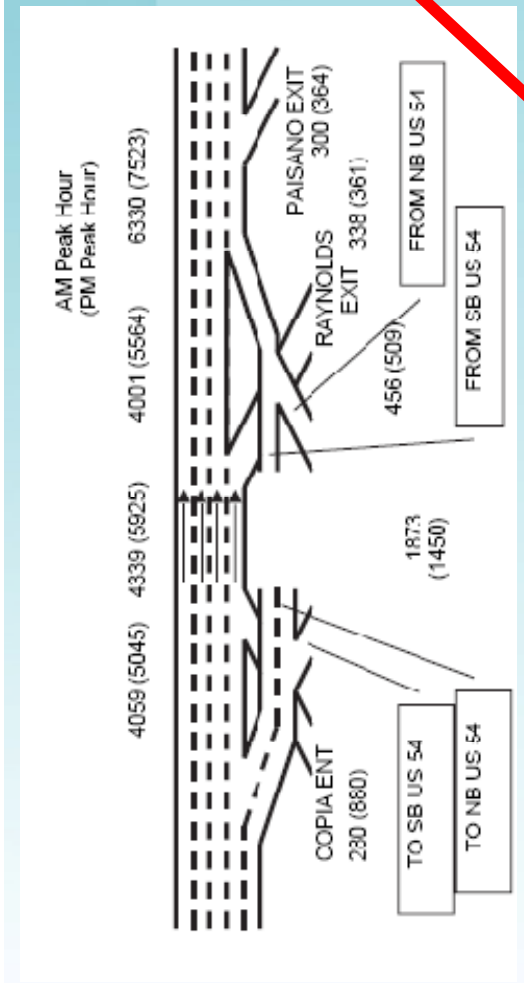
Examples

I-10 – US 54 interchange, El Paso

- Congestion
  - Southbound to Eastbound ramp
  - Eastbound I-10
- Auxiliary lane improperly used to bypass queue

Examples

I-10 – US 54 interchange, El Paso

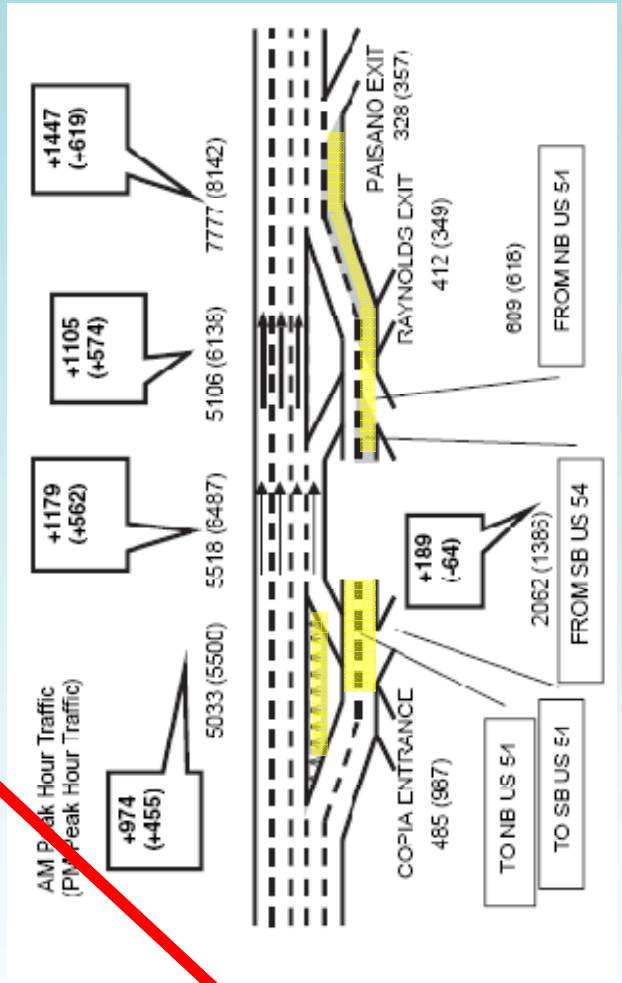


←Deficiency

- **Congestion**
  - **Southbound to Eastbound ramp**
  - **Eastbound I-10**
- **Auxiliary lane improperly used to bypass queue**

Solution →

- **Restripe US 54 entrance ramp for (original) 2 lanes**
- **Extend added lane as auxiliary lane to drop at Paisano exit**
- **Stripe out inside lane between US 54 exit and Copia entrance ramps**



Examples

I-10 – US 54 interchange, El Paso

Examples

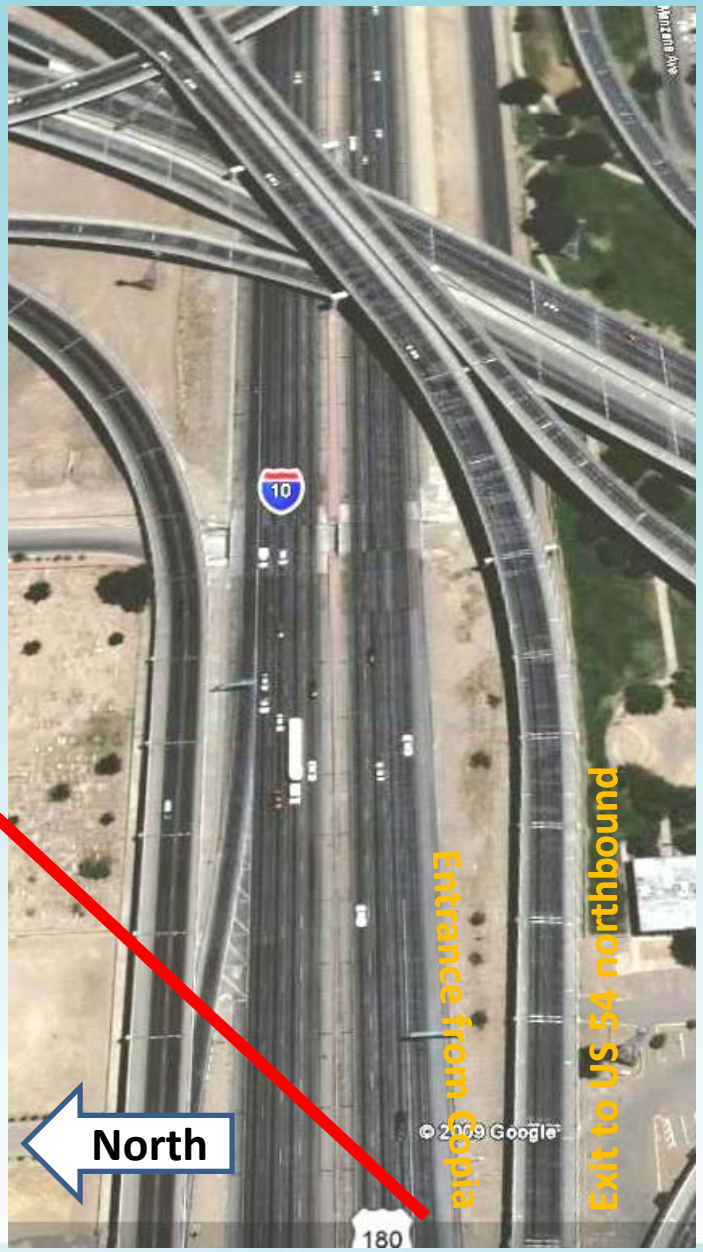
I-10 – US 54 interchange, El Paso

Examples

I-10 – US 54 interchange, El Paso

Examples

I-10 – US 54 interchange, El Paso

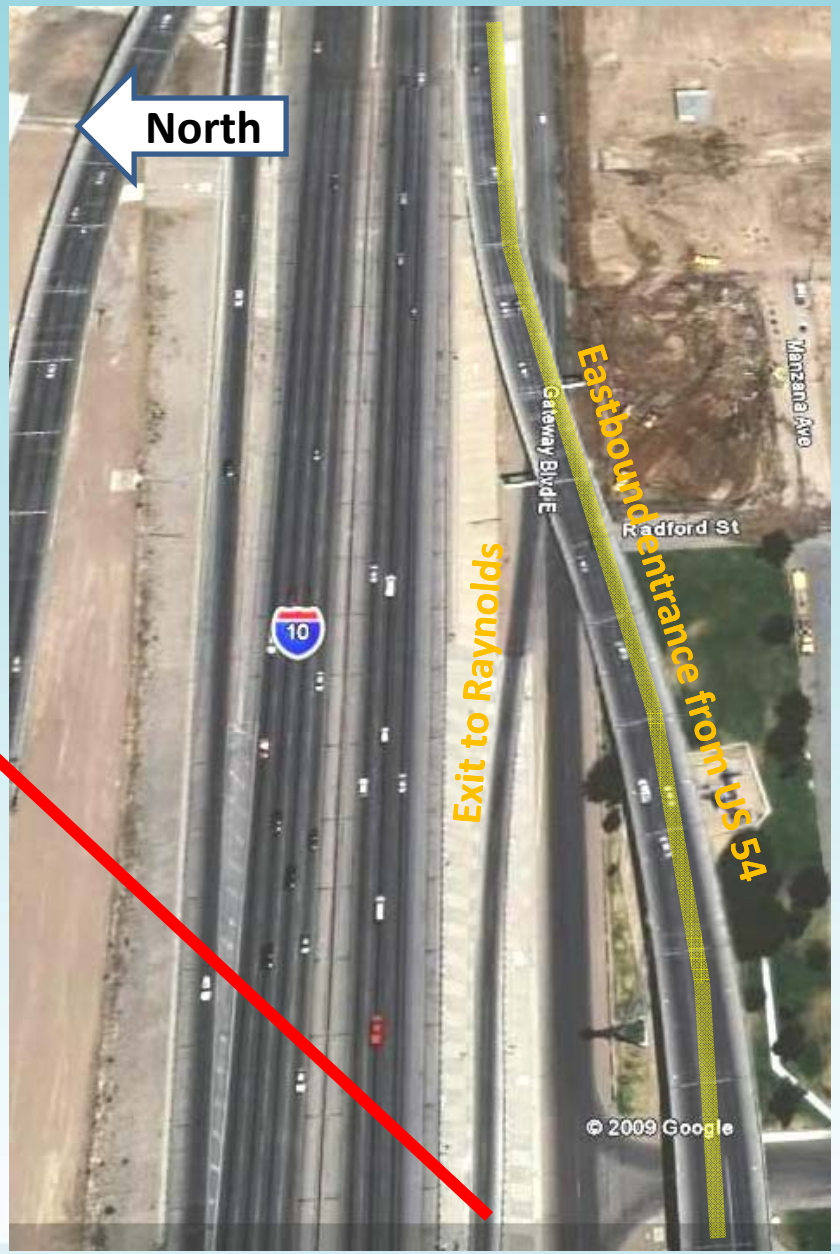


Examples

I-10 – US 54 interchange, El Paso

Examples

I-10 – US 54 interchange, El Paso



Examples

I-10 – US 54 interchange, El Paso

Examples

I-10 – US 54 interchange, El Paso

Examples

I-10 – US 54 interchange, El Paso

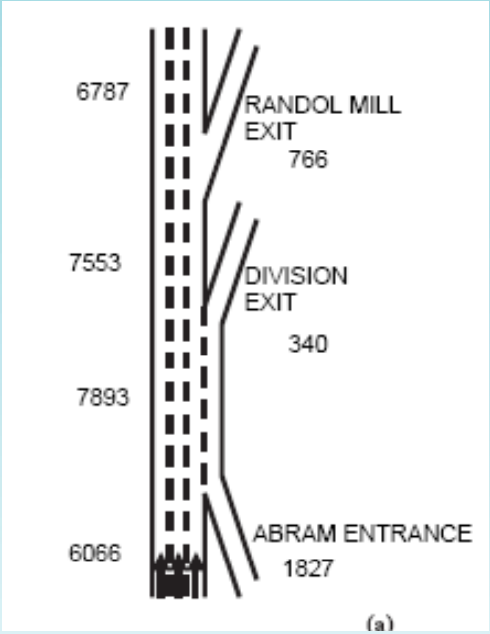
- Cost - $530,000
- Benefits - $1.3 million annually
  - Delay reduction
  - Decreased injury crashes

Examples

SH 360, Arlington

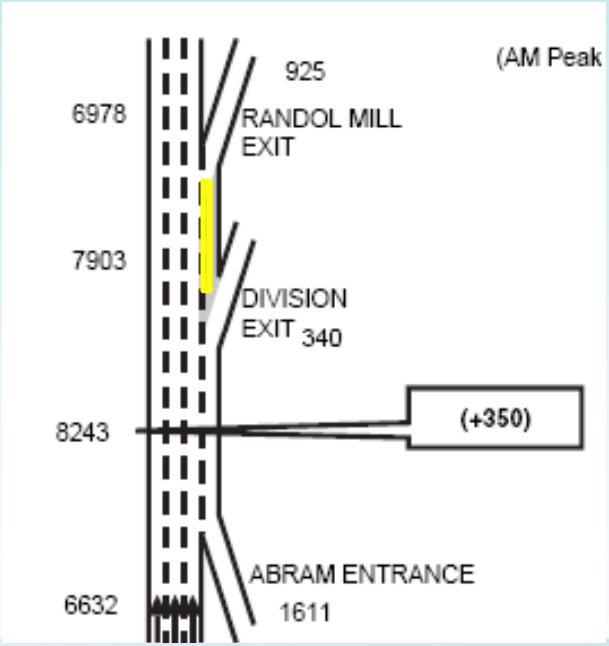
Examples

SH 360, Arlington



Deficiency

- **Congestion in short weave between Abrams on ramp and Division exit ramp**
- **Lane drop at Division exit**
- **Second exit ramp to Randol Mill**



Solution

- **Extend auxiliary lane to Randol Mill exit**

Examples

SH 360, Arlington (after)

Examples

SH 360, Arlington

(after)

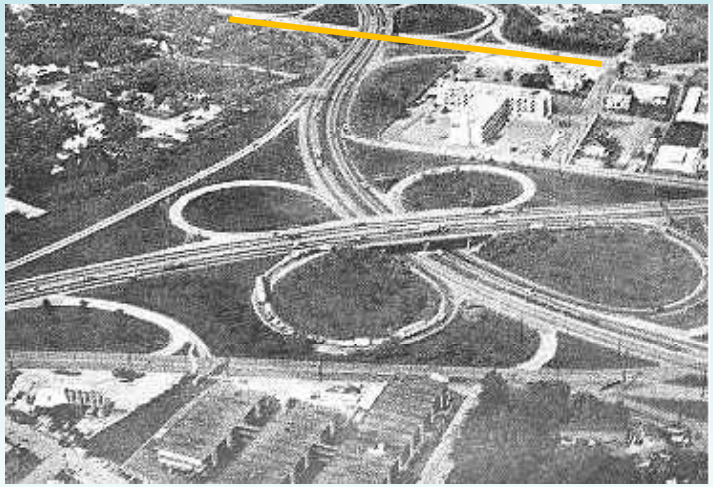
Examples

SH 360, Arlington

- Cost - $150,000 (contract change)
- Benefits
  - o $200,000 annual delay reduction
  - o 76% fewer injury crashes

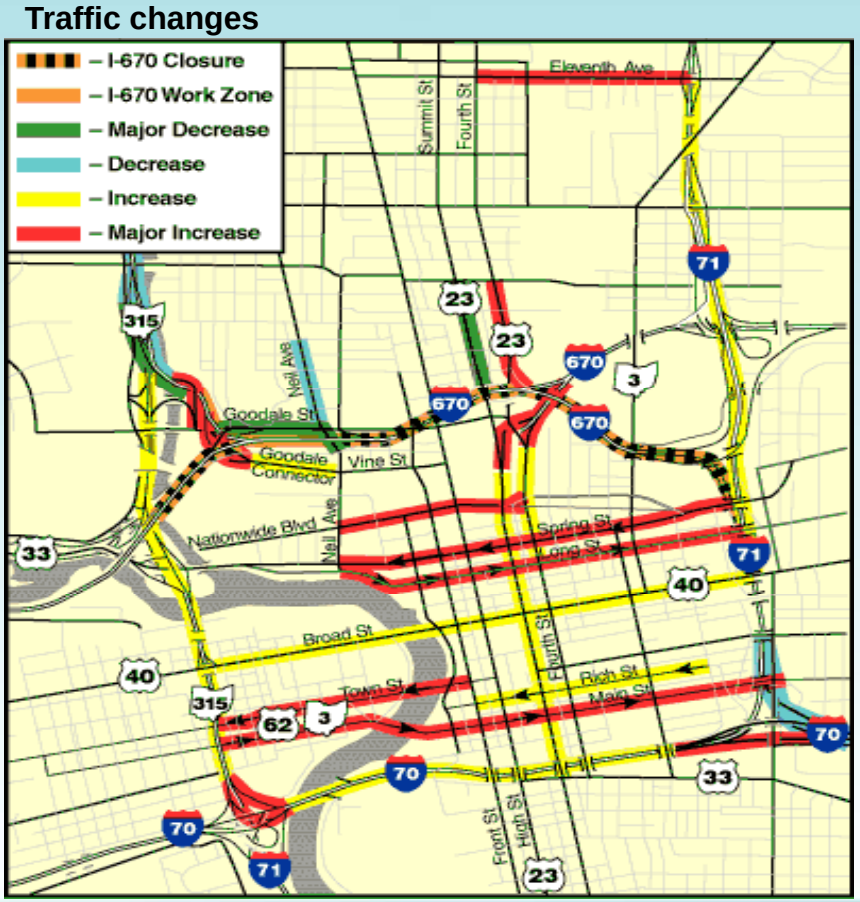
Examples

I-40 – I-275 Interchange,
Knoxville, TN



Examples

- I-670 reconstruction, Columbus, OH



Internet Sources

- FHWA freeway management website
  - http://ops.fhwa.dot.gov/freewaymgmt/index.htm
- FHWA arterial management website
  - http://ops.fhwa.dot.gov/arterial_mgmt/index.htm
- FHWA incident management website
  - http://www.ite.org/M&O/resources.asp
- ITE management and operations website
  - http://www.ite.org/M&O/resources.asp
- FHWA travel demand management website
  - http://ops.fhwa.dot.gov/tdm/
- FHWA real time traveler information website
  - http://ops.fhwa.dot.gov/travelinfo/index.htm
- FHWA work zone mobility and safety program website
  - http://ops.fhwa.dot.gov/travelinfo/index.htm
- FHWA emergency transportation operations website
  - http://ops.fhwa.dot.gov/eto_tim_pse/index.htm
- FHWA operations performance measurement website
  - http://ops.fhwa.dot.gov/perf_measurement/index.htm

Preserving and Recapturing Operational Functionality

Questions?

Exercise

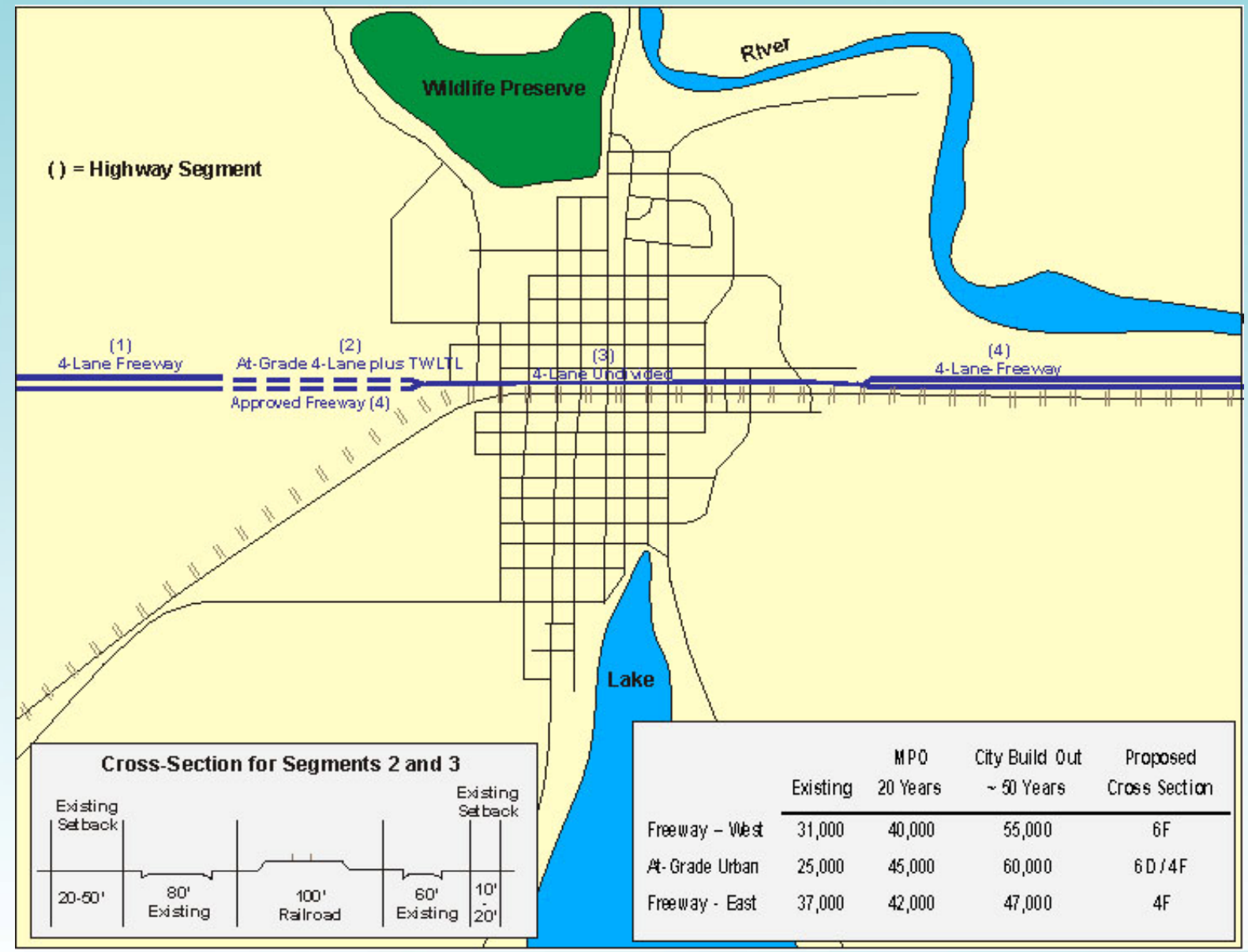

EXERCISE

Develop A Functionality Preservation Strategy

- Recommend strategy to preserve the functionality of this highway for at least the next 50 years.
  - Short term: 0-5 years
  - Medium term: 5-20 years
  - Long term: 20-50 years

- Details on handout

Develop A Functionality Preservation Strategy



	Existing	MPO 20 Years	City Build Out ~ 50 Years	Proposed Cross Section
Freeway – West	31,000	40,000	55,000	6F
At-Grade Urban	25,000	45,000	60,000	6D/4F
Freeway - East	37,000	42,000	47,000	4F

Develop A Functionality Preservation Strategy

Looking west with highway on right and local street on left of rail line

Existing state highway

Texas Transportation Institute

Develop A Functionality Preservation Strategy

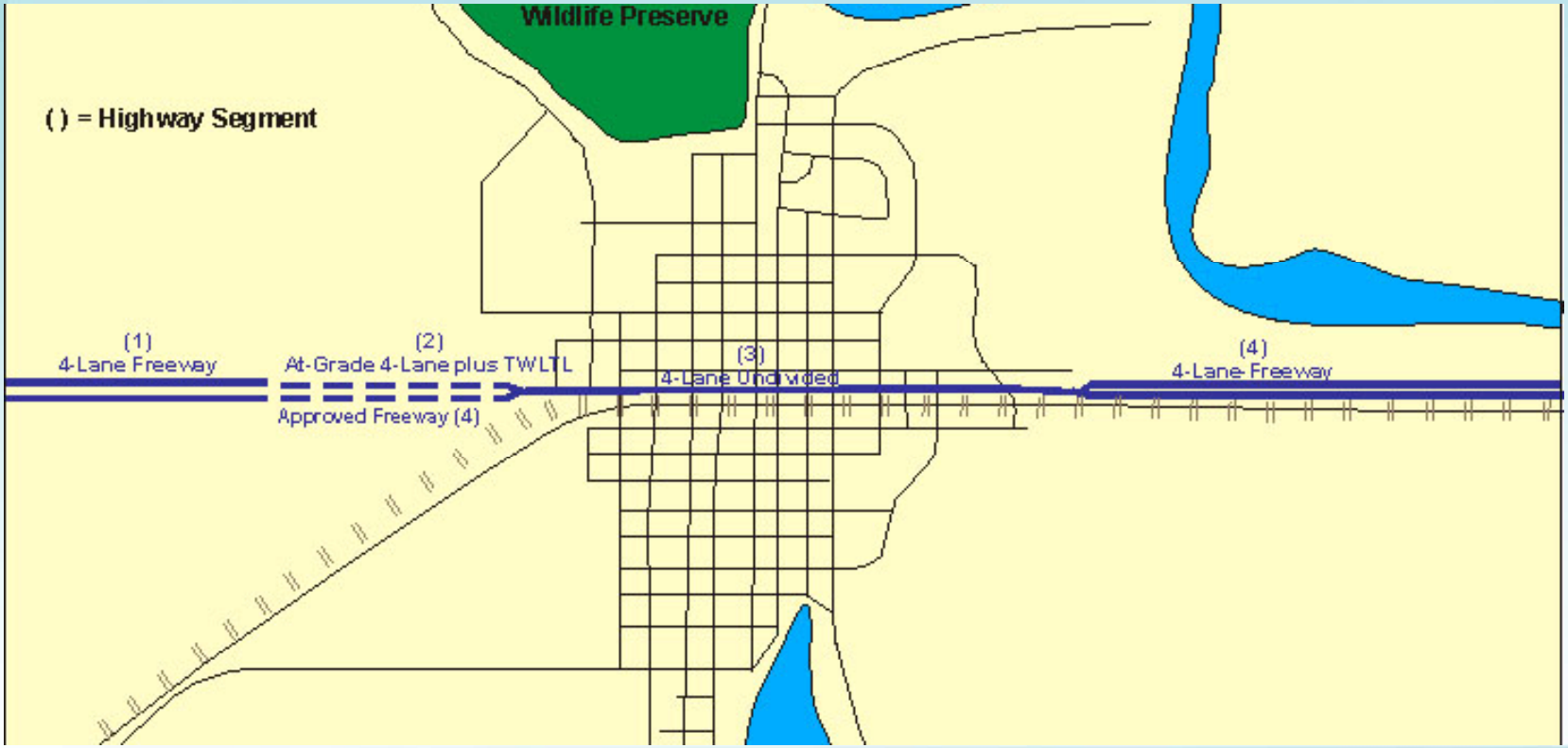
- Example

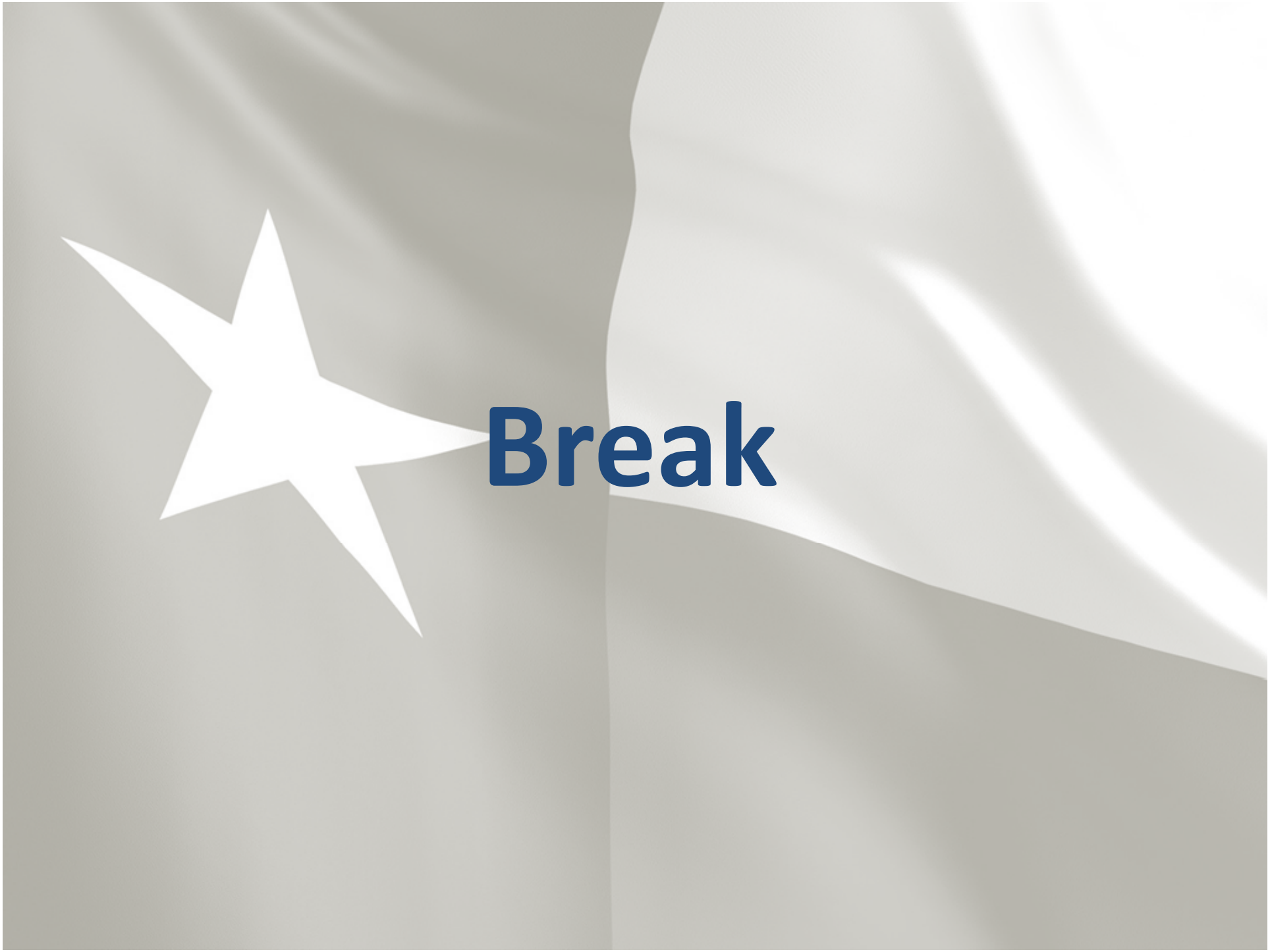
Time Period			Strategy	Comment
Short	Medium	Long		
			Planning and development coordination	
✓	✓	✓	Development overlay district	Manage development and reserve ROW for long term configuration
			Access management	
✓	✓	✓	Increased intersection spacing	Consider future interchange locations
			Traffic operations	
			Minor roadway improvements	
			Major roadway improvements	
			Right of way actions	
			Other	

Develop A Functionality Preservation Strategy

Group reports and discussion

- 3 minutes: your team's recommendations
- Discussion after last report




Break

MODULE 3

Right of Way and Functionality

Factors Affecting ROW Functionality

- Acquisition
- Protection
- Utility Accommodation

Right-of-Way Acquisition

Right-of-Way Acquisition

- ROW planning and acquisition are critical to:
  - Functionality
  - Project development
- Planning affects function and acquisition
- Acquisition can be:
  - Time consuming
  - Socially sensitive

Potential Functionality Loss

- Right-of-way acquisition delays
  - Construction delays
  - Increased right-of-way cost
- Insufficient right of way
  - Insufficient for desired improvement
  - Cannot accommodate utilities or other features
- Resulting functionality shortfalls
  - Congestion
  - Safety
  - Other project objectives

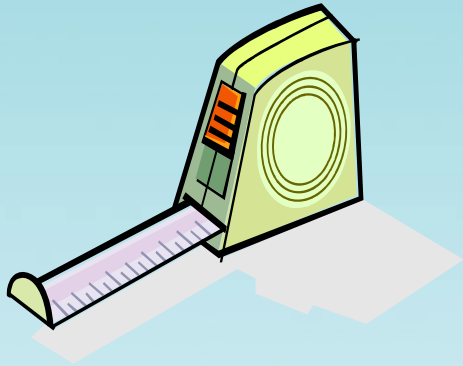
ROW Best Practices or Countermeasures

- Right-of-way plan
  - Provide adequate ROW for ultimate needs
  - Consider alignment that shifts ROW to parcels with willing sellers
  - Avoid ROW alignments causing environmental impacts

ROW Best Practices or Countermeasures

- Improve acquisition methods
  - Obtain more ROW through local planning/platting process
  - Use land consolidation strategies to reduce number of parcels to be acquired
  - One-agent concept: use same agent in area to ensure consistency, efficiency, and accountability
  - Coordinate and communicate early and frequently
    - With property owners
    - Between ROW staff
    - With other agencies

Sample Performance Measures
ROW Acquisition



- Average parcel acquisition duration
- Overall duration of ROW acquisition
- Parcel condemnation rate
- Percent of parcels acquired within a specified period
- ROW costs saved for land dedicated or donated
- Number or percent of parcels acquired by early acquisition
- Percent of highway miles with inadequate ROW for desired improvements

Right-of-Way Protection

Right-of-Way Protection

- Important for future new and improved facilities
- General topics for ROW protection
  - Early or advance acquisition
  - Coordination in local planning and development
  - Roadside management

Interstate 4 at SR 408, Orlando, Florida

Early Acquisition and Protection

Method	TxDOT Authority	Local Authority	Purchase/ Possession	Obtain Rights
Acquisition				
Fee simple/negotiated purchase	●	●	●	
Condemnation	●	●	●	
Early acquisition – hardship purchase	●	●	●	
Early acquisition – protective purchase	O	●	●	
Early acquisition – donations	⊙	●	●	
Dedication through platting		●	●	
Preservation	●			
Option to purchase	⊙	●		●
Right of first refusal	●	●		●
Reservation through platting		●		●
Purchase development rights	●	●		●
Development agreement	●	●		●

O - More limited than local authority in some cases. **⊙ - More limited but also requires Commission approval.**

Protection via Coordination with Local Agencies

- TxDOT authority ends at the ROW line
- Activities most requiring coordination:
  - Subdivision
  - Zoning
  - Site plan review
  - Short /long-range planning
  - Roadway design plans and schematics (during project development)
  - Corridor/access management planning
  - Local major thoroughfare design standards and policies

Protection via Roadside Management

- ROW encroachment prevention
  - Encroachment identification
    - Development review, permits, monitoring, maintenance
  - Policies and regulations for roadside encroachment management
- Outdoor advertisement management
  - ROW Manual Vol.7 - Beautification
  - Local billboard ordinances

Potential ROW-Related Functionality Loss

- ROW factors causing functionality loss
  - Lack of coordination with local planning
  - Insufficient ROW requirements for major local thoroughfares
  - Lack of ROW reservation
  - Delay in ROW acquisition
  - Limitations on early acquisition
  - Failure to protect existing corridors
- Forms of functionality loss
  - Delayed construction/improvements
  - Inability to implement planned improvements
  - Deterioration in mobility and safety

Best Practices or Countermeasures

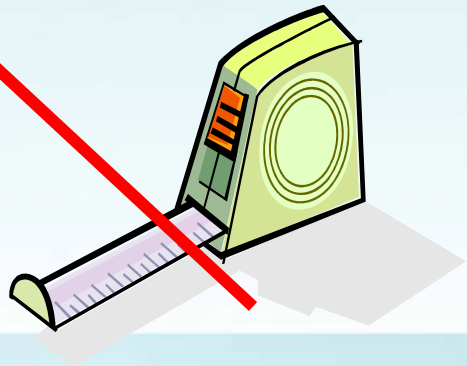
- Local agency coordination
  - Use multi-jurisdictional partnering to preserve, protect, or acquire ROW for long-term facility needs
- Early acquisition methods
  - Seek funds and authority for use in protective ROW purchases
  - Seek donations
- ROW protection via local thoroughfare plans and authority
  - Protect needed ROW via in local planning/platting process
  - Incorporate TxDOT (or other agreed) ROW and/or design requirements into local development regulations

Best Practices or Countermeasures

- ROW protection and roadside management
  - Utilize computer technology such as GIS, database, and Internet to facilitate outdoor advertising permitting and management
  - Pursue the use and enforcement of local building and parking setbacks and sign ordinances to prevent encroachment in TxDOT ROW

Selected Performance Measures

- Extent of pavement or shoulder cracks caused by vegetation encroachment
- Number of noncompliant outdoor advertising signs
- Percent of all plats and development proposals adjacent TxDOT facilities that are reviewed by TxDOT and coordinated with local agencies
- ROW acquisition unit cost



Utility Accommodation

Texas Transportation Institute

Utility Accommodation and Relocation

- Utility accommodation and relocation are major concerns for highway engineers
  - Joint use of ROW is in public interest and can avoid additional cost for exclusive utility ROW
  - Utility facilities are not owned or controlled by highway agencies
  - Joint use requires extensive collaboration

Preparing For Utility Coordination

- Assess highway and utility needs early in project development
- Identify alignments that minimize conflict
  - Ultimate
  - Design life
- If adjustments needed, do it just once
- Critical steps in the utility adjustment process:
  - Identify utility facilities and their ownership
  - Determine utility conflicts
  - Develop utility plans
  - Obtain, review, and approve agreements
  - Relocate utilities

TxDOT-Utility Cooperative Management Process

- Major activities:
  - **Preliminary information**: annual meetings
  - **Project specific information**: initial project notification, preliminary design meetings, and field verification
  - **Design and utility construction phase**: design conference, intermediate design meetings, final design and initial construction coordination meeting, and pre-letting utility meeting
  - **Construction phase**: utility meeting after award and utility coordination meeting during project construction

Potential Functionality Loss

- Factors leading to utility-related project delays:
  - Failure of utility conflict identification
  - Late project notification to utility owners
  - Limited staffing and fiscal resources
  - Unresponsive or uncooperative utility owners
  - Lengthy process to obtain required agreements for reimbursable utility relocations
- Forms of functionality loss
  - Increased construction costs
  - Delayed construction/improvements
  - Deterioration in mobility and safety

Best Practices or Countermeasures

- Utility coordination
  - Involve utilities early and frequently
  - Maintain good working relationships with utilities
- Utility relocation
  - Avoid relocating utilities where possible

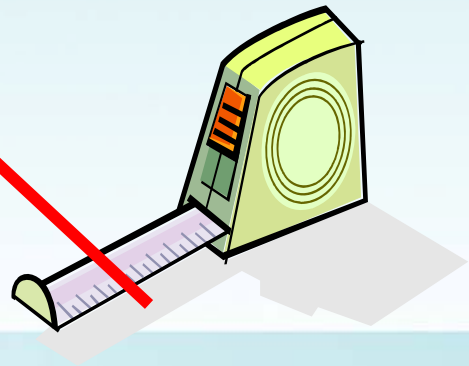
- Utility conflict detection and management
  - Detect utility conflicts early and accurately
  - Use advanced utility conflict management systems to effectively inventory and track utility conflicts

Best Practices or Countermeasures

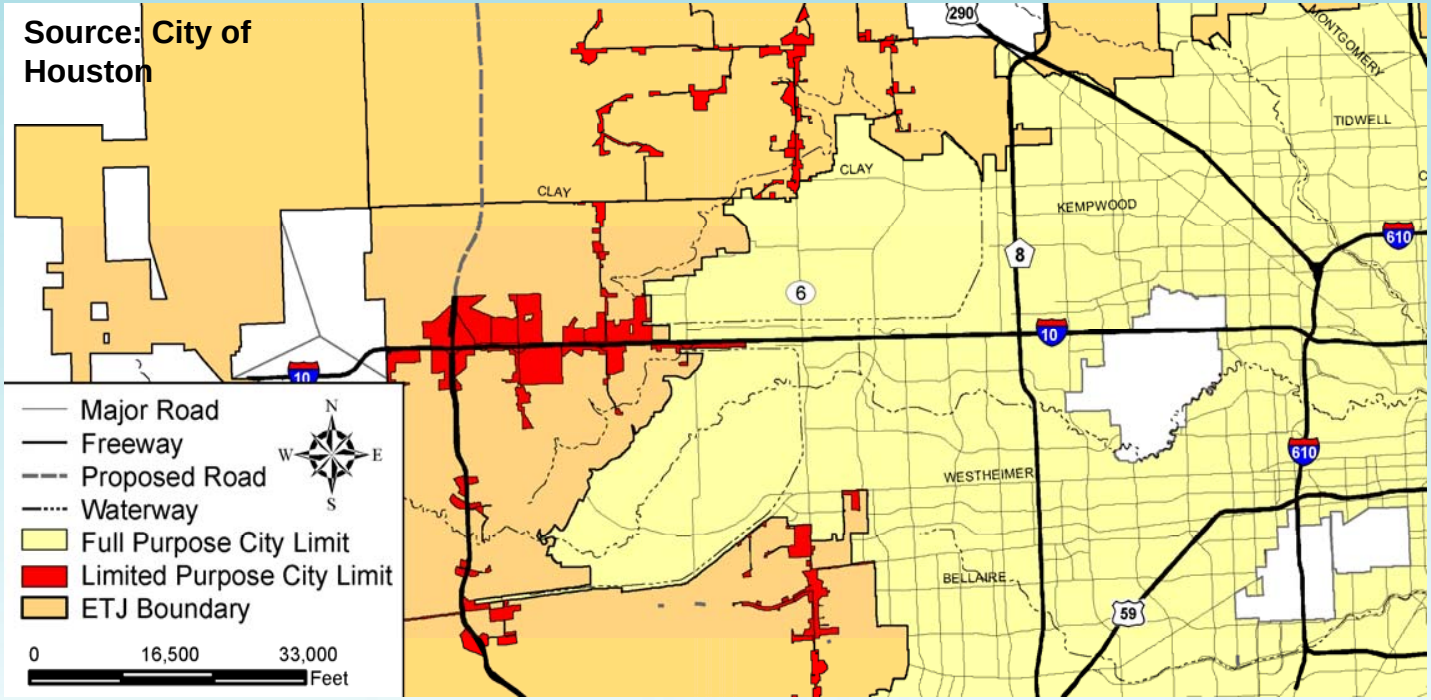
- Utility Accommodation
  - Consider protecting certain urban arterial highways from new utility installations
  - Consider innovative utility accommodation practices such as utility corridors or joint
  - Acquire ROW for utility accommodation

Performance Measures

- Number or length of utility relocations per mile or per project
- Utility conflict points per mile
- Percent of project budget for utility relocation
- Utility relocation cost per project mile
- Length of project duration for utility relocations, and
- Percent of utility-delayed projects



Functionality Case Study:
IH-10 Katy Freeway, Houston TX



Limits: Between SH 6 and Loop 610

Length: 11.5 miles

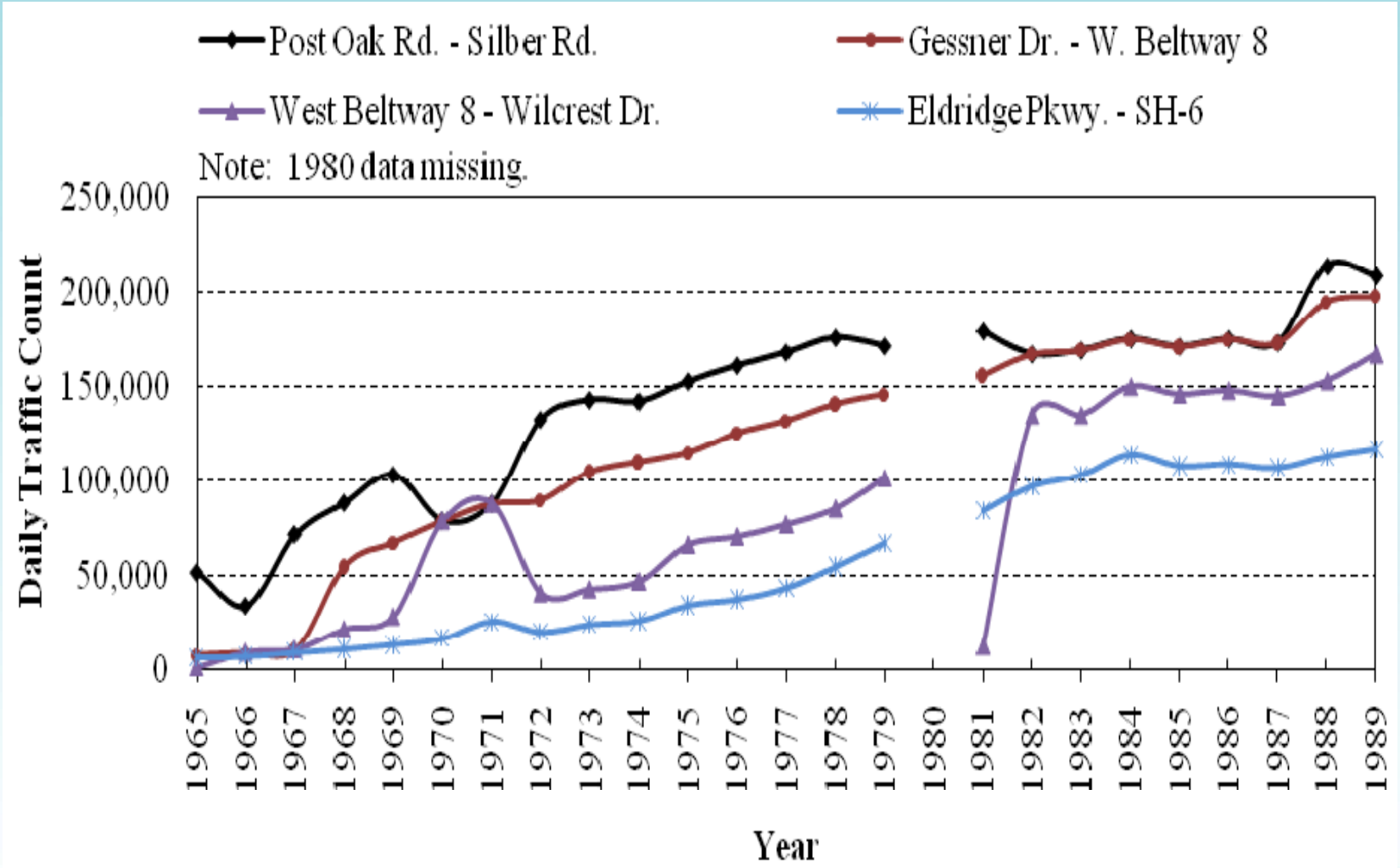
Historic Review

Year	Event
1930s	Originally SH 73 (generally located along the route of today's IH 10)
1941	West Houston portion of SH 73 designated as US 90
1953	US 90 between Katy and Loop 610 designated as full freeway
1954-1968	US 90 between Katy and Loop 610 upgraded to freeway
1980s	Katy Freeway Transitway between Loop 610 and SH 6
1992	100 ft. railroad right of way along Katy Freeway acquired from Union Pacific Railroad
2000s	Katy Freeway reconstruction

Key Areas Affecting Functionality

- Right of way and ROW constraints
- Mainlane, frontage, and interchange design
- Travel demand/systems management
- Planning and development
- Coordination and partnerships

Early Development in West Houston



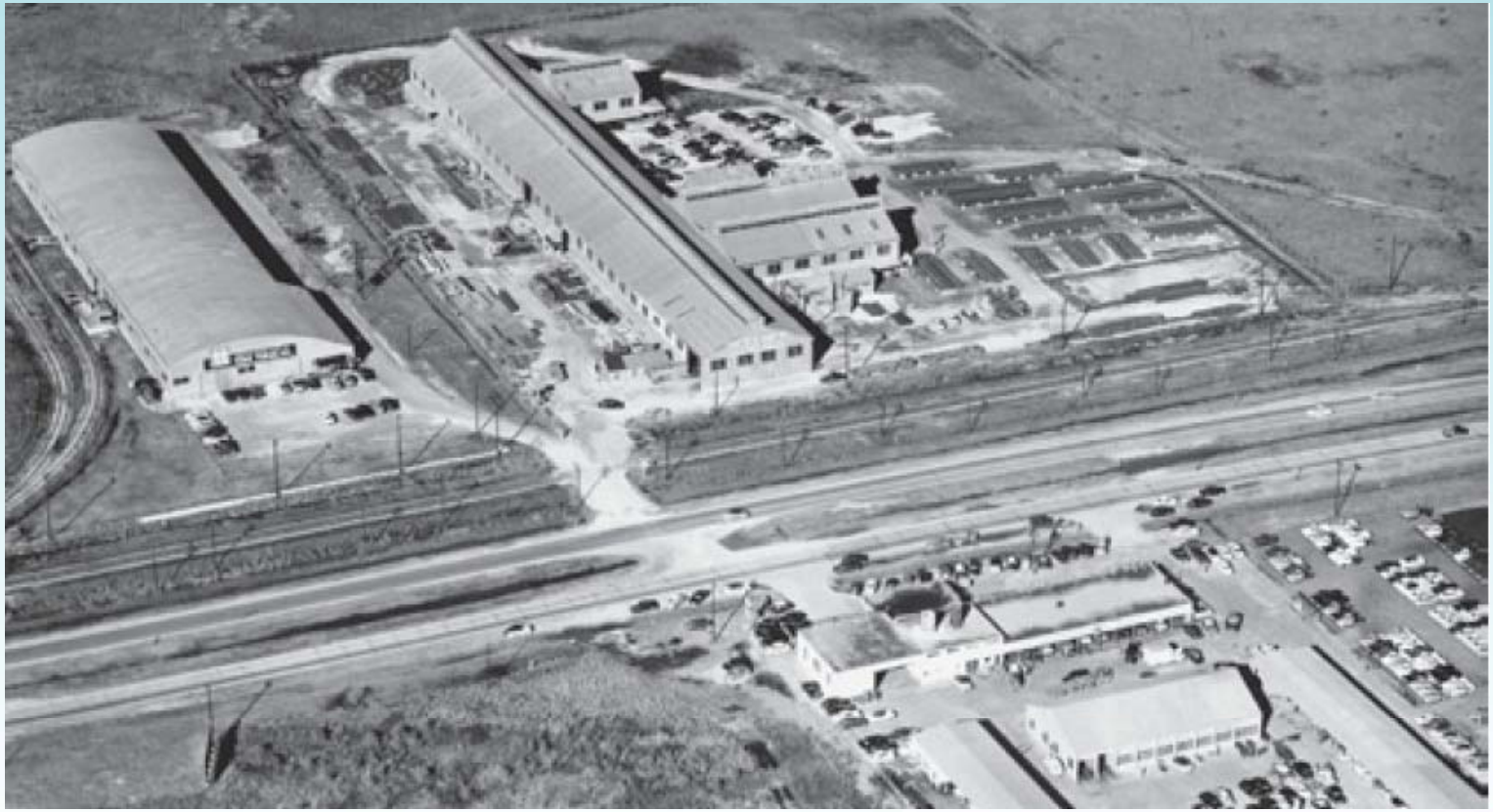
IH-10: Early Planning

Inside vs. Outside Loop 610

- Different engineers in charge of planning/design
- Disagreed on ultimate ROW needs
- Inside – ample ROW acquired, designed for future
- Outside – under-designed in existing ROW
  - Major constraint, source of delay for future expansion

IH-10 West: Early Planning

- 1954 view of US 90 as a 4-lane divided highway just west of today's Loop 610



Katy Freeway Upgrade in 1960s

IH-10 outside of Loop 610:

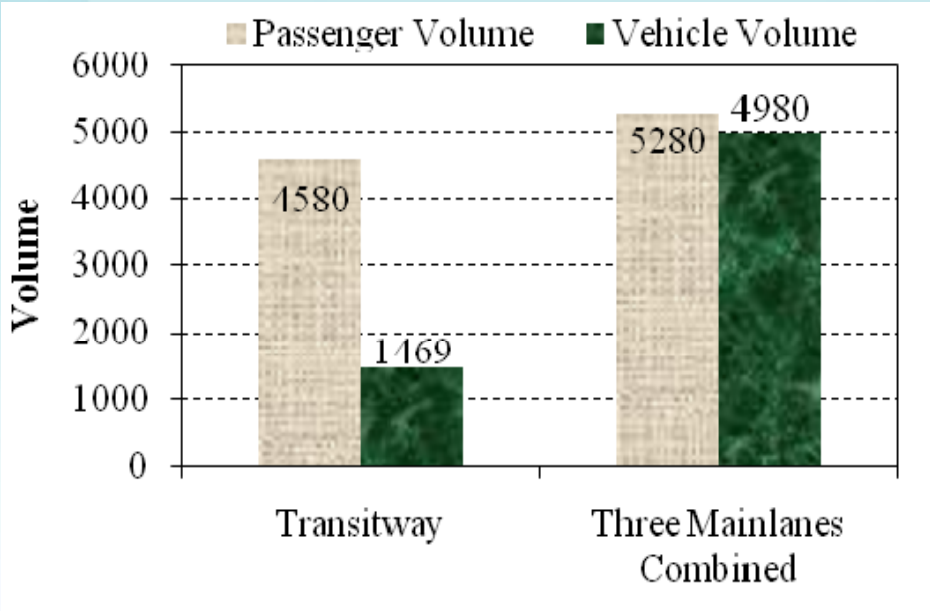
- Built on existing ROW
- 3 main + 2 frontage lanes
- ROW limit prevented further improvement

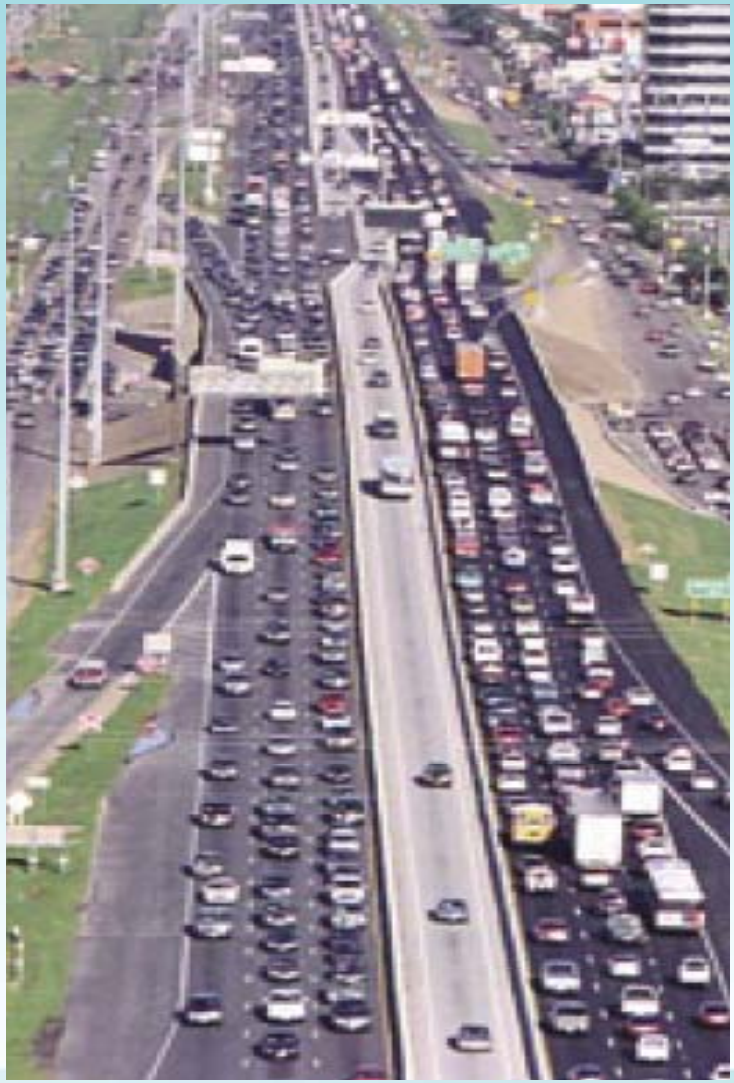
IH-10 inside of Loop 610:

- 10 main lanes minimum
- Currently still in service

Katy Freeway Transitway (1980s)

- SH 6 to IH 610: 15 min. on transitway vs. 45 min. on general lanes
- Served 23% of vehicle volume but 46% of passenger volume during morning peak hour

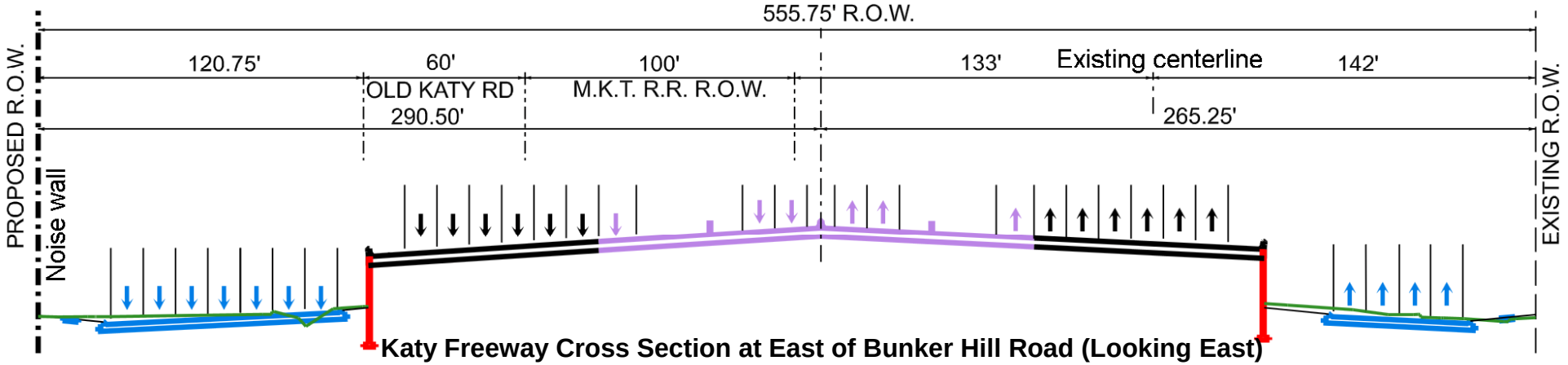




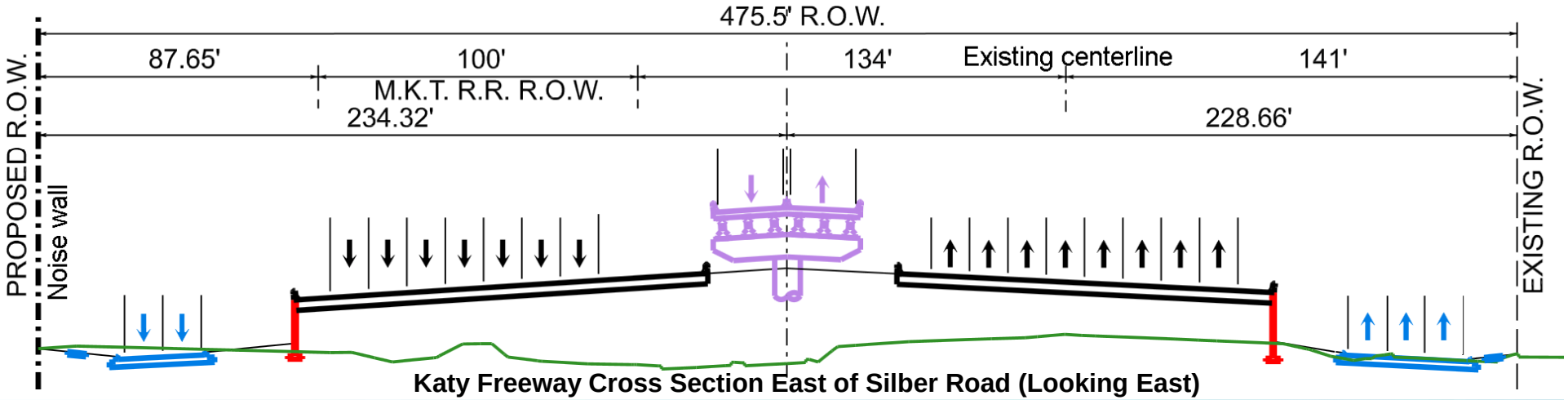
Katy Freeway Reconstruction (2000s)

- Study for expansion started in mid-1980s
- 1992: 100 ft. railroad ROW along Katy Freeway acquired from UP Railroad
- 1995: Katy Freeway MIS - preferred alternative selected
- Later involvement of HCTRA - HOV lanes converted to HOT lanes
- August 2002: FHWA issued Record of Decision
- March 2003: FHWA, TxDOT, and HCTRA signed agreement finalizing operational/financial arrangements
- October 2008: grand opening of the new freeway

Katy Freeway Reconstruction – Final Design



Katy Freeway Cross Section at East of Bunker Hill Road (Looking East)



Katy Freeway Cross Section East of Silber Road (Looking East)

The New Katy Freeway

IH10 at SH 6, Before Construction

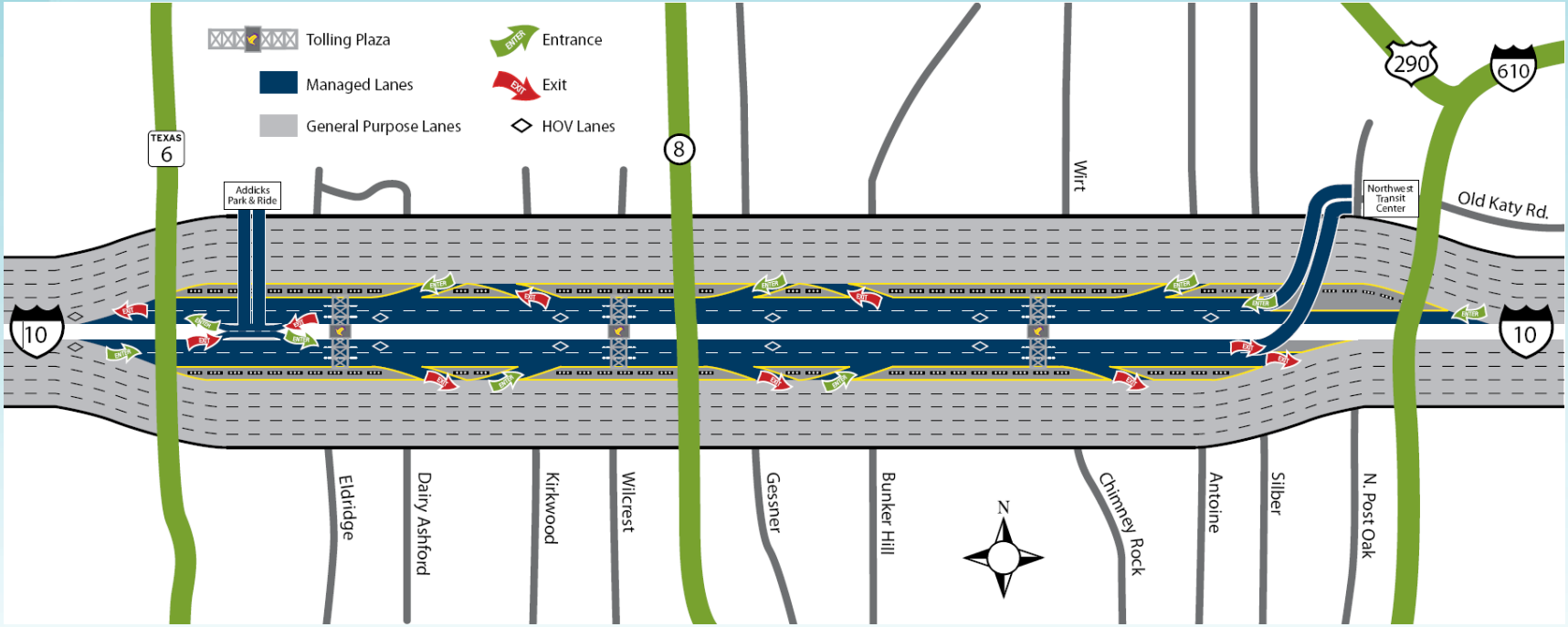
IH10 at SH 6, After Construction

I-10 at Beltway 8

Before Construction

After Construction

Katy Freeway Managed Lanes



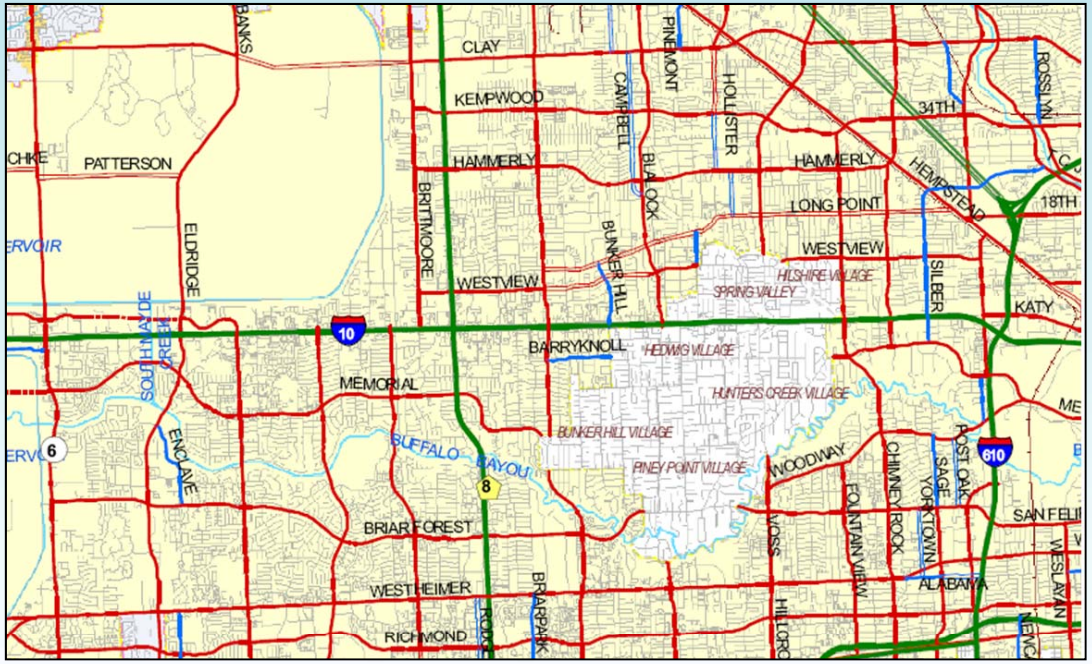
Katy Freeway Managed Lanes

- Opened April 2009
- 4 managed lanes between SH 6 and Loop 610, separated by barrier
- Combine HOV lanes, transit, and toll roads; first in Texas
- METRO and school buses use for free
- Dynamic tolling method used
- Provides faster option and funding source for maintenance

Katy Freeway Managed Lanes Video

Local Thoroughfare Planning

- Houston's adopted in MTFP 1942
- General 1 mile thoroughfare grid system
- Houston's adopted in MTFP 1942
- Plan amendments considered once per year via public hearing
- I-10 functionality supported through local street connectivity



City of Houston 2008 Major Thoroughfare and Freeway Plan

Katy Freeway Case Study Discussions

- Importance of ROW preservation
- Use of minor improvements
- Use of managed lanes
- Interagency collaboration (FHWA, TxDOT, HCTRA, and METRO)
- Local thoroughfare planning support

MODULE 4

Safety and Functionality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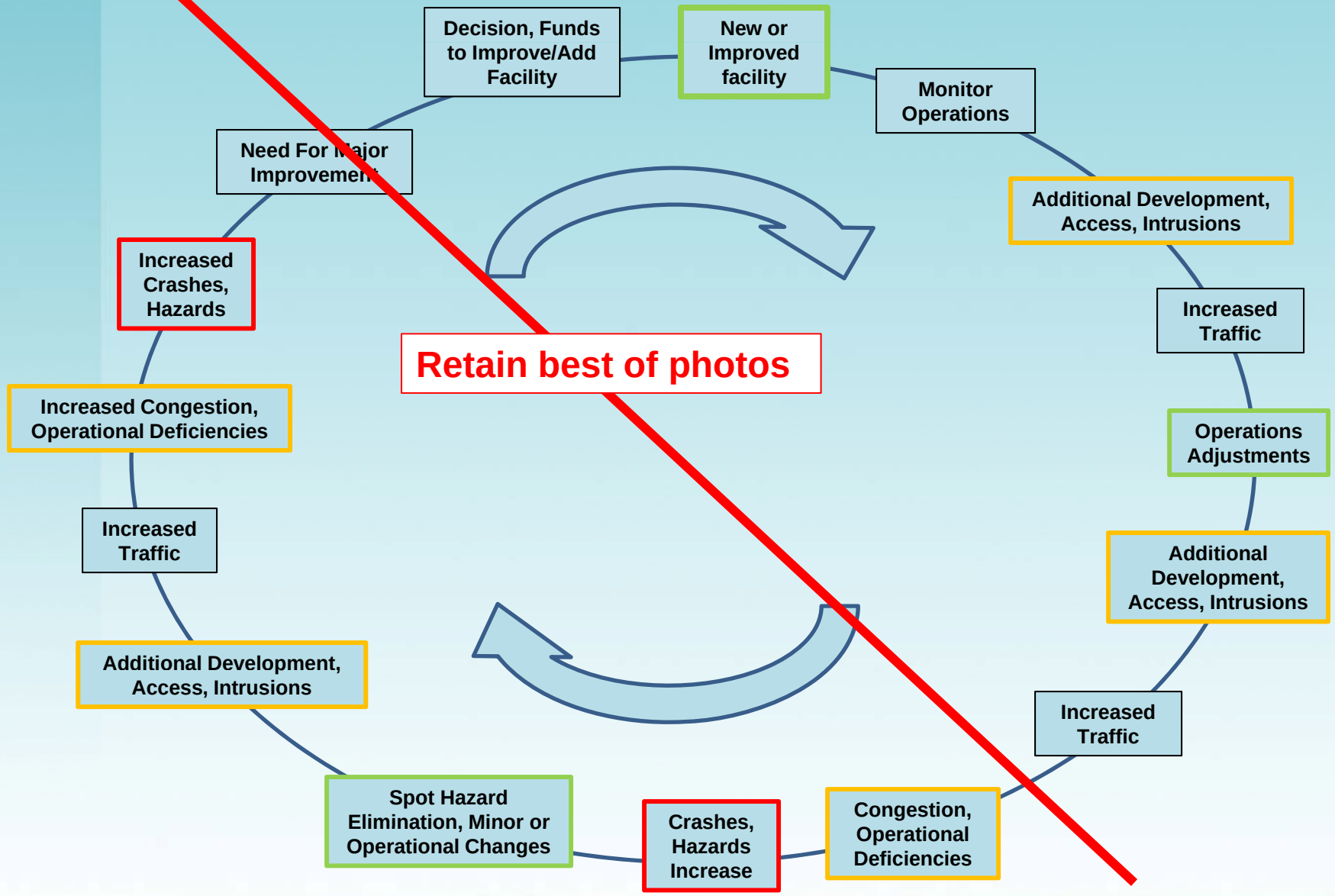
Safety Functionality Cycle



Keeping Up with Safety Changes

- Complaints
- Requests
- Performance measures

Clearing undergrowth on the right side would significantly improve sight distance through the curve and allow motorists to judge more accurately the length and sharpness of the curve—and more importantly see oncoming traffic.

Safety Performance Measures

- Crash rates
  - Segments
    - Crashes/100 MVM
    - Serious injuries + fatalities/100 MVM
    - Fatalities/100 MVM
  - Intersections
    - Crashes/million entering vehicles
    - Fatalities/million entering vehicles (rarely used)
- Crash severity (segments and intersections)
  - Percent fatal or serious injury crashes
  - Severity index (weighted severity)

Before: Outdated guardrail at the SR 7/SR 705 interchange with I-5 in Tacoma.

After: The replacement guardrail meets current safety standards, and creates a continuous transition to the bridge rail, removing the blunt end that had existed previously.

Data Sources for Performance Measures

- Crash report information (TxDOT)
  - Crash record information system (CRIS)
  - Accident history database
- Safety performance analysis
  - Highway Safety Information System (HSIS)

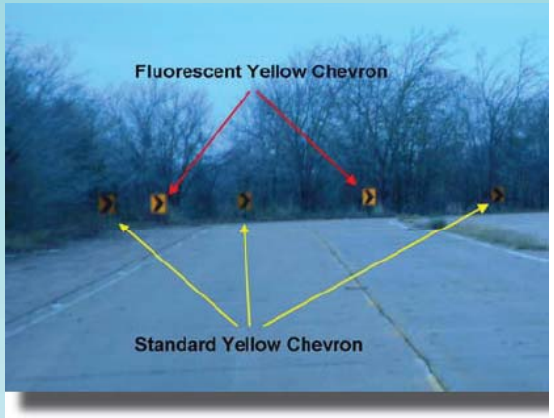
Causes of Safety Deterioration

- Design deficiencies
- Changed conditions, such as:
  - Pavement
  - Roadside objects
  - Sight obstructions
    - Development
    - Plants
    - Signs
  - Development access
  - Traffic volume or composition
    - Vehicle types
    - Modes
  - Sign, marking deterioration or loss
  - Shoulder, roadside erosion

Example of blue bike lane between right turn lane and shared right-through lane (Portland, OR)

Causes of Safety Deterioration

- Changed conditions (cont.)
  - Increased volumes
    - Total
    - Merge
    - Weave
    - Turns
  - Warrants for improvement are exceeded
    - Access management/medians
    - Lanes, ramps
    - Lighting
    - Signals



Source: Texas Transportation Institute

Stimulus photo illustrating enhanced chevron visibility.

Doubling-up of the sign proved effective at this site because tree limbs partially blocked the right side sign.

Causes of Safety Deterioration

- Changed conditions (cont.)
  - Signals not retimed periodically
  - Increased pedestrian, bicycle activity
  - Speed limit not commensurate with conditions
  - Hazards installed over time
    - Poles and boxes
      - Utility
      - Signals
      - Lighting
    - Signs
    - Drainage structures

Factors Related to Safety Deterioration

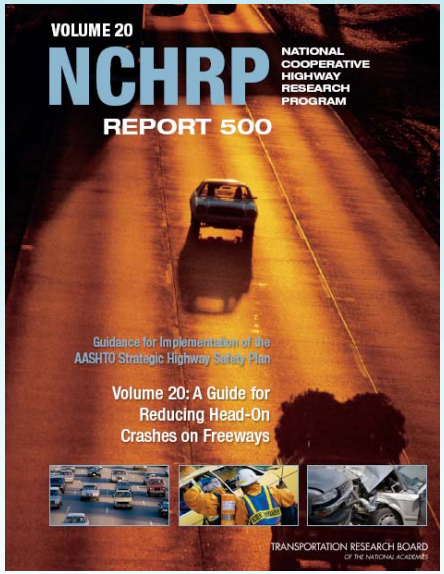
- Access management
- Horizontal, vertical curves
- Cross-sections
- Clear zone
  - Width
  - Obstructions
- Sight distances
- Interchange spacing, merge, weave sections
- Drainage
- Pedestrian, bicycle facilities
- Drainage
- Grades
- Intersection design
- Lighting
- Roadway delineation
- Traffic control
- Design consistency
- Maintenance conditions
- Pavement friction

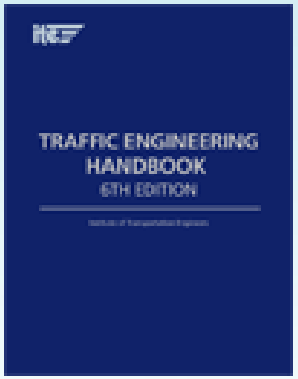
Deterioration of pavement edge and shoulder due to poor drainage.

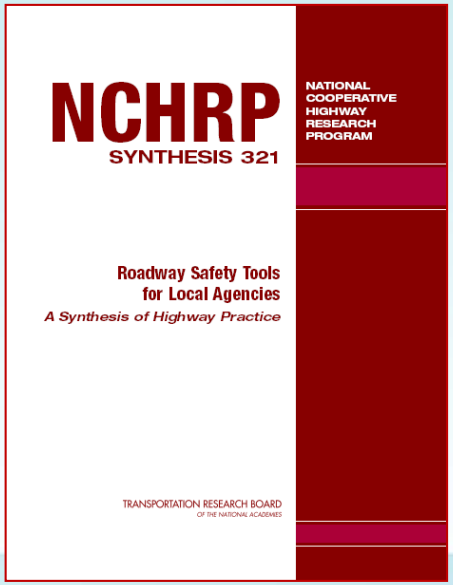
Application of skid-resistive pavement surface in curve.

Countermeasures

- Multiple sources
  - ITE Traffic Engineering Handbook, chapter 5
  - NCHRP Report 500 (several volumes)
  - NCHRP Synthesis 321







Countermeasures
Example – Rural Run-Off-Road

Potential Causal Factor	Some Possible Countermeasures
Excessive speed	Reduce speed limit; enforce
Slippery pavement	Reduce speed limit; enforce Overlay pavement Provide adequate drainage Groove pavement Provide SLIPPERY WHEN WET signs
Inadequate roadway lighting	Improve lighting
Poor visibility of curve warning sign	Increase sign size
Inadequate roadway design	Widen lanes Re-align curve Install guardrail
Inadequate delineation	Install/improve warning signs Install/improve Pavement markings Install/improve delineation
Inadequate shoulder	Upgrade shoulder
Inadequate pavement maintenance	Repair road surface

Source: *Traffic Engineering Handbook*, 6th edition, Institute of Transportation Engineers

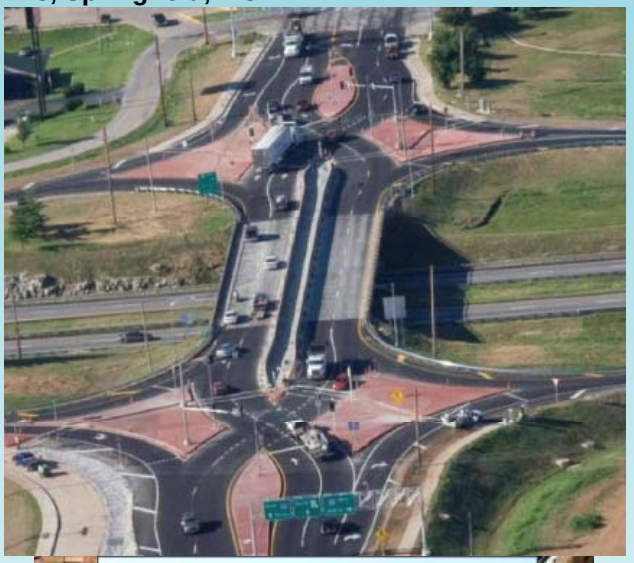
Countermeasures
Example – Rural Roadside Safety

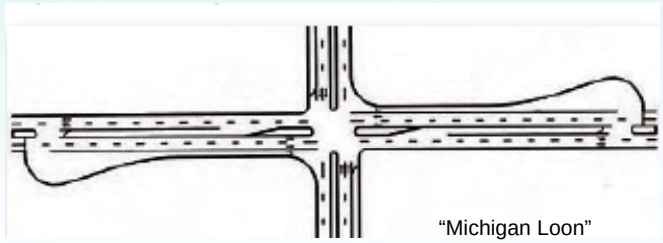
- ~50% of all crashes run-off-road
- Fatalities usually involve fixed objects
  - Trees, shrubs
  - Culverts, ditches, curbs
  - Utility poles
- Improvement options
  - Remove obstacle
  - Relocate or redesign obstacle to be less likely struck
  - Use breakaway base
  - Shield obstacle with barrier or other device
  - Delineate obstacle (only if other methods not viable)

Countermeasures – Geometrics Examples

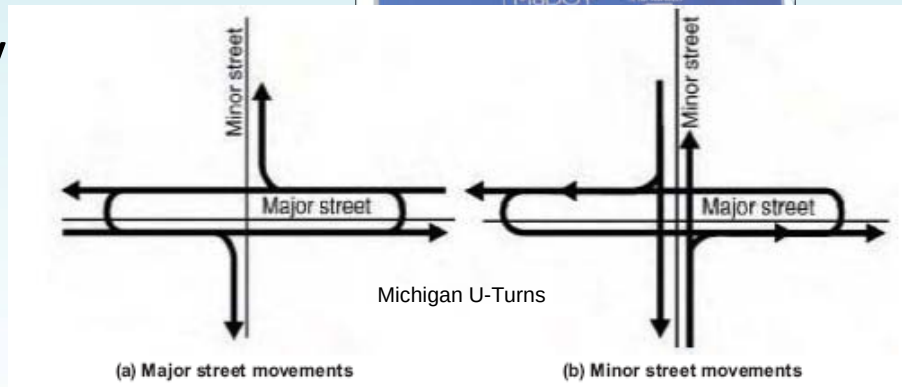
- Geometric design
  - Improve access control
    - Close/consolidate access points
    - Relocate access to side road
    - Add turn/speed change lanes
    - Increase distance to ramps
    - Redesign access for higher speed
  - Improve curve features
    - Widen lanes or shoulders through curve
    - Realign to increase radius
    - Increase sight distance
  - Increase roadside recovery distance

Diverging Diamond Interchange, I-40 at Hwy 13, Springfield, MO



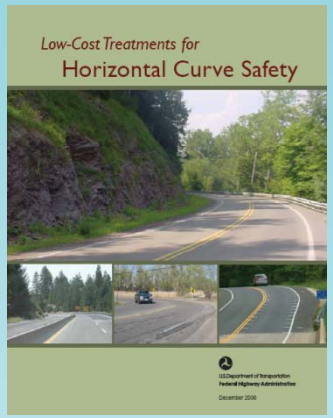


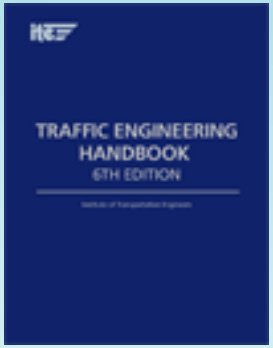
"Michigan Loon"

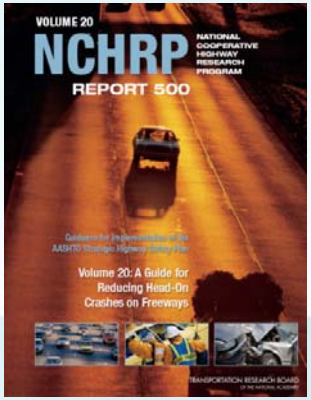


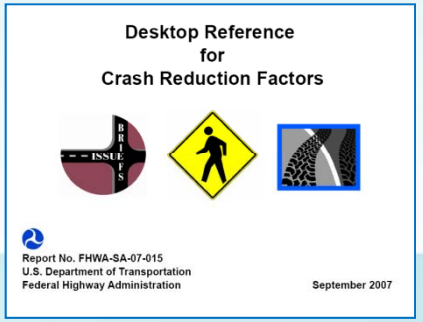
Tools, Sources

- Low Cost Treatments for Horizontal Curve Safety (FHWA)
- Interactive Highway Safety Design Model (IHSDM) (FHWA)
- Highway Safety Manual (FHWA)
- NCHRP Report 500 – several volumes (TRB)
- Traffic Engineering Handbook (ITE)
- Desktop Reference For Crash Reduction Factors (FHWA) and Highway Safety Improvement Program Manual (TxDOT)
- SafetyAnalyst software (FHWA)
- Highway/Utility Guide (FHWA)







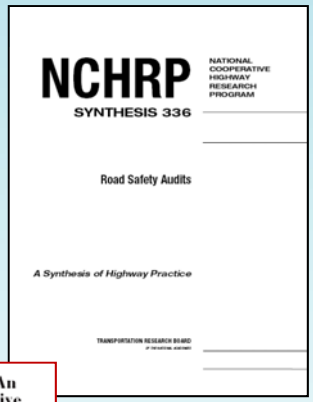


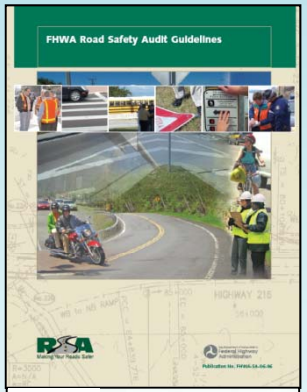
Assessing Safety in Design

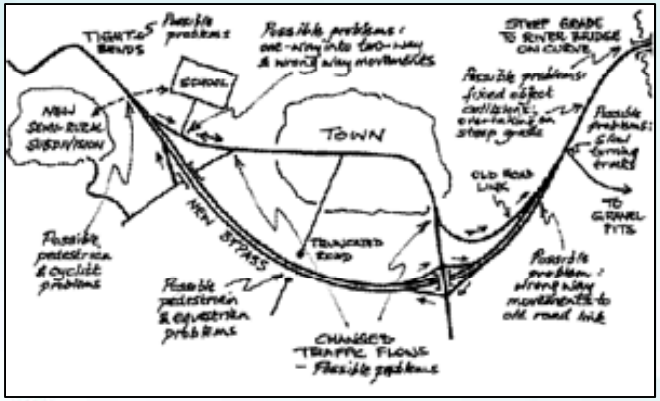
Starting Point		Work Stage
Existing		1. Use performance measures to identify problems
		2. Analyze crash records and existing conditions
		3. Identify effective countermeasures
		4. Select best countermeasure
New design	Road Safety Audit Review Each stage	1. Project feasibility/initial schematic design
		2. Preliminary design
		3. Final design
		4. Pre-opening

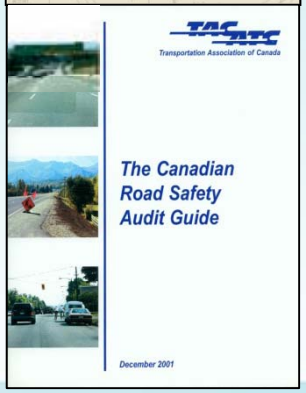
Road Safety Audit (RSA)

- Proactive low cost effort to prevent crashes before they happen
- Performed by specially trained personnel
  - RSAs and crash prevention
  - Independent of design team
  - Not unlike value engineering









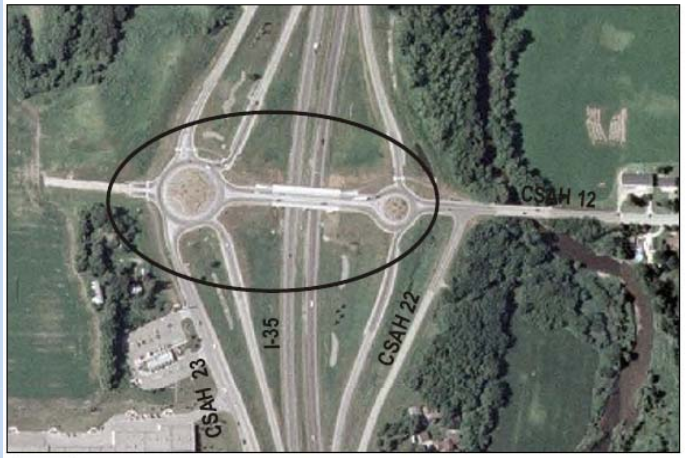
RSA Benefits

1. Can
   - Help produce designs that result in fewer and less severe crashes
   - Reduce costs by identifying safety issues and correcting them before projects are built
2. Considers human factors in all facets of design
3. Raises profile of safety
4. Promotes awareness of safe design practices
5. Integrates multimodal safety concerns

RSA Checklist (partial)

- Design criteria and application
- Design speed
- Design volumes and vehicle and mode types
- Alignment and continuity
- Cross-sections
- Intersections, interchanges
- Sight distances
- Shoulder and edge treatments
- Access management
- Lighting
- Traffic control devices
- Drainage
- Landscaping
- Construction staging
- Traffic operations, incident management
  (differs by type of facility)

MnDOT Road Safety Assessment



SRF — SITE 15 AERIAL - CSAH 12/I-35 INTERCHANGE AND BRIDGE — Figure 15
STEELE COUNTY ROAD SAFETY AUDIT REPORT
Steele County

Conditions (partial)

- Numerous unreported minor crashes
- Considerable curb damage
- Skid marks and curb jumping at ramp approach to west roundabout
- 11 inch curb on medians and roundabouts
- Faded markings
- Sight distance limited by plants

Recommendations (partial)

- Install YIELD and ONE-WAY signs on ramps
- Trim vegetation
- Refresh pavement markings
- Check geometrics for turn radii for vehicles using interchange

RSA Finding Examples

- Sight line obstructions resulting from proposed improvements
- Insufficient merge or weave section length
- Transition problems
- Temporary pavement marking still clearly visible
- Improper sign sizes used
- Missing traffic control devices
- Proposed pole unconstructable; utility beneath
- Potential for wrong way turns
- Drainage headwall creates clear zone obstruction
- Water ponds in curb lanes

- Combination horizontal and vertical curves create condition well below design speed
- View of signal heads will be obstructed from one approach when trucks present
- Guardrail lacks end treatments
- Traffic signal timing insufficient for pedestrians
- Insufficient night visibility
- CCTV camera view blocked by overhead sign
- Near right traffic signal has insufficient target value
- Sidewalks to or at bus stops badly cracked/broken

RSA Applicability

- New facilities
- Existing facilities ("roadway safety assessment")
  - During project development/design
  - In operation
- Any size project

Example - 12-inch heads, one signal head per lane, back plates

RSA Example

Existing Interchange

Improved Interchange (simulation)

Improvements include:

- Replacement of left-side ramps with conventional right-side ramps
- Lengthening or elimination of existing short weaving sections
- Increased curve radii on ramps
- Lane continuity and consistency for through traffic
- Increased capacity on system ramps
- Increased barrier height

TABLE A.4 SUMMARY OF SELECTED SAFETY ISSUES AND SUGGESTIONS WISCONSIN DOT RSA

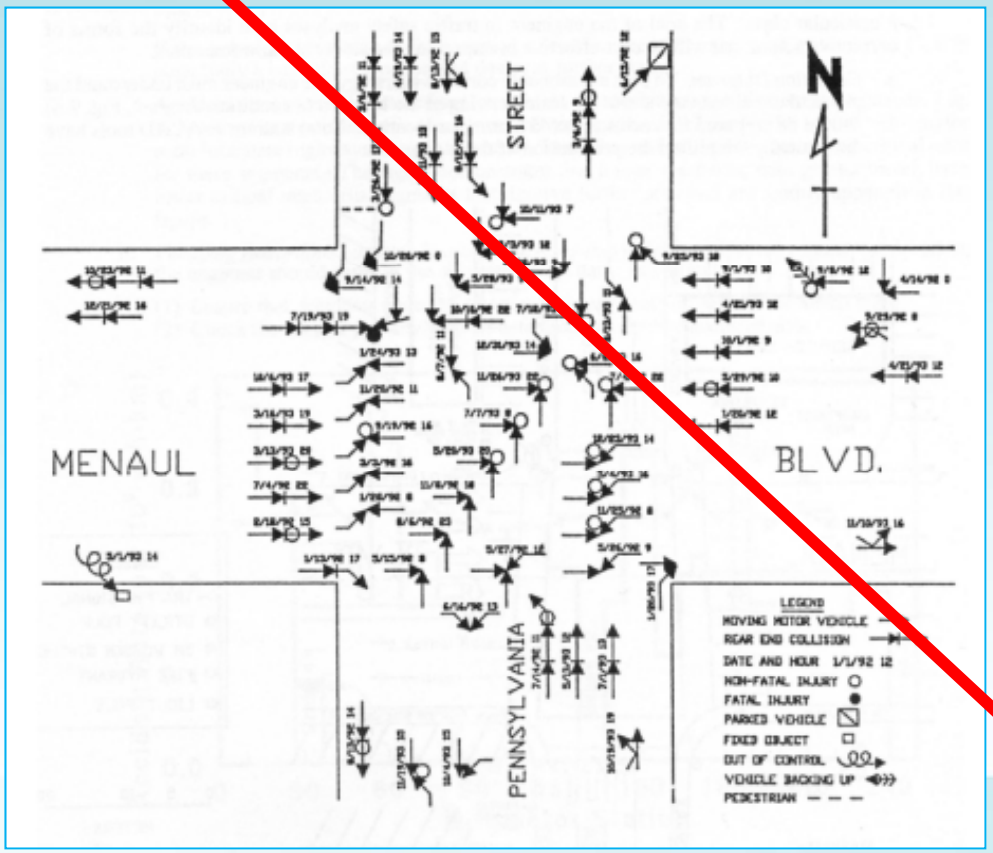
SELECTED SAFETY ISSUE (Number and Description)		RISK RATING	SUGGESTIONS
1	Plankinton Exit Ramp and Clybourn Street Entry Ramp: Mainline drivers may attempt an abrupt, unsafe lane change to access these ramps.	D	• Extend a proposed concrete barrier to block unsafe movements.
2	Westbound I-94: Traffic from two high-volume system ramps meets the east-west mainline approximately about 1,700 feet upstream of Exit 309B, resulting in a limited weave distance.	E	• Provide advanced signing for Exit 309B to reduce the need for sudden lane changes. • Block access to Exit 309B from westbound I-94.
3A	Wisconsin Avenue at 11th Street: Dual turning lanes leading to different destinations may cause driver confusion and erratic movements.	C	• Improve signing and pavement marking. • Consider geometric changes (possibly as a future retrofit).
3B	Highland Street: During peak periods, left-turn queues may extend into or past adjacent closely-spaced intersections on Highland Street.	D	• Conduct microsimulation modeling. • Signalize / coordinate ramp intersection. • Restrict some left-turn movements.
3C	Highland Street at 12th: Long crossing distances, diagonal curb ramps, and a partial crosswalk obstruction may increase the pedestrian collision risk.	D	• Review / improve accommodation of pedestrians.
4	Barrier Heights at Ramps: The proposed barrier height of 42 inches on system-to-system ramps may not be sufficient to prevent truck roll-over collisions.	C	• Consider higher barriers where needed and where feasible.
5	Signing: Some proposed signing may not provide sufficient guidance, especially to unfamiliar drivers.	B	• Clarify "Downtown" signing. • Clarify cardinal directions. • Add advance signing at noted locations. • Add ramp advisory speed limit signs.
6A	Distractions During Construction: Roadside construction activities may distract or startle drivers,	C	• Consider "gawk screens" to block drivers' view of construction activities.
6B	Construction Phase Traffic Management: Construction-phase routing may entail some risk for drivers.	D	• Conduct microsimulation analysis, and consider specified road closures or turning restrictions to reduce traffic load on unsuitable local streets.

TxDOT Programs

- Highway Safety Improvement Program
  - 90% federal, 10% state/local
  - Hazard elimination (non-Interstate)
- High Risk Rural Roads
  - Major and minor collectors
  - Fatal/incapacitating injury rate above statewide average
  - Excludes Interstates, bridges, general maintenance
- Administered by TxDOT Traffic Operations Division

Crash Data

- Obtain from Traffic Operations Division
- Crash Records Information System (CRIS)
- Use 3 (or more) years of data



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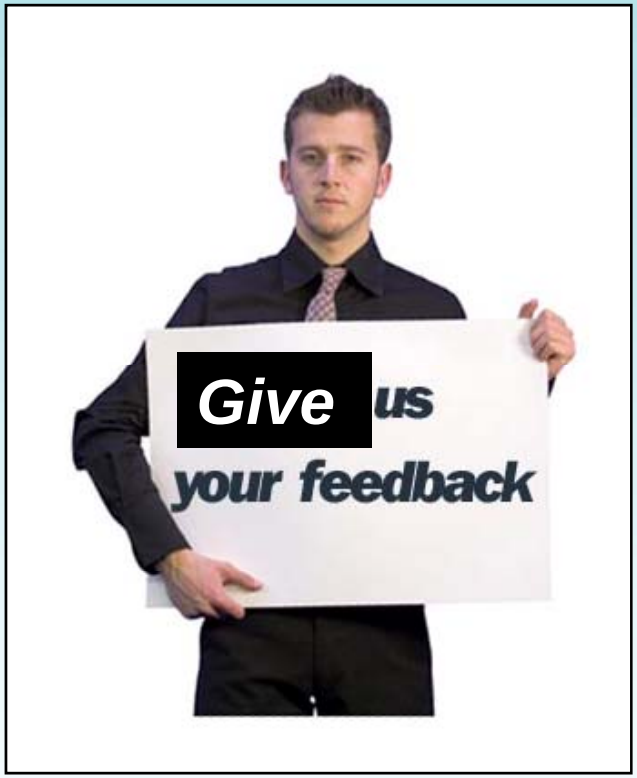
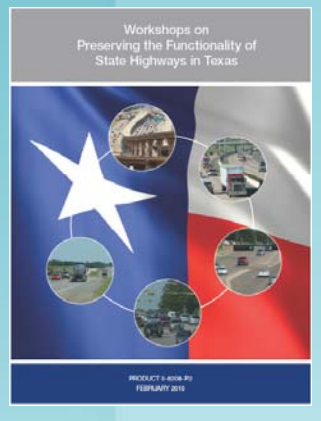
Preserving and Recapturing Safety Functionality

Questions?

Participant Feedback on Workshop

- How can we improve this workshop?
  - Content?
  - Organization?
  - Time on each topic?
  - Instructor delivery?
  - Other?
- Please complete evaluation form





Preserving and Enhancing the Functionality of Highways in Texas

….for attending!

Questions Later?

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