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Research Forest Drive and Lake Woodlands Drive – Project Summary Meeting

The Woodlands
Montgomery County Precinct 3
April 15, 2021

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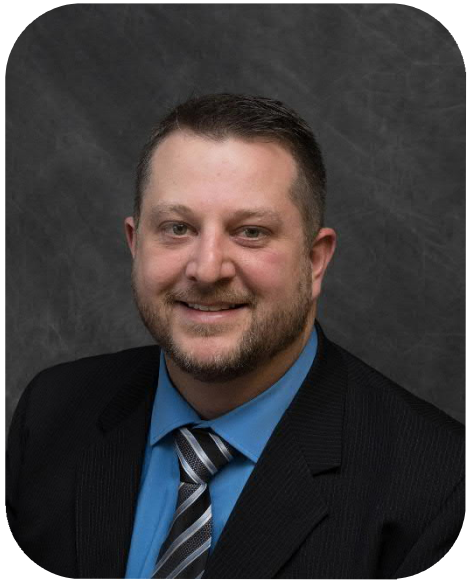
Welcome and Introductions

Strand Associates Team



Luke Holman, P.E.
Project Manager

Jared Engelke, P.E.
Project Engineer

Kyle Henderson
Traffic Engineer

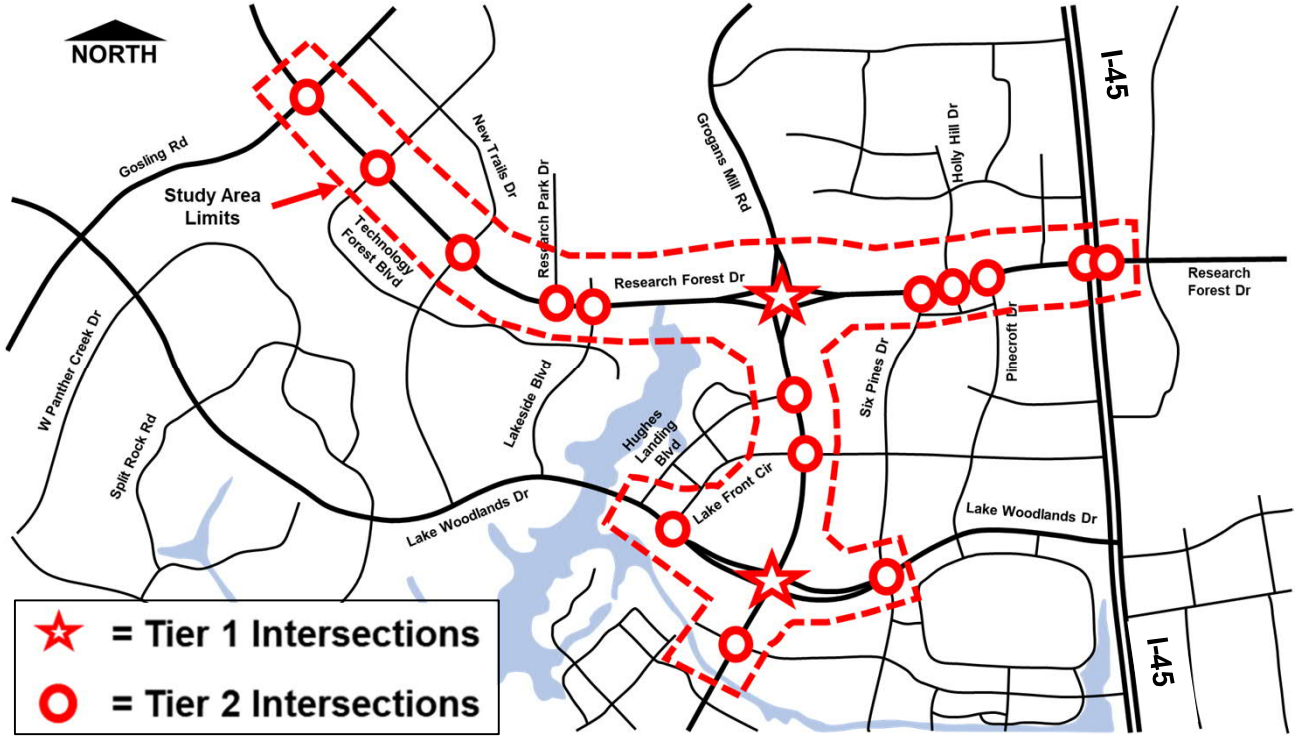
Craig Kankel, P.E.
Project Advisor

Agenda

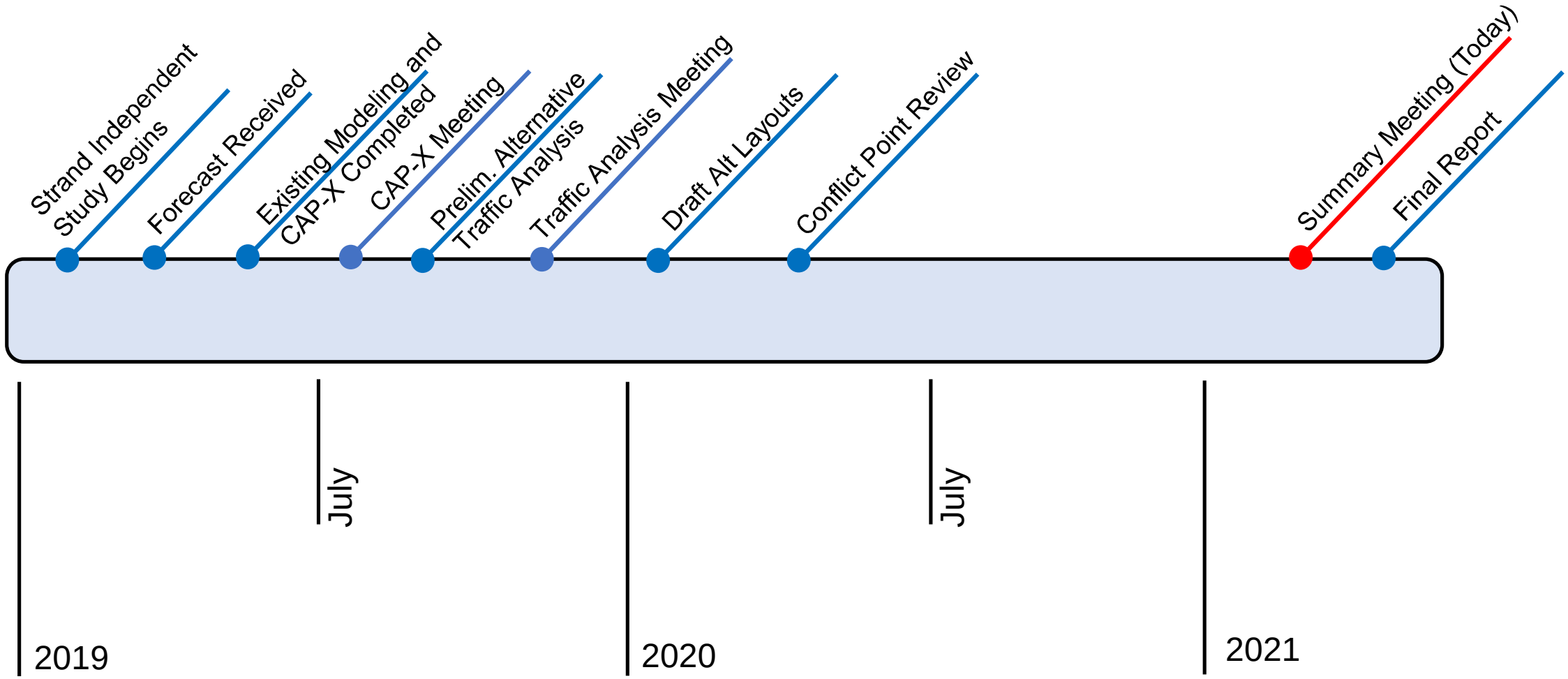
1. Project Overview – Needs Identification
2. Initial (CAP-X) Screening Summary
3. Detailed Operational Analysis Summary
4. Intersection Alternative Development
5. Alternative Conflict Point Analysis
6. Preliminary Alternative Costs
7. Project Next Steps

Project Overview – Location and Scope

- Intersection Analysis
  - Tier 1 intersections (2) at-grade and grade-separated alternatives
  - Tier 2 (15) traffic signal optimization and turn-lane improvement alternatives
  - Today's focus: Tier 1 intersections, particularly Grogan's Mill & Research Forest



Project Overview – Project Timeline



Intersection History (Grogans Mill & Research Forest)

- Previous study history
- High crash rates at Grogans Mill Road and Research Forest Drive
  - 37 crashes per year (3 crashes per month)
  - 3 serious crashes per year
- Short term improvements have been exhausted
  - Added supplemental wrong way signage
  - Ordered flashing “Wrong Way” signage along with “Do Not Enter” signage
  - Added signage to the signal mast arms
  - Adjusted signal timing for safety
  - Relocated the SE signal pole to the other side of the street
  - Guard rails were added on the eastbound approach
  - Vegetation is routinely trimmed

Project Overview – Comparison of Current to Previous Traffic Counts

- Existing traffic counts – Current vs Previous study
  - Geoffrey E. Havers (GEH) statistical test – evaluate similarity of two data sets
  - GEH values: below 5 = good match, values >5 and <10 = additional investigation may be warranted
  - Goal: 90 percent of data points with a GEH less than or equal to 5

Peak Hour	# of data points	# with GEH < 5	% with GEH <5
Research Forest Drive and Grogans Mill Road			
AM Peak	16	15	93.8%
PM Peak	16	16	100%
Lake Woodlands Drive and Grogans Mill Road			
AM Peak	14	14	100%
PM Peak	14	14	100%

  - The EB thru at SB Grogans Mill Road has a GEH of 5.38. The new count is 1301 vs. the previous study value of 1114

Project Overview – Future Volume Development

- Future traffic volumes developed by applying the Houston-Galveston Area Council (H-GAC) travel demand model growth rates to 2019 traffic count data

H-GAC Travel Demand Model Growth (from 2019 Base)

Corridor	2030 Growth	2045 Growth
Research Forest Drive	16.4%	29.8%
Lake Woodlands Drive	55.8%	65.1%
Grogan Mill Road	41.3%	62.0%

Initial (CAP-X) Screening Summary

- What is CAP-X? An intersection capacity screening tool developed by FHWA
- 15 at-grade and 8 grade-separated alternatives were screened for each Tier 1 intersection
- Why 15 at-grade alternatives? Many ways to accommodate left-turn traffic (typically, left-turn lanes are the least efficient movements)
- Evaluated both AM and PM peak hour traffic for each alternative
- Most promising CAP-X alternatives were then evaluated in greater detail

Capacity Analysis for Planning of Junctions

Input Worksheet

		Critical Lane Volume Sum			
Project Name:	Research Forest and Lake Woodlands	Acceptable Configurations			
Project Number:	4609.001	< 1200	1200 - 1399	1400 - 1599	≥ 1600
Location	2045 PM Reasearch Forest Drive and Grogans Mill Road	7	11	5	9
Date	April 18, 2019				

Results for Intersections

#	TYPE OF INTERSECTION	Sheet	Zone 1 (North) CLV	Zone 1 (North) V/C	Zone 2 (South) CLV	Zone 2 (South) V/C	Zone 3 (East) CLV	Zone 3 (East) V/C	Zone 4 (West) CLV	Zone 4 (West) V/C	Zone 5 (Center) CLV	Zone 5 (Center) V/C	Overall v/c Ratio	Ranking
1	Conventional	FULL									1430	0.89	0.89	10
2	Conventional Shared RT LN	CSRL									1600	1.00	1.00	14
3.1	Quadrant Roadway	S-W			1289	0.81			1122	0.70	1100	0.69	0.81	6
3.2		N-E	1128	0.70			1057	0.66			1385	0.87	0.87	8
3.3		S-E			1459	0.91	1459	0.91			1254	0.78	0.91	11
3.4		N-W	1084	0.68					1257	0.79	1198	0.75	0.79	4
4.1	Partial Displaced Left Turn	N-S	554	0.35	901	0.56					1212	0.76	0.76	2
4.2		E-W					698	0.44	1059	0.66	1260	0.79	0.79	5
5	Displaced Left Turn	FULL	325	0.20	659	0.41	821	0.51	1059	0.66	1009	0.63	0.66	1
6.1	Restricted Crossing U-Turn	N-S	1595	1.00	1855	1.16	3213	2.01	2136	1.33			2.01	15
6.2		E-W	1256	0.79	1134	0.71	1391	0.87	973	0.61			0.87	9
7.1	Median U-Turn	N-S	982	0.61	1067	0.67					1257	0.79	0.79	3
7.2		E-W					1346	0.84	962	0.60	1351	0.84	0.84	7
8.1	Partial Median U-Turn	N-S	836	0.52	826	0.52					1485	0.93	0.93	12
8.2		E-W					850	0.53	905	0.57	1485	0.93	0.93	12

CAP-X (Capacity Analysis for Planning of Junctions)

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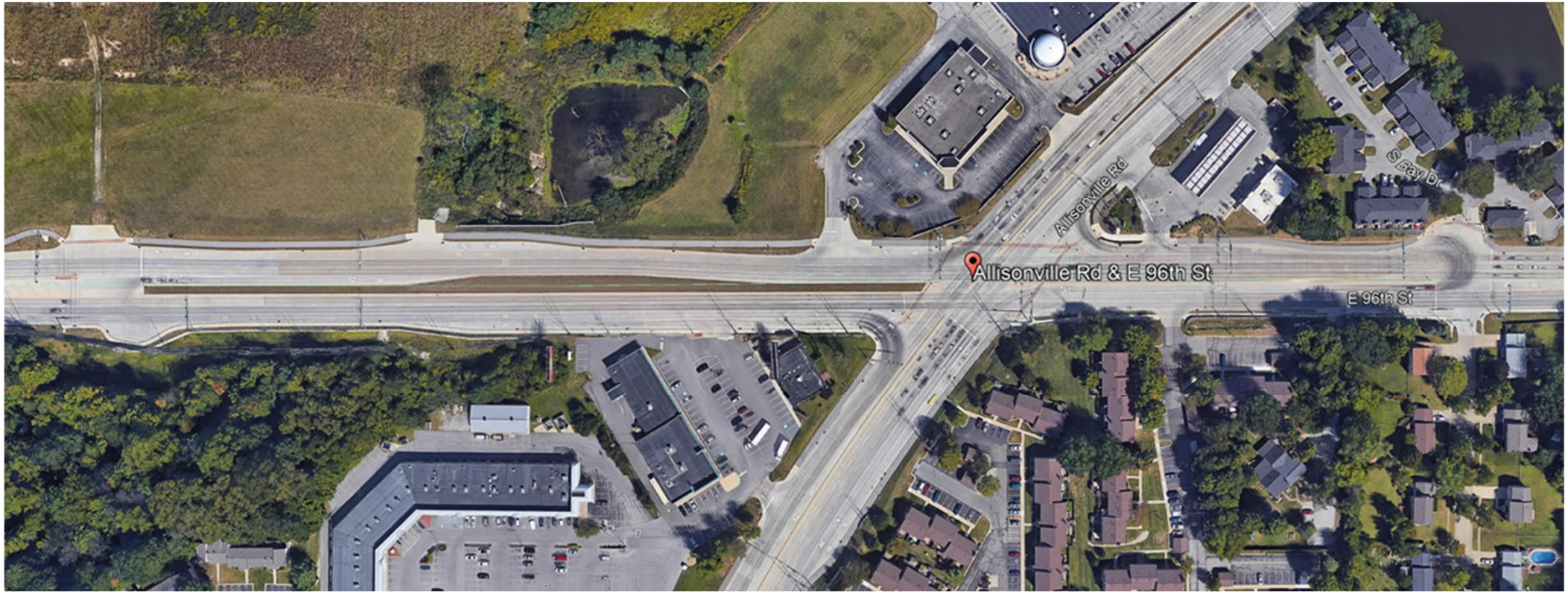
Initial (CAP-X) Screening Summary

- Median U-turn example of non-traditional at-grade intersection alternatives from CAP-X



Median U-Turn – Fishers, IN

Initial (CAP-X) Screening Summary

- Displaced Left Turn and Quadrant Roadway examples of non-traditional, at-grade intersection alternatives from CAP-X

Partial DLT – Baton Rouge, LA

Quadrant Roadway – Fairfield, OH

Initial (CAP-X) Screening Summary

Summary of intersection alternatives to evaluate in detailed traffic analysis

	Research Forest Drive	
At-Grade Alternatives	1. Conventional intersection 2. Conventional shared RT lane 3. Quadrant roadway SW 4. Quadrant roadway NE 5. Quadrant roadway SE 6. Quadrant roadway NW 7. Partial displaced left-turn (N-S) 8. Partial displaced left-turn (E-W)	9. Full displaced left-turn 10. Restricted crossing U-turn (N-S) 11. Restricted crossing U-turn (E-W) 12. Median U-turn (N-S) 13. Median U-turn (E-W) 14. Partial median U-turn (N-S) 15. Partial median U-turn (E-W)
Grade-Separated Alternatives	1. Tight diamond (N-S) 2. Tight diamond (E-W) 3. Partial cloverleaf (N-S) 4. Partial cloverleaf (E-W)	5. Diverging diamond (DDI) (N-S) 6. Diverging diamond (DDI) (E-W) 7. Single point (N-S) 8. Single point (E-W)

Intersection identified for detailed traffic evaluation

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Initial (CAP-X) Screening Summary

Summary of intersection alternatives to evaluate in detailed traffic analysis

	Lake Woodlands Drive	
At-Grade Alternatives	1. Conventional intersection 2. Conventional shared RT lane 3. Quadrant roadway SW 4. Quadrant roadway NE 5. Quadrant roadway SE 6. Quadrant roadway NW 7. Partial displaced left-turn (N-S) 8. Partial displaced left-turn (E-W)	9. Full displaced left-turn 10. Restricted crossing U-turn (N-S) 11. Restricted crossing U-turn (E-W) 12. Median U-turn (N-S) 13. Median U-turn (E-W) 14. Partial median U-turn (N-S) 15. Partial median U-turn (E-W)
Grade-Separated Alternatives	1. Tight diamond (N-S) 2. Tight diamond (E-W) 3. Partial cloverleaf (N-S) 4. Partial cloverleaf (E-W)	5. Diverging diamond (DDI) (N-S) 6. Diverging diamond (DDI) (E-W) 7. Single point (N-S) 8. Single point (E-W)

Intersection identified for detailed traffic evaluation

Detailed Operational Analysis

- All Tier 1 intersection alternatives were evaluated in the 2030 and 2045 horizon year
  - 2030 evaluated the short-term intersection needs
  - 2045 evaluated the long-term intersection needs

Level of Service	Signalized Delay (sec)	Unsignalized Delay (sec)	Typical Roadway Conditions
A	< 10	< 10	Primarily free-flow operations. Control delay at intersections is minimal.
B	10 to 20	10 to 15	Ability to maneuver in traffic is slightly restricted. Delay at intersections is not significant.
C	> 20 to 35	> 15 to 25	Stable operations with ability to maneuver in traffic being restricted. Delay at intersections may contribute to congestion.
D	> 35 to 55	> 25 to 35	Small increases in traffic volumes may cause substantial increases in delay. Congestion at intersections is apparent.
E	> 55 to 80	> 35 to 50	Significant delay and poor travel speeds can be expected. Intersections experience significant delay and queuing.
F	> 80	> 50	Delays are at unacceptable levels for most drivers. Roadway network capacity has been exceeded.

- Primary criteria used to evaluate and compare included:
  - Overall intersection area delay (LOS = Level of Service)
  - Number of LOS E and LOS F movements
  - Number of east/west roadway thru lanes and maximum approach width
  - Number of north/south roadway thru lanes and maximum approach width
  - 2045 alternative residual capacity (ability to operate beyond 2045)

- Synchro Traffic Analysis software was utilized for this analysis using Highway Capacity Manual (HCM) formulas

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Detailed Operational Analysis

- Research Forest Drive and Grogan's Mill Road Intersection Operations Summary

Alternatives Comparsion - Research Forest Drive 2045 Operations				
	Overall Intersection Area Delay	Individual LOS E/F Movements	Residual Capacity	Alternative Notes
Existing Geometry (6-lane RFD, 4-lane GMR)	LOS D/LOS E	5 - AM Peak 8 - PM Peak	0%	Existing intersection geometry fails at 2045 horizon year.
Conventional Expansion (8-lane RFD, 4-lane GMR)	LOS D/LOS D	3 - AM Peak 4 - PM Peak	20%	LOS E turning operations, requires 8-lane RFD to not have overall interseciton failure.
Quadrant Roadway SW (6-lane RFD, 4-lane GMR)	LOS D/LOS D	4- AM Peak 4- PM Peak	25%	Overall operations acceptable, all left-turn operate at effective LOS E/F.
Partial Displaced LT N-S (6-lane RFD, 4-lane GMR)	LOS C/LOS C	0 - AM Peak 0- PM Peak	30%	Best operations of at-grade alternatives with largest footprint and access impacts.
Median U-Turn N-S (6-lane RFD, 4-lane GMR)	LOS C/LOS D	4- AM Peak 4- PM Peak	25%	Overall operations acceptable, all left-turns operate at effective LOS E/F.
Diamond N-S (6-lane RFD, 4-lane GMR)	LOS D/LOS D	0 - AM Peak 1- PM Peak	60%	Provides LOS D operations with one LOS E movement. Has significant residual capacity.
Diverging Diamond N-S (6-lane RFD, 4-lane GMR)	LOS C/LOS B	0 - AM Peak 0- PM Peak	60%	Operates at LOS B/C and provides significant residual capacity.

Poor	
Good	
Best	

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Detailed Operational Analysis

- Research Forest Drive and Lake Woodlands Drive Intersection Operations Summary

Alternatives Comparsion - Lake Woodlands Drive 2045 Operations				
	Overall Intersection Area Delay	Individual LOS E/F Movements	Residual Capacity	Reason for Recommendation
Existing Geometry (4-lane LWD, 4-lane GMR)	LOS F/LOS F	6 - AM Peak 9 - PM Peak	0%	Existing intersection geometry fails at 2045 horizon year.
Conventional (6-lane LWD, 6-lane GMR)	LOS C/LOS D	4 - AM Peak 4 - PM Peak	20%	Overal LOS is accetpable, however may LOS E/F movements.
Partial Displaced LT N-S (6-lane LWD, 6-lane GMR)	LOS C/LOS C	2 - AM Peak 2 - PM Peak	55%	Large intersction size and would require rework of nearby Lake Woodland Drive signals.
Median U-Turn E-W (6-lane LWD, 6-lane GMR)	LOS C/LOS D	4 - AM Peak 4 - PM Peak	20%	Highest delay of at-grade. Left-turns operate at LOS E/F.
Diamond N-S (4-lane LWD, 6-lane GMR)	LOS C/LOS C	0 - AM Peak 0 - PM Peak	40%	Additional lanes on GMR provide 5% more residual capacity.
Single Point N-S (4-lane LWD, 4-lane GMR)	LOS C/LOS C	0 - AM Peak 0 - PM Peak	35%	Similar operations with smaller footprint vs. tight diamond.

Poor	
Good	
Best	

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Detailed Operational Analysis

Summary of intersection alternatives to proceed to preliminary geometric layout

	Research Forest Drive	
At-Grade Alternatives	1. Conventional intersection 2. Conventional shared RT lane 3. Quadrant roadway SW 4. Quadrant roadway NE 5. Quadrant roadway SE 6. Quadrant roadway NW 7. Partial displaced left-turn (N-S) 8. Partial displaced left-turn (E-W)	9. Low-impact PDLT (N-S) 10. Full displaced left-turn 11. Restricted crossing U-turn (N-S) 12. Restricted crossing U-turn (E-W) 13. Median U-turn (N-S) 14. Median U-turn (E-W) 15. Partial median U-turn (N-S) 16. Partial median U-turn (E-W)
Grade-Separated Alternatives	1. Tight diamond (N-S) 2. Tight diamond (E-W) 3. Partial cloverleaf (N-S) 4. Partial cloverleaf (E-W)	5. Diverging diamond (DDI) (N-S) 6. Diverging diamond (DDI) (E-W) 7. Single point (N-S) 8. Single point (E-W)

Intersection selected for detailed traffic evaluation

Additional short-term alternative to extend life of existing infrastructure

Intersection identified for preliminary geometric layout

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Detailed Operational Analysis

Summary of intersection alternatives to proceed to preliminary geometric layout

	Lake Woodlands Drive	
At-Grade Alternatives	1. Conventional intersection 2. Conventional shared RT lane 3. Quadrant roadway SW 4. Quadrant roadway NE 5. Quadrant roadway SE 6. Quadrant roadway NW 7. Partial displaced left-turn (N-S) 8. Partial displaced left-turn (E-W)	9. Full displaced left-turn 10. Restricted crossing U-turn (N-S) 11. Restricted crossing U-turn (E-W) 12. Median U-turn (N-S) 13. Median U-turn (E-W) 14. Partial median U-turn (N-S) 15. Partial median U-turn (E-W)
Grade-Separated Alternatives	1. Tight diamond (N-S) 2. Tight diamond (E-W) 3. Partial cloverleaf (N-S) 4. Partial cloverleaf (E-W)	5. Diverging diamond (DDI) (N-S) 6. Diverging diamond (DDI) (E-W) 7. Single point (N-S) 8. Single point (E-W)

Intersection selected for detailed traffic evaluation

Intersection identified for preliminary geometric layout

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Intersection Alternative Development

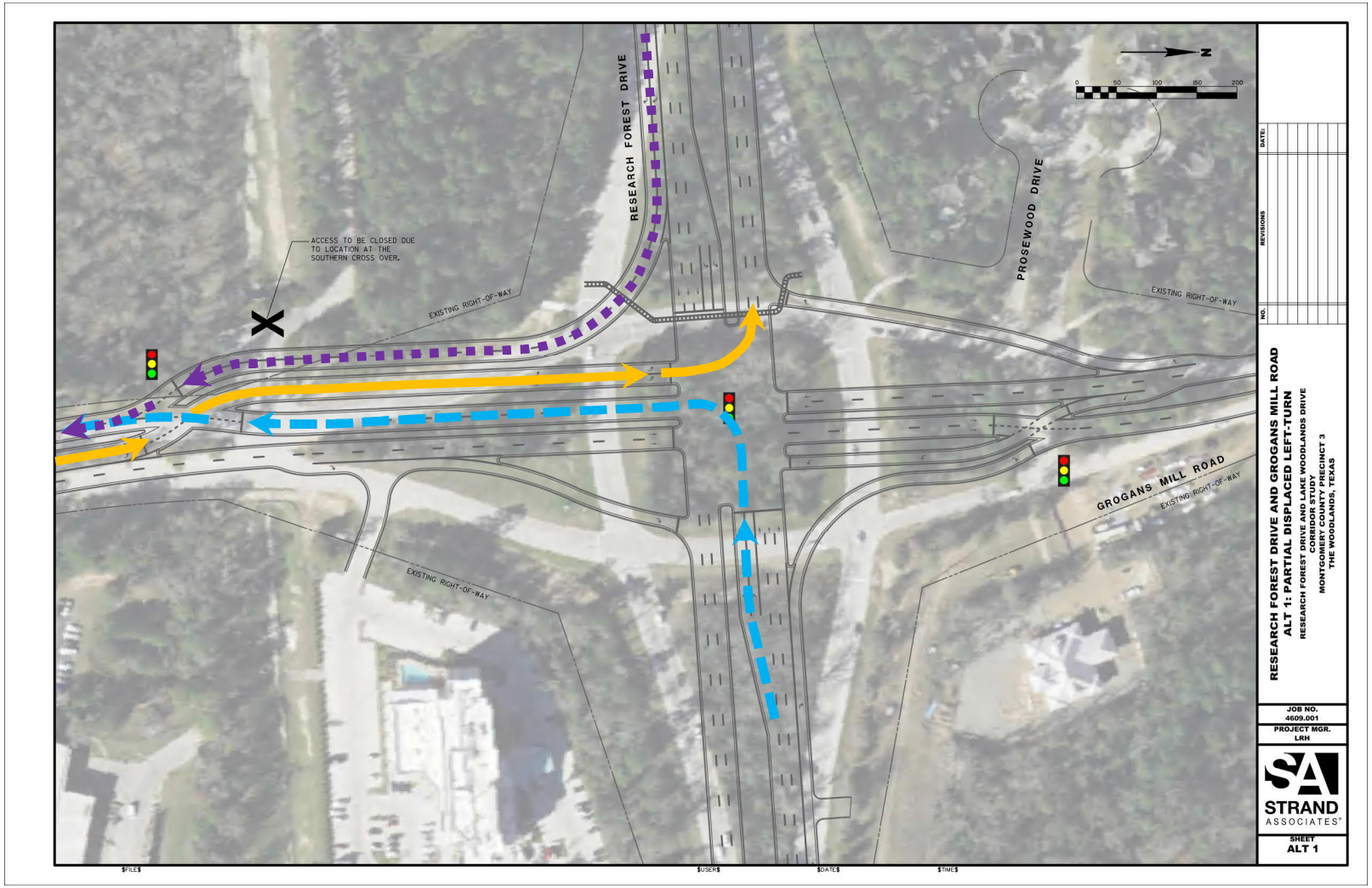
- Preliminary geometric layout completed to evaluate roadway and real estate impacts

- Research Forest Drive
  - Alternative 1: Partial Displaced Left-Turn
  - Alternative 2: Diverging Diamond Interchange
  - Alternative 3: Tight Diamond Interchange
  - Alternative 4: Low-Impact Partial Displaced Left-Turn
  - Alternative 5: 8-Lane Research Forest Drive Conventional Intersection

- Lake Woodlands Drive
  - Alternative 1: Tight Diamond Interchange

Intersection Alternative Development

- Research Forest Drive Alternative 1: Partial Displaced Left-Turn



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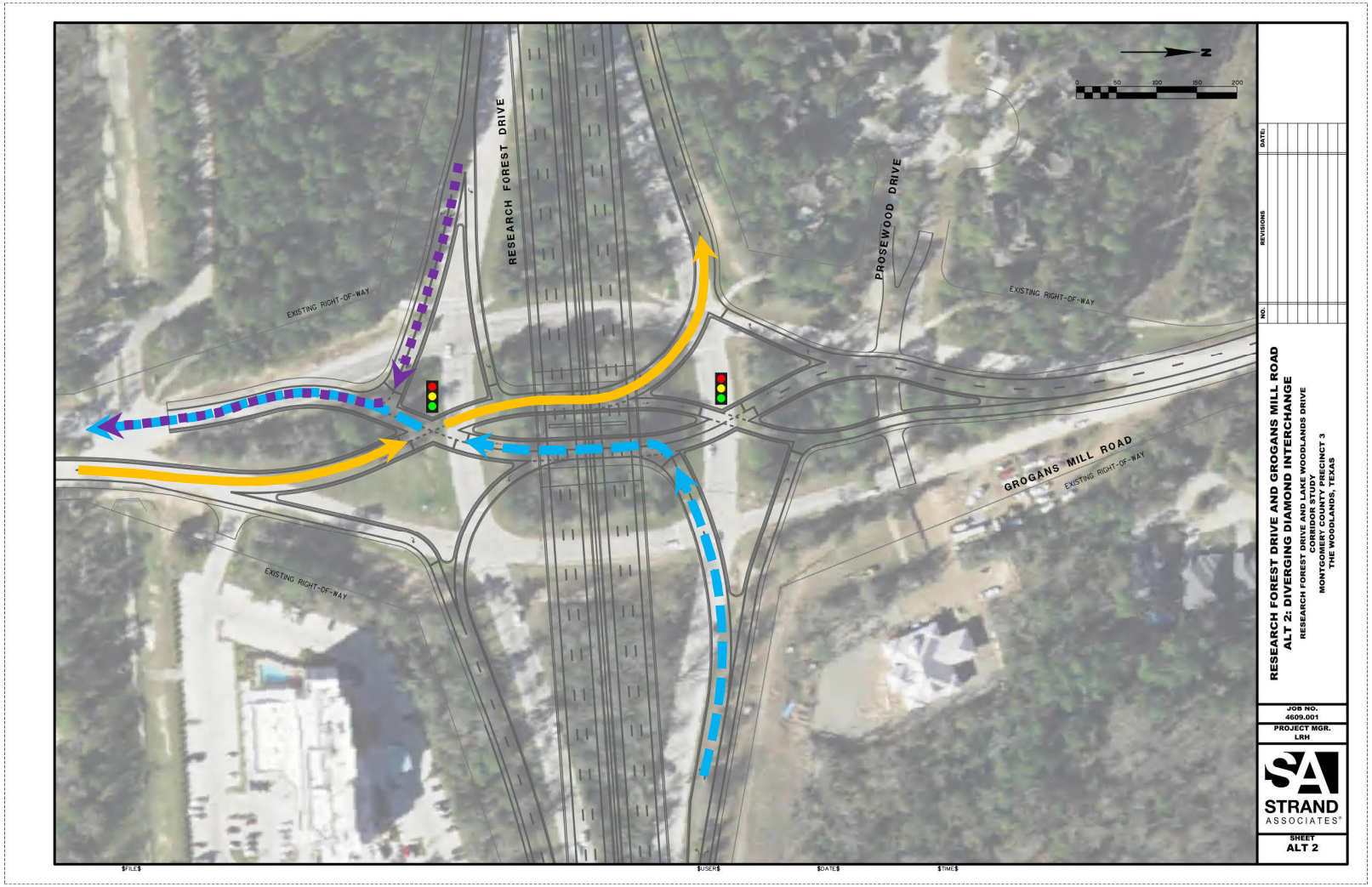
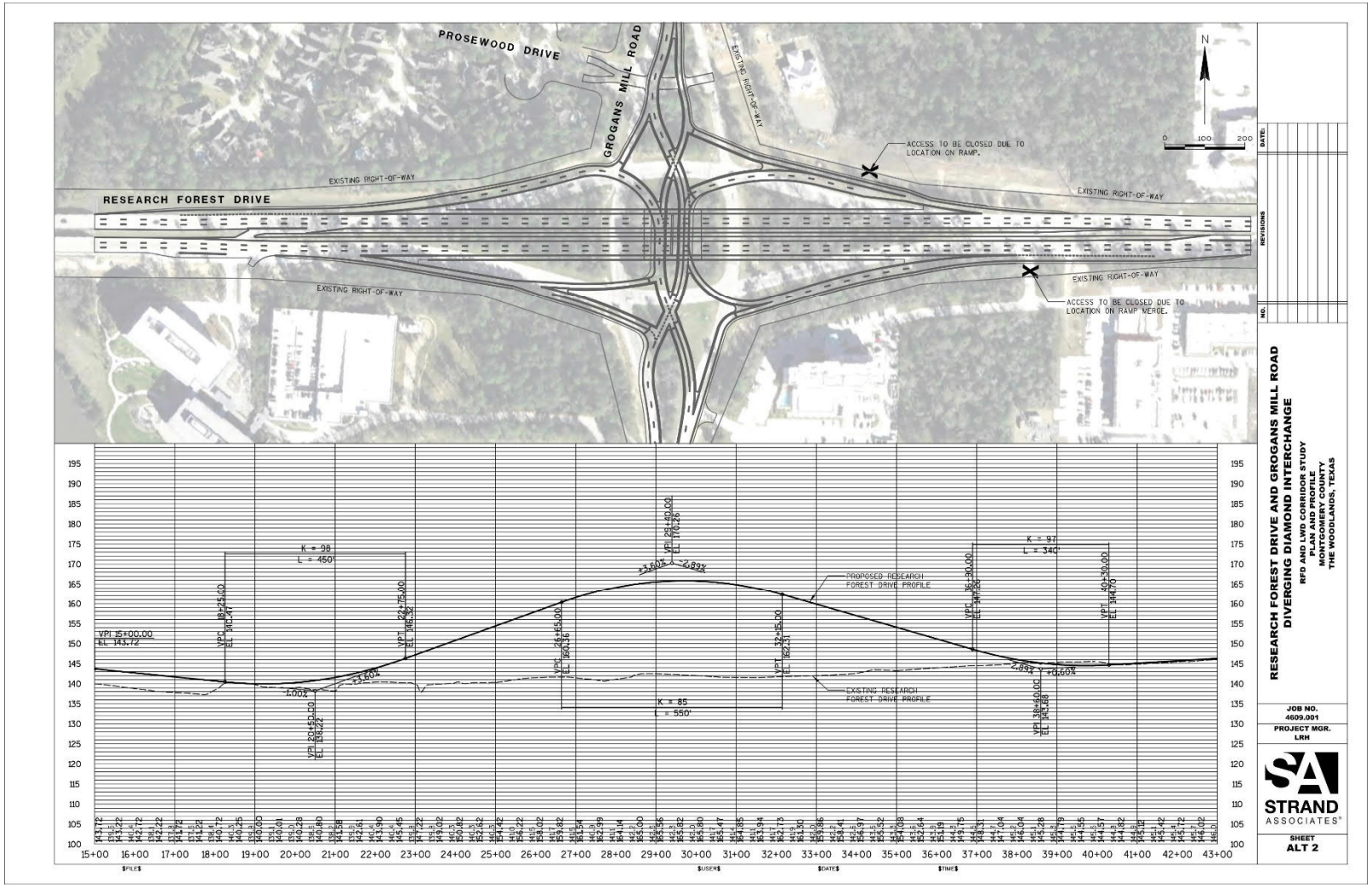
Intersection Alternative Development

- Research Forest Drive Alternative 2: Diverging Diamond Interchange



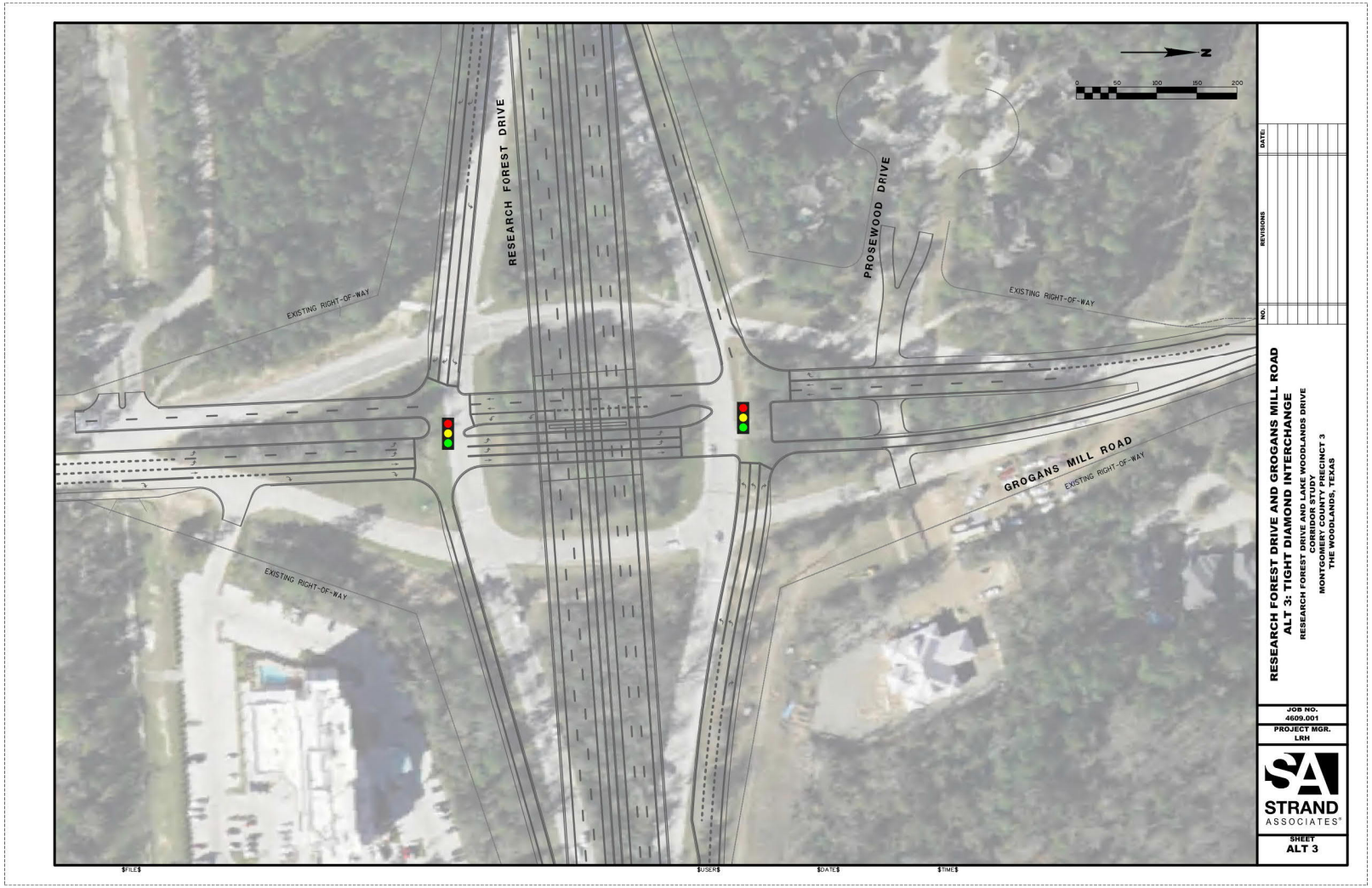
Intersection Alternative Development

- Research Forest Drive Alternative 2: Diverging Diamond Interchange Profile



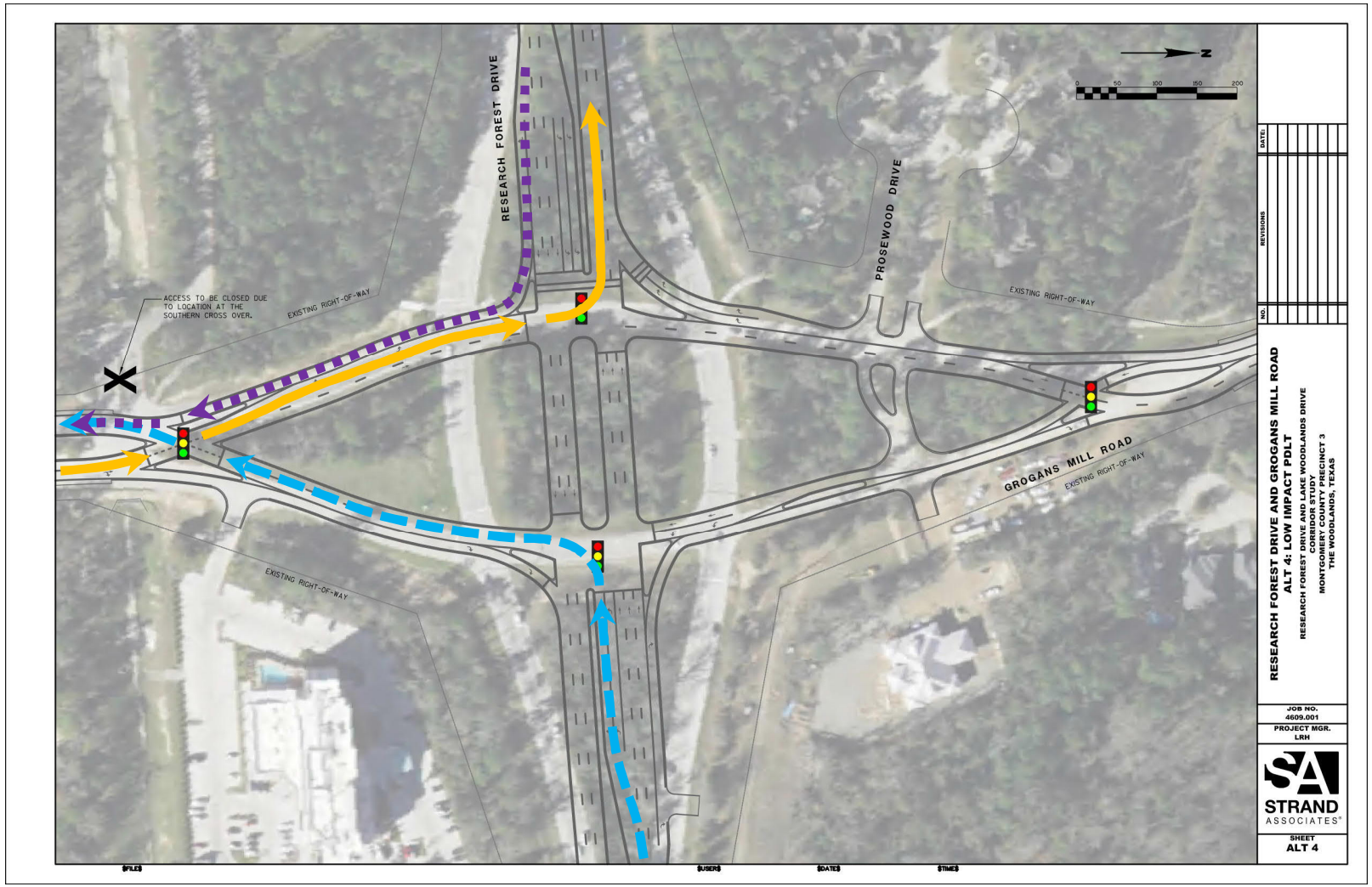
Intersection Alternative Development

- Research Forest Drive Alternative 3: Tight Diamond Interchange



Intersection Alternative Development

- Research Forest Drive Alternative 4: Low-Impact Partial Displaced Left-Turn



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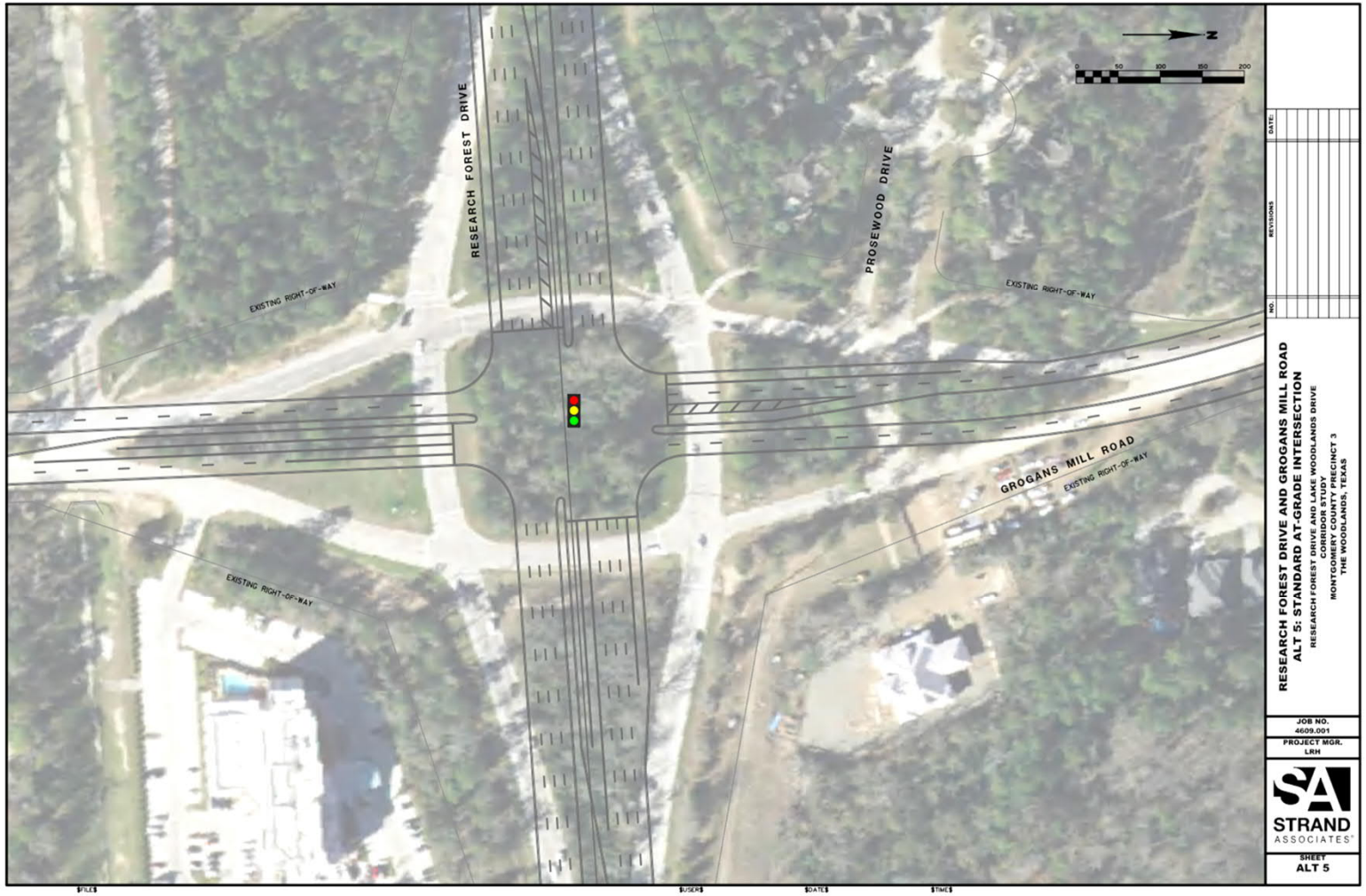
Intersection Alternative Development

- Research Forest Drive Alternative 5: 8-Lane Research Forest Drive Conventional Intersection



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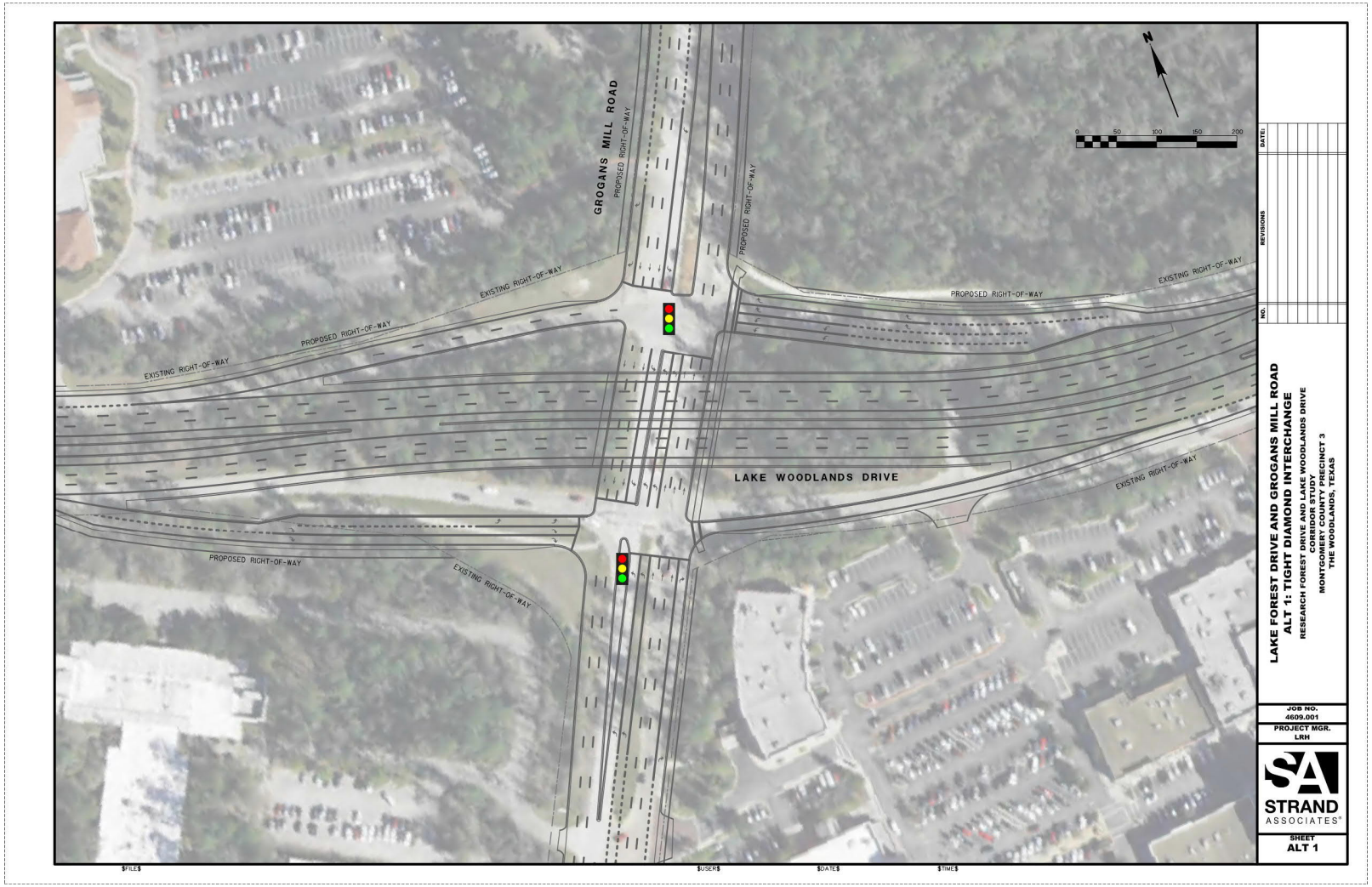
Intersection Alternative Development

- Lake Woodlands Drive Alternative 1: Tight Diamond Interchange



Comparison of Conflict Points at Existing and Alternative Intersections

“A Safe System approach to intersection design can include strategies such as minimizing and modifying conflict points…”

FHWA, https://safety.fhwa.dot.gov/intersection/ssi/index.cfm, accessed on 4/7/2021

- Some of the highest crash frequencies in The Woodlands are seen at Tier 1 intersections (Research Forest Drive/Grogans Mill Rd and Lake Woodlands Drive/Grogans Mill Rd)
- To evaluate the impact on intersection safety, a conflict point analysis was performed comparing existing intersections and proposed alternatives

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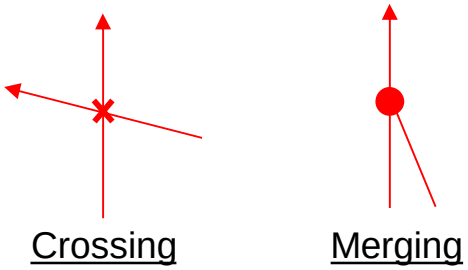
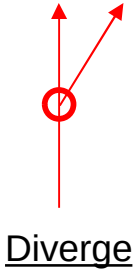
Comparison of Conflict Points at Existing and Alternative Intersections

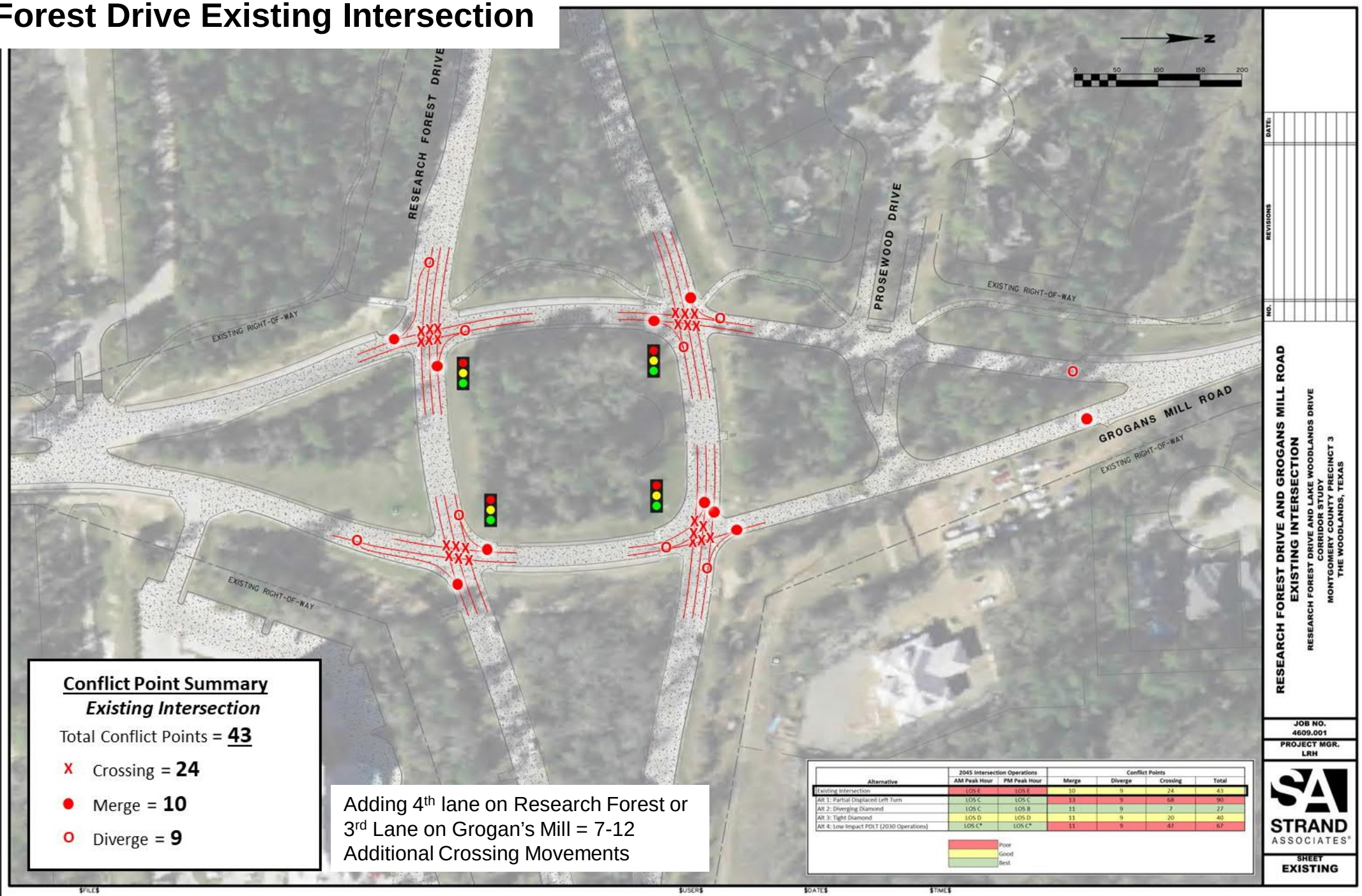
- There are three types of conflict points:
  - Crossing – two traffic movement paths cross each other
    - Typically have a higher incidence of angle and injury crashes
  - Merging – two traffic movement paths merge into one path
  - Diverging – two traffic movement paths split from one beginning path



- The more conflict points at an intersection, the more potential for crashes
  - Reducing the number of conflict points results in lower potential for crashes



Research Forest Drive Existing Intersection



Conflict Point Summary
Existing Intersection

Total Conflict Points = **43**

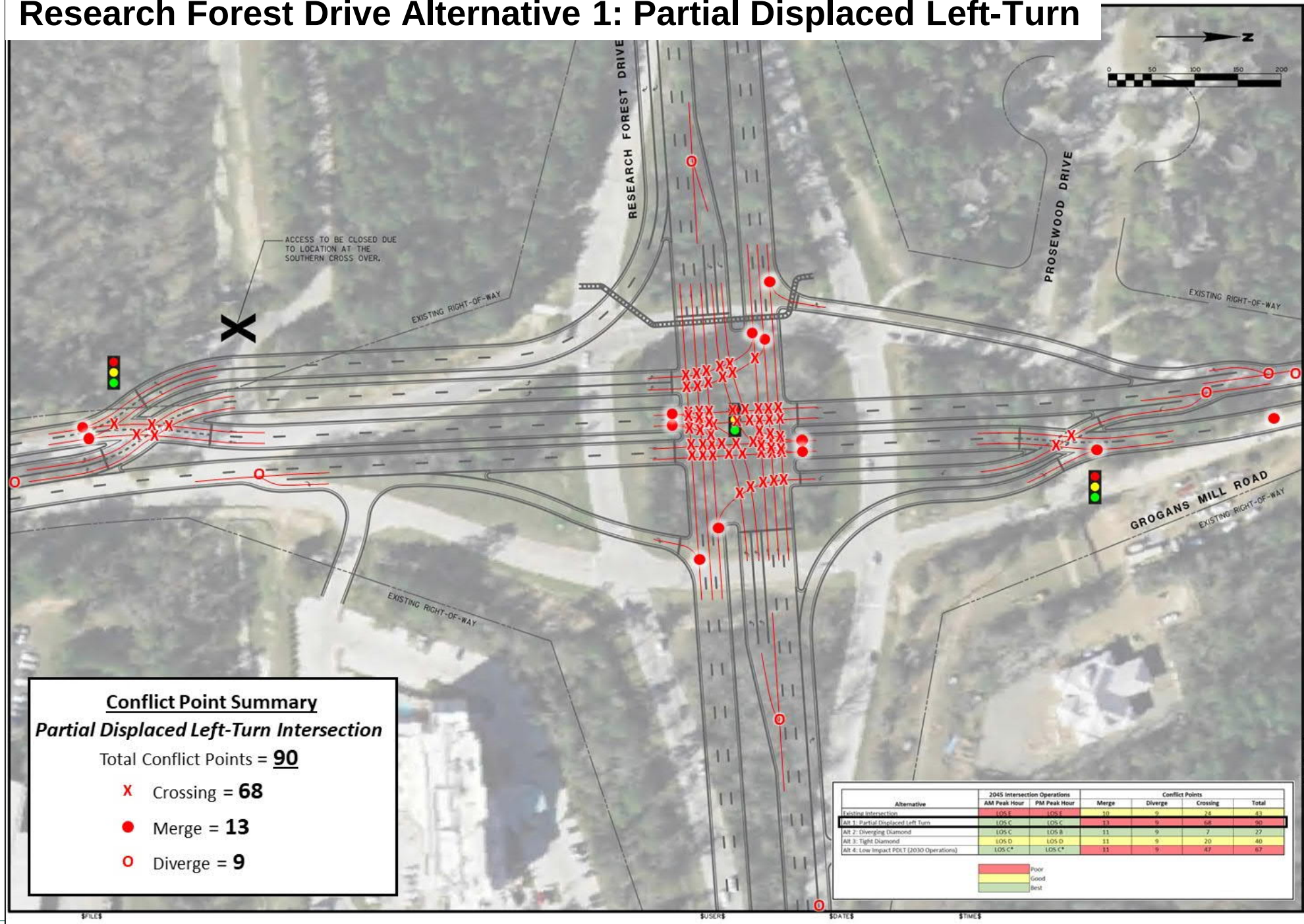
- X Crossing = **24**
- ● Merge = **10**
- O Diverge = **9**

Adding 4th lane on Research Forest or 3rd Lane on Grogan's Mill = 7-12 Additional Crossing Movements

Alternative	2045 Intersection Operations		Conflict Points			
	AM Peak Hour	PM Peak Hour	Merge	Diverge	Crossing	Total
Existing Intersection	LOS E	LOS E	10	9	24	43
Alt 1: Partial Displaced Left Turn	LOS C	LOS C	13	9	68	90
Alt 2: Diverging Diamond	LOS C	LOS B	11	9	7	27
Alt 3: Tight Diamond	LOS D	LOS D	11	9	20	40
Alt 4: Low Impact PDLT (2030 Operations)	LOS C*	LOS C*	11	9	47	67

Poor
Good
Best

Research Forest Drive Alternative 1: Partial Displaced Left-Turn



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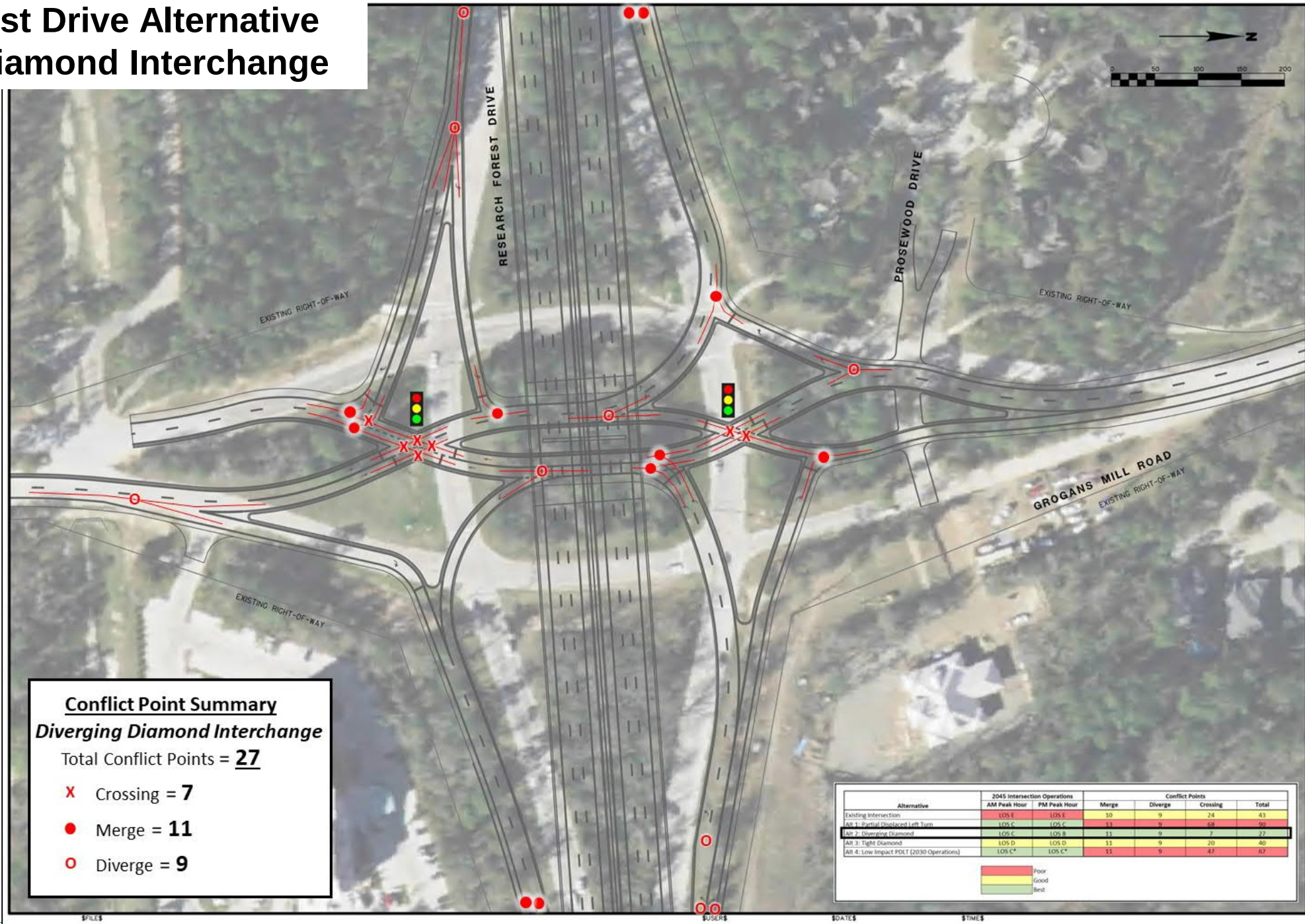
Research Forest Drive Alternative 2: Diverging Diamond Interchange



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Alt 3: Tight Diamond	LOS D	LOS D	11	9	20	40
Alt 4: Low Impact PDLT (2030 Operations)	LOS C*	LOS C*	11	9	47	67

Poor
Good
Best

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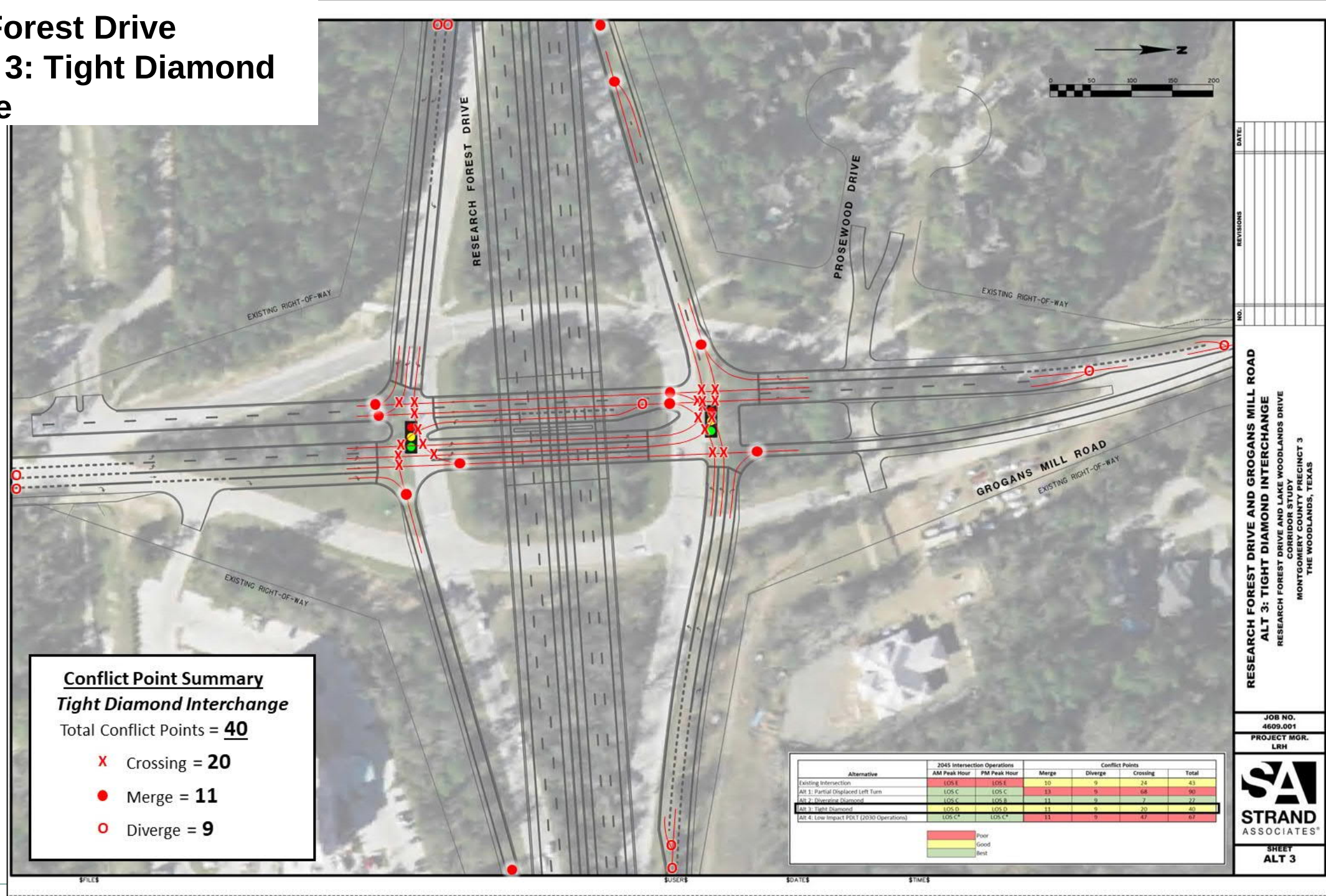
Research Forest Drive Alternative 3: Tight Diamond Interchange



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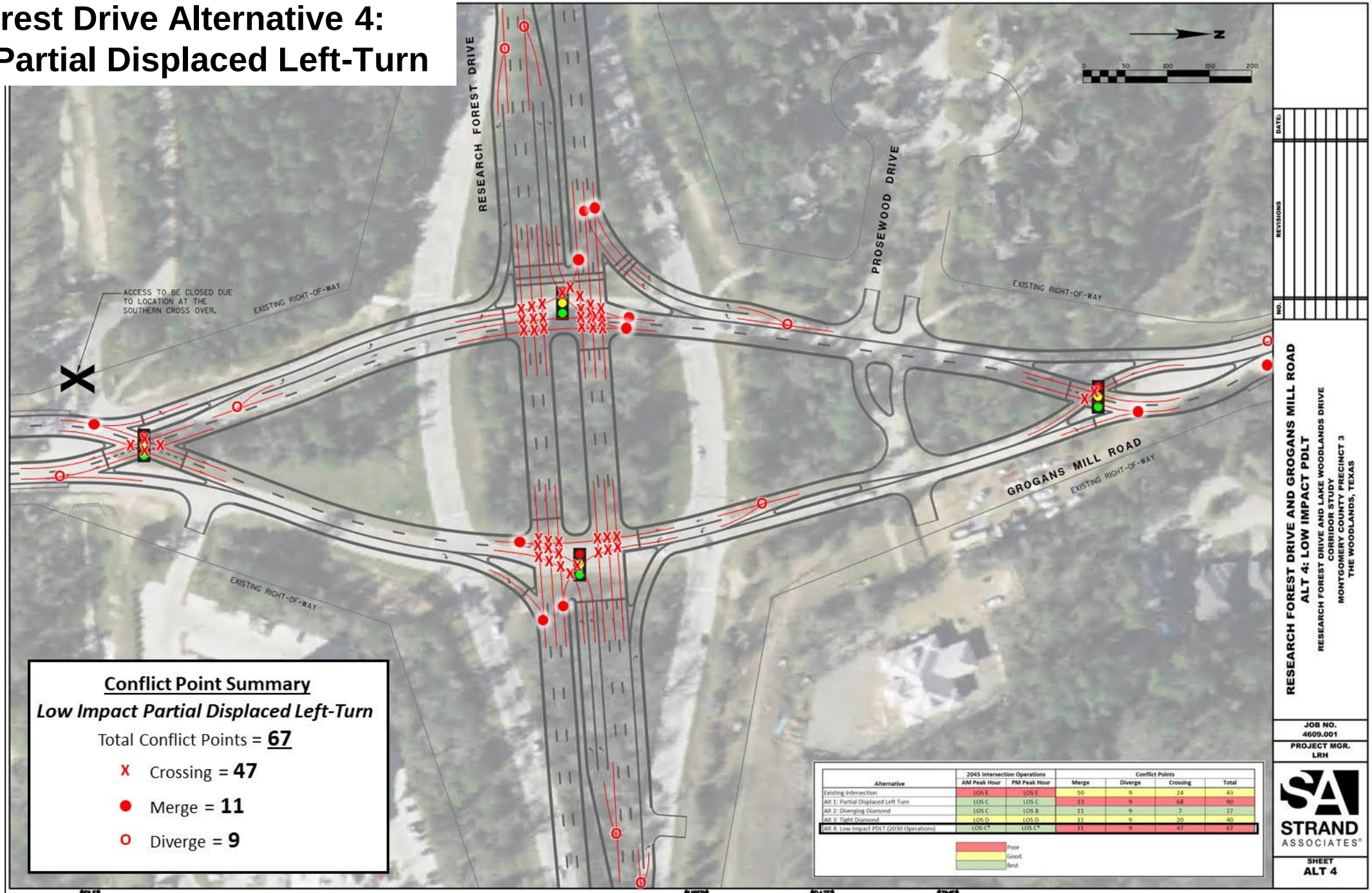
Alt 3: Tight Diamond	LOS D	LOS D	11	9	20	40
Alt 4: Low Impact PDLT (2030 Operations)	LOS C*	LOS C*	11	9	47	67

Poor
Good
Best

Research Forest Drive Alternative 4: Low Impact Partial Displaced Left-Turn



Conflict Point Summary

Low Impact Partial Displaced Left-Turn

Total Conflict Points = **67**

- X Crossing = **47**
- ● Merge = **11**
- O Diverge = **9**

Alternative	2045 Intersection Operations		Conflict Points			
	AM Peak Hour	PM Peak Hour	Merge	Diverge	Crossing	Total
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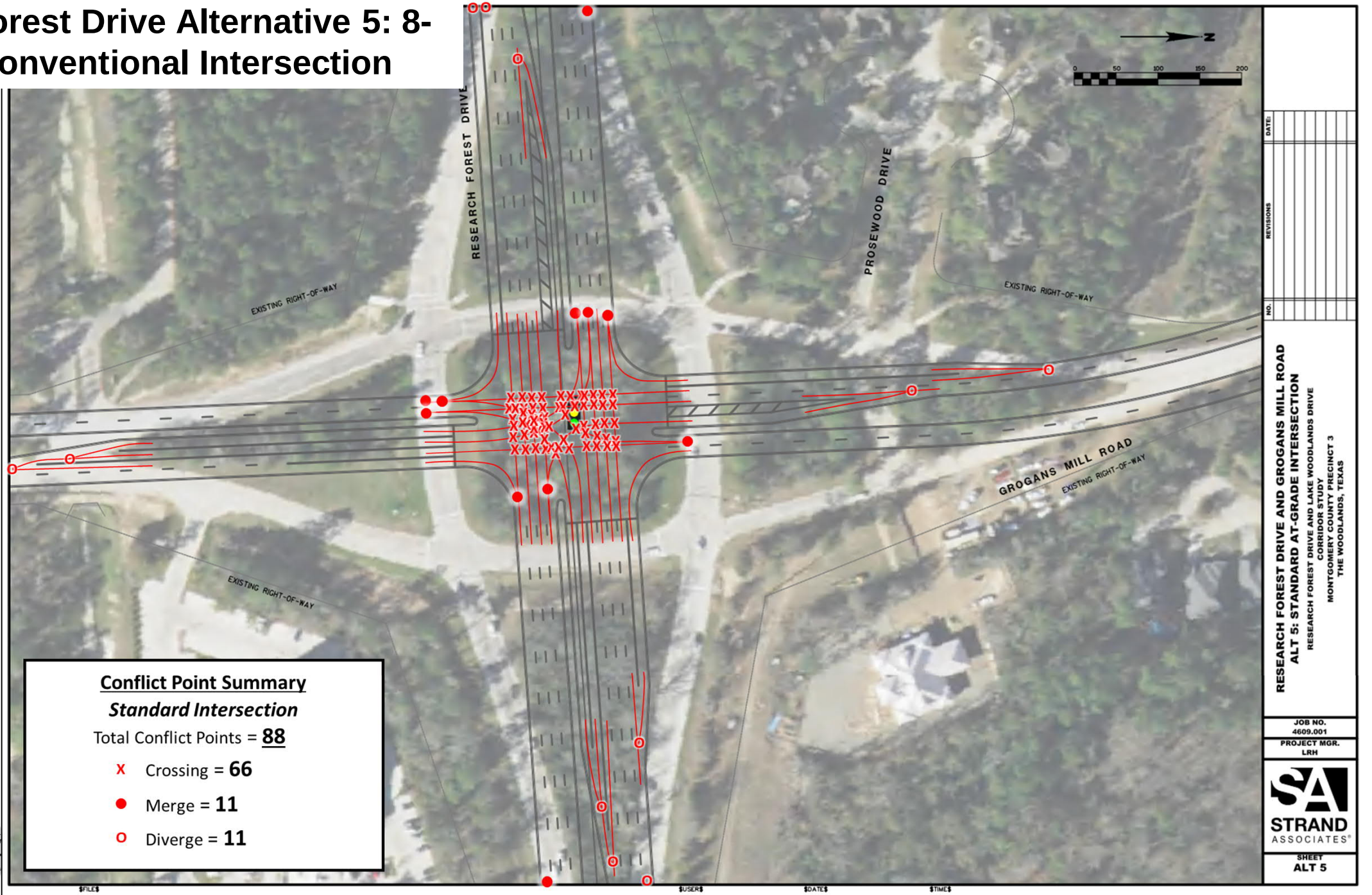
Alt 2: Diverging Diamond	LOS C	LOS B	11	9	7	27
Alt 3: Tight Diamond	LOS D	LOS D	11	9	20	40
Alt 4: Low Impact PDLT (2030 Operations)	LOS C*	LOS C*	11	9	47	67

Poor
Good
Best

Research Forest Drive Alternative 5: 8-Lane RFD Conventional Intersection



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Comparison of Conflict Points at Existing and Alternative Intersections

- Research Forest Drive Summary

Alternative	2045 Intersection Operations		Conflict Points			
	AM Peak Hour	PM Peak Hour	Merge	Diverge	Crossing	Total
Existing Intersection	LOS E	LOS E	10	9	24	43
Alt 1: Partial Displaced Left Turn	LOS C	LOS C	13	9	68	90
Alt 2: Diverging Diamond	LOS C	LOS B	11	9	7	27
Alt 3: Tight Diamond	LOS D	LOS D	11	9	20	40
Alt 4: Low Impact PDLT (2030 Operations)	LOS C*	LOS C*	11	9	47	67
Alt 5: Conventional 8-Lane RFD	LOS D#	LOS D#	11	11	66	88

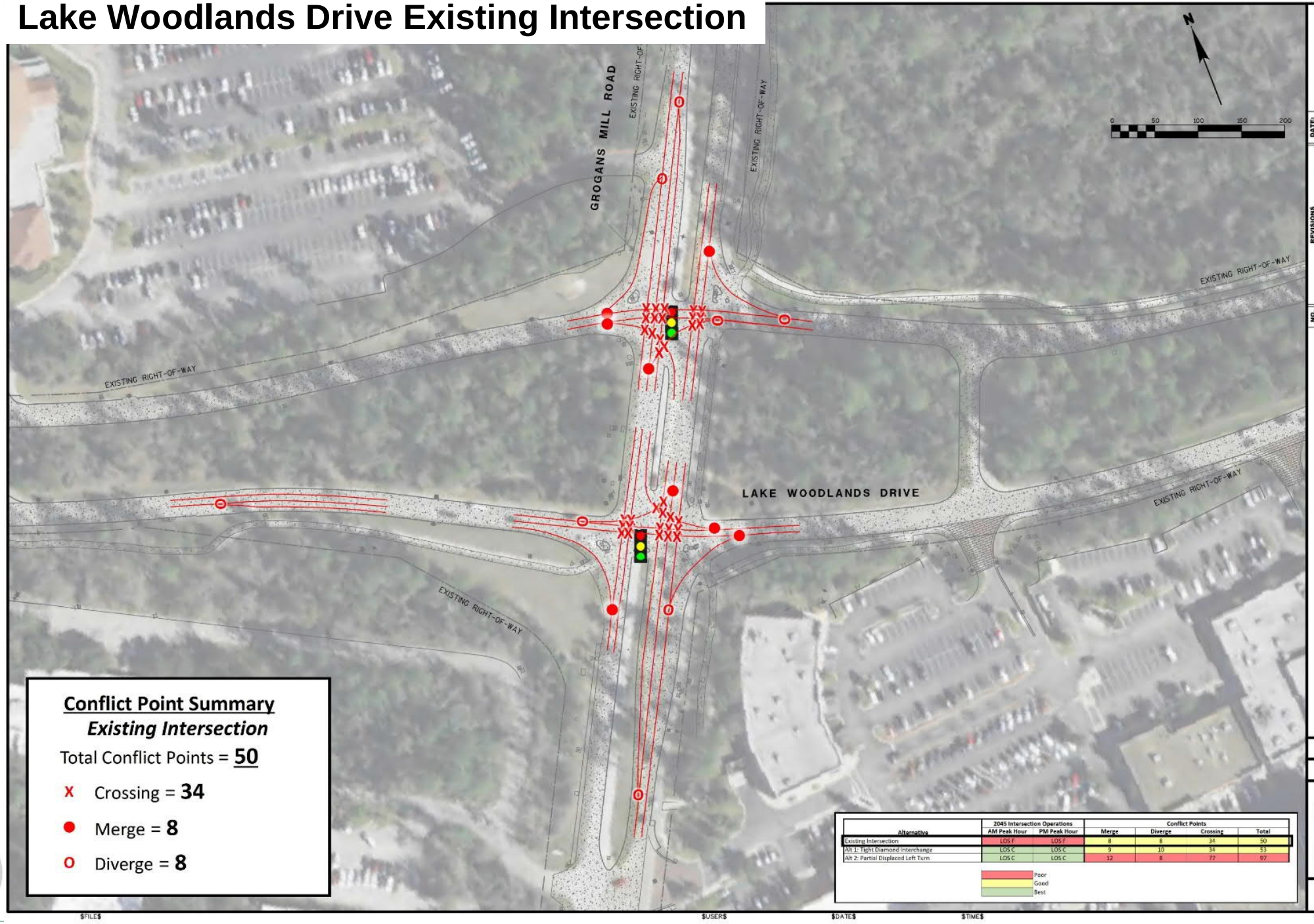
* 2030 LOS - 2045 LOS is LOS F

Several LOS E movements. V/C ratio is 0.99

Poor
Good
Best

- At-grade improvement alternatives have more conflict points than the existing intersection
  - This is due in part to the additional lanes
- The grade separated alternatives provide a decrease in the number of conflict points
  - The Diverging Diamond interchange reduces the conflict points by 37% when compared to existing intersection

Lake Woodlands Drive Existing Intersection



DATE:
REVISIONS
NO.

LAKE FOREST DRIVE AND GROGANS MILL ROAD
EXISTING INTERSECTION
RESEARCH FOREST DRIVE AND LAKE WOODLANDS DRIVE
CORRIDOR STUDY
MONTGOMERY COUNTY PRECINCT 3
THE WOODLANDS, TEXAS

JOB NO.
4609.001
PROJECT MGR.
LRH

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SHEET
EXISTING

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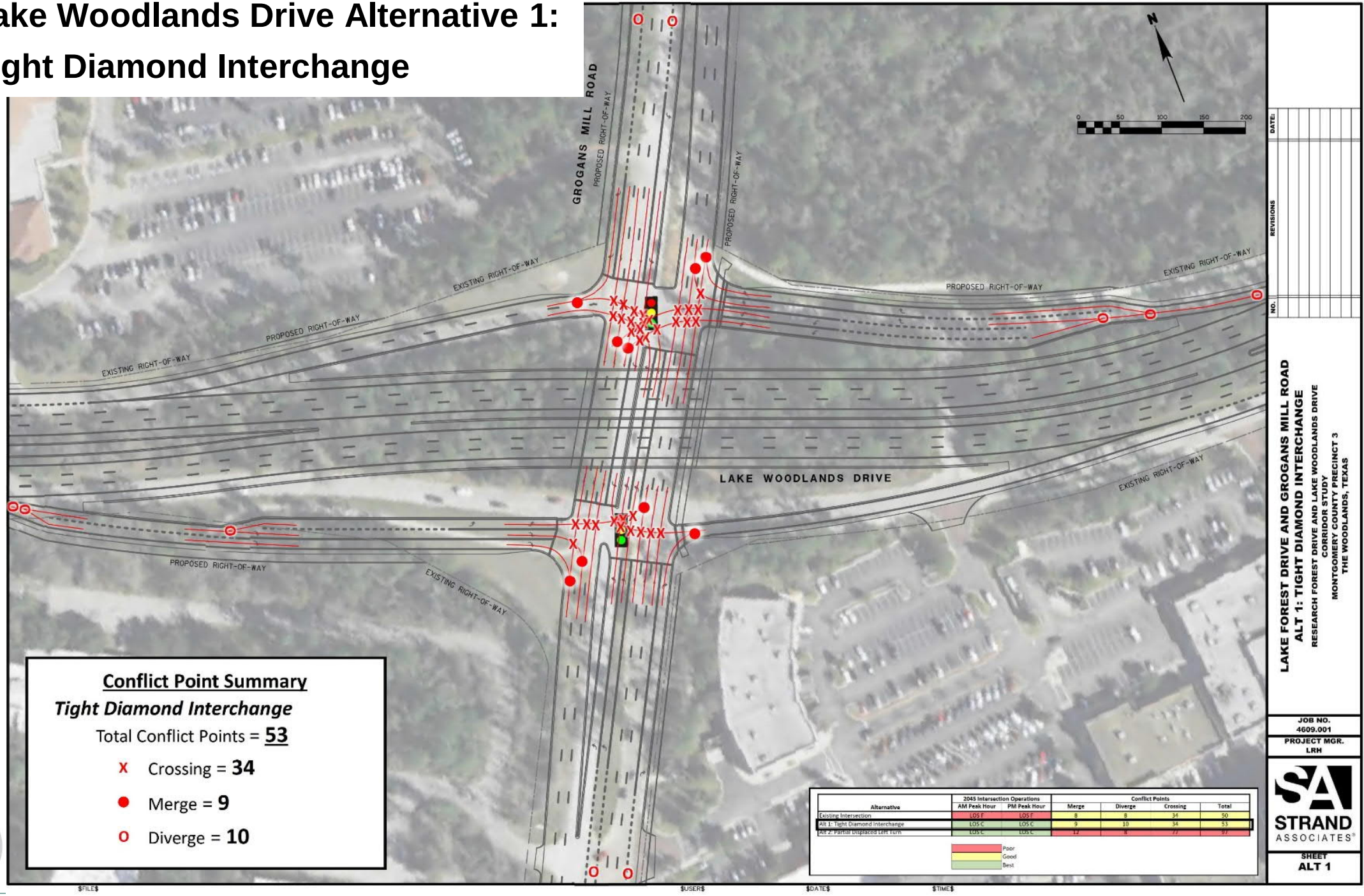
Lake Woodlands Drive Alternative 1: Tight Diamond Interchange



Comparison of Conflict Points at Existing and Alternative Intersections

- Lake Woodlands Drive Summary

Alternative	2045 Intersection Operations		Conflict Points			
	AM Peak Hour	PM Peak Hour	Merge	Diverge	Crossing	Total
Existing Intersection	LOS F	LOS F	8	8	34	50
Alt 1: Tight Diamond Interchange	LOS C	LOS C	9	10	34	53
Alt 2: Partial Displaced Left Turn	LOS C	LOS C	12	8	77	97

Poor
Good
Best

- The grade-separated alternative maintains the same number of conflict points as existing
  - Similar number of overall lanes on Grogans Mill Road and Lake Woodlands Drive

- At-grade improvement alternative has more conflict points than the existing intersection
  - This is due in part to the additional lanes

Preliminary Alternative Costs for Grade-Separated Alternatives

- Research Forest Drive/Grogans Mill Road
  - Alternative 1: Partial Displaced Left Turn - $9.8 million (2021 dollars)
  - Alternative 2: Diverging Diamond Interchange - $14.9 million (2021 dollars)
  - Alternative 3: Tight Diamond Interchange - $15.1 million (2021 dollars)

- Lake Woodland Drive/Grogans Mill Road
  - Alternative 1: Tight Diamond Interchange - ~$17+ million (2021 dollars)

Final Recommendations

- Research Forest Drive and Grogans Mill Road
  - Alternative 2: Diverging Diamond Interchange
    - Improved operations
    - Reduced conflict points
    - Fits within the available right of way
- Lake Woodlands Drive and Grogans Mill Road
  - Alternative 1: Tight Diamond Interchange
    - Improved Operations
    - Reduces volume through the traffic signals

Project Next Steps

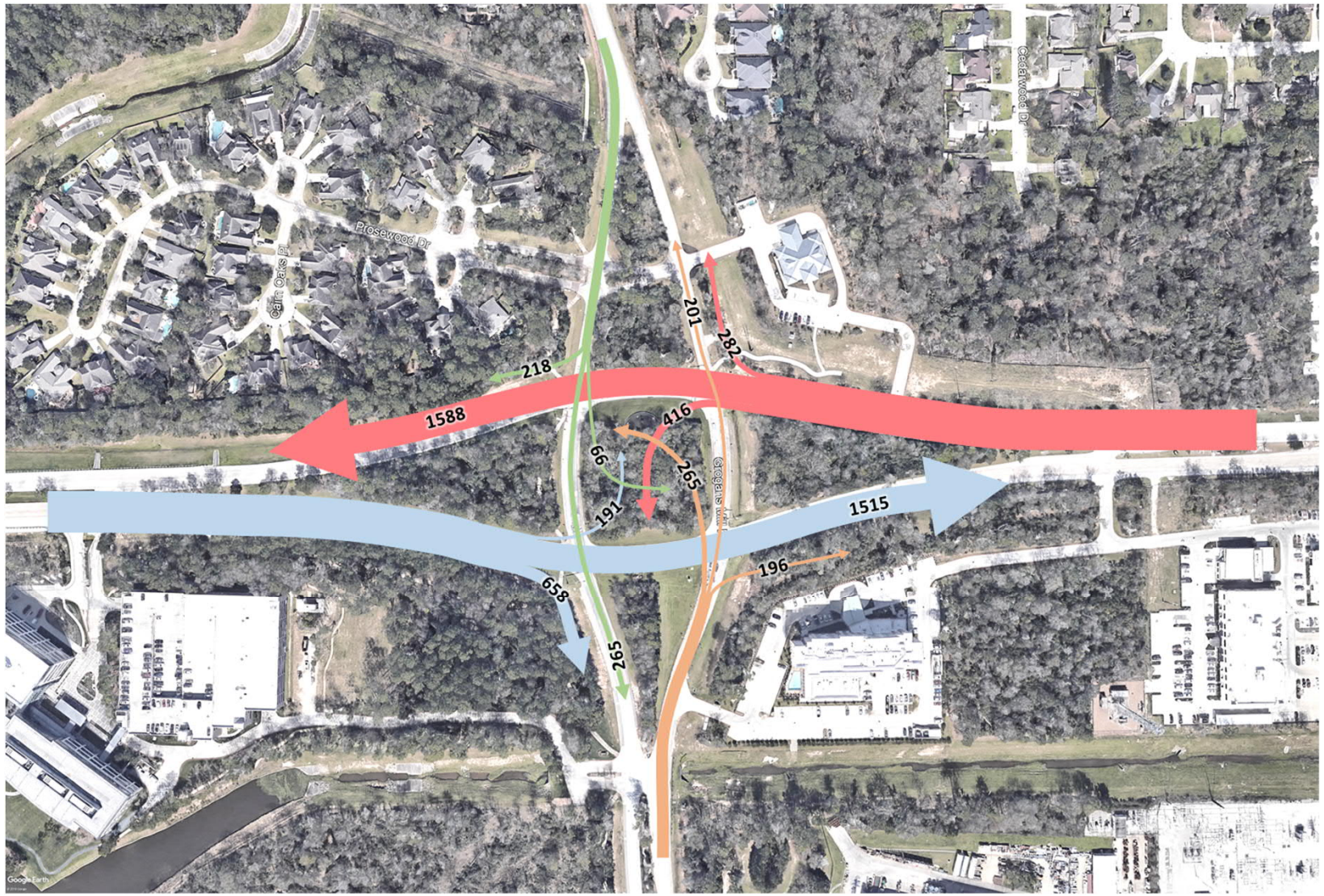
- Complete the Draft analysis report for review by the County
- Deliver the final Research Forest Drive and Lake Woodlands Drive Traffic Analysis

Intersection Traffic Volumes

Research Forest Drive and Grogans Mill Road – 2030 AM Peak Hour Traffic Volumes

Largest Traffic Volumes

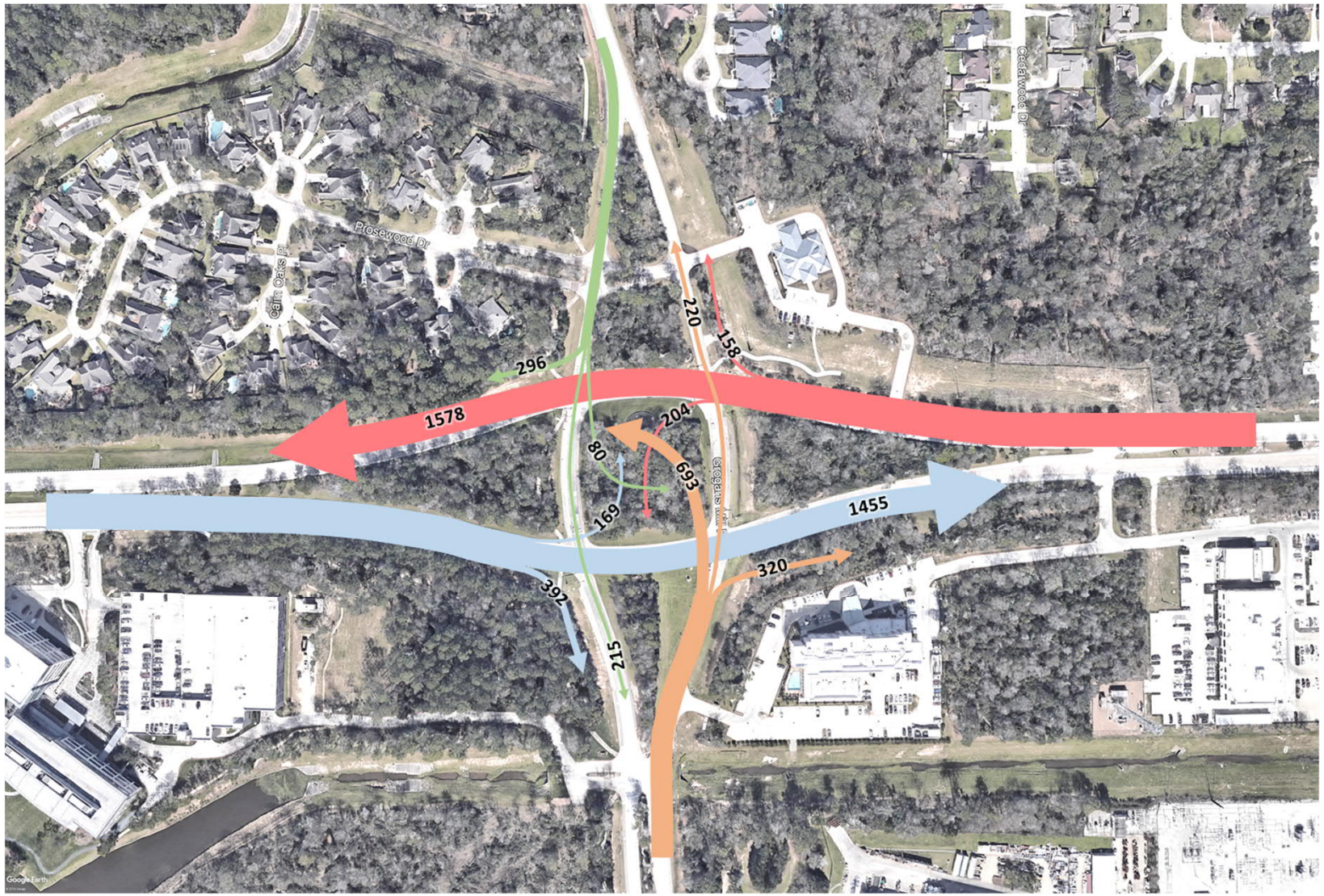
Westbound Thru	1588
Eastbound Thru	1515
Eastbound Right	658
Westbound Left	416
Westbound Right	282



Research Forest Drive and Grogans Mill Road – 2030 PM Peak Hour Traffic Volumes

Largest Traffic Volumes

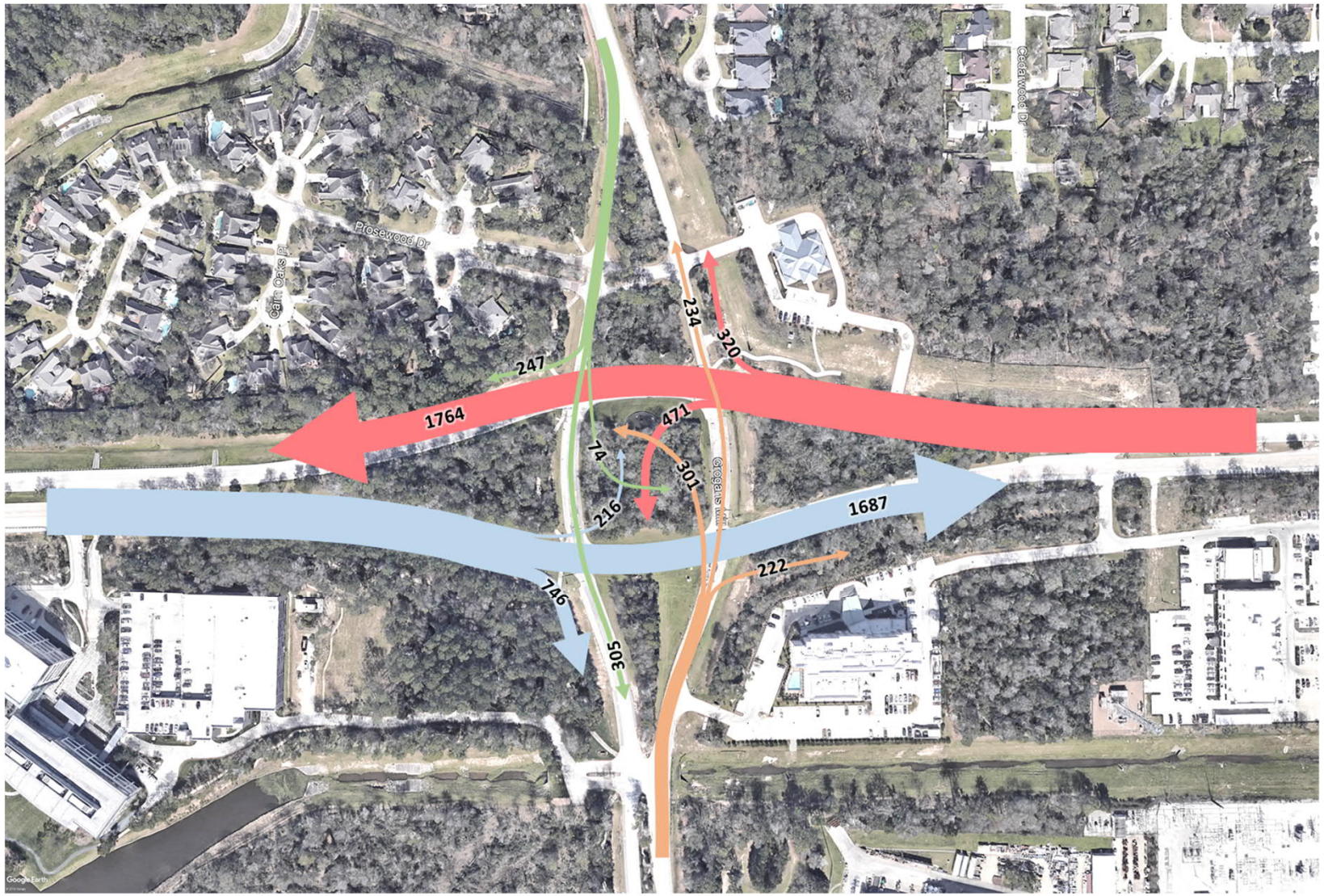
Westbound Thru	1578
Eastbound Thru	1455
Northbound Left	693
Eastbound Right	392
Northbound Right	320



Research Forest Drive and Grogans Mill Road – 2045 AM Peak Hour Traffic Volumes

Largest Traffic Volumes

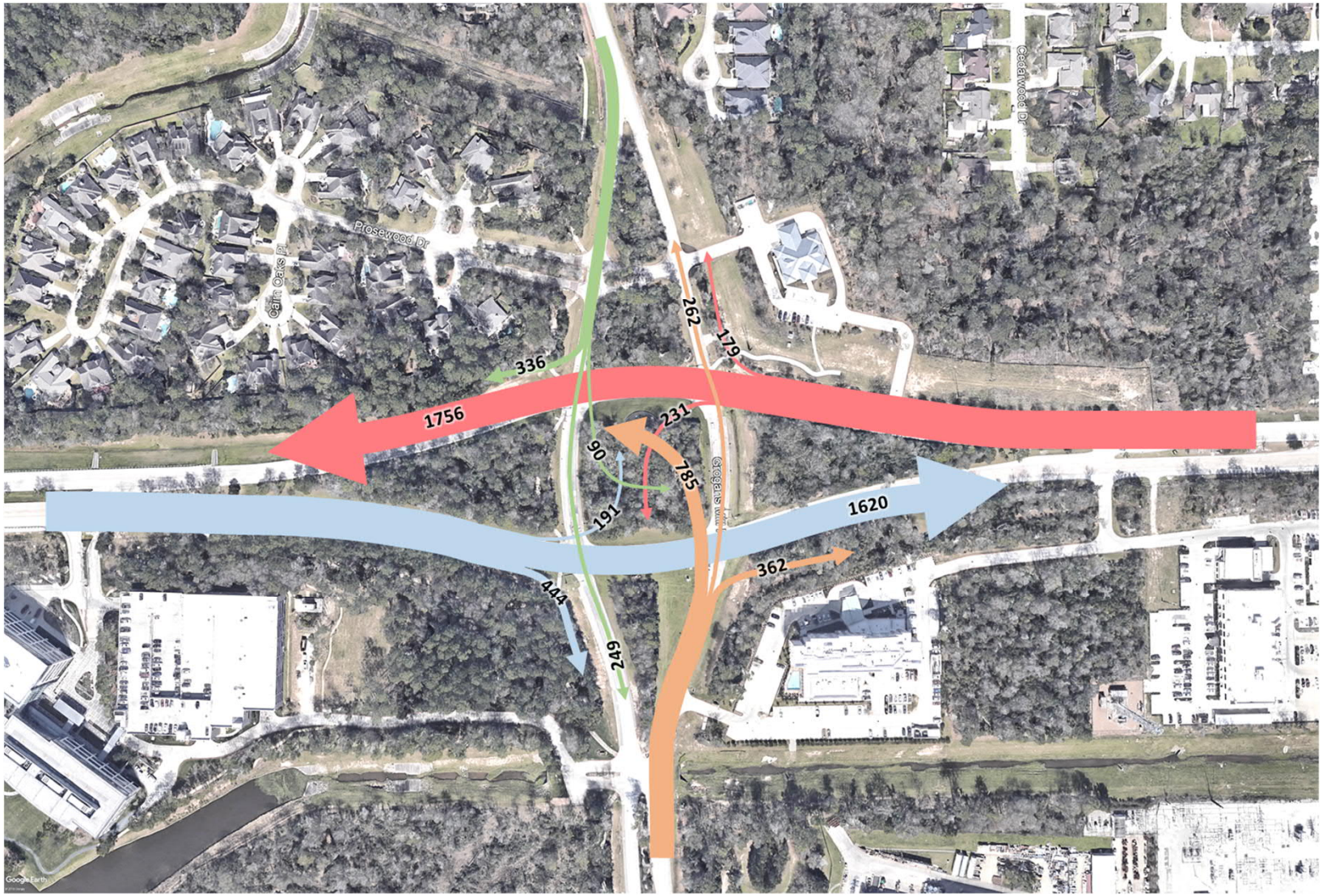
Westbound Thru	1764
Eastbound Thru	1687
Eastbound Right	746
Westbound Left	471
Westbound Right	320



Research Forest Drive and Grogans Mill Road – 2045 PM Peak Hour Traffic Volumes

Largest Traffic Volumes

Westbound Thru	1756
Eastbound Thru	1620
Northbound Left	785
Eastbound Right	444
Northbound Right	362



Lake Woodlands Drive and Grogans Mill Road – 2030 AM Peak Hour Traffic Volumes

Largest Traffic Volumes

Westbound Thru	1218
Northbound Thru	858
Eastbound Thru	759
Southbound Thru	607
Westbound Right	466

Lake Woodlands Drive and Grogans Mill Road – 2030 PM Peak Hour Traffic Volumes

Largest Traffic Volumes

Westbound Thru	1250
Eastbound Thru	1137
Southbound Thru	759
Northbound Thru	735
Northbound Left	694

Lake Woodlands Drive and Grogans Mill Road – 2045 AM Peak Hour Traffic Volumes

Largest Traffic Volumes

Westbound Thru	1291
Northbound Thru	1002
Eastbound Thru	804
Southbound Thru	700
Westbound Right	514

Lake Woodlands Drive and Grogans Mill Road – 2045 PM Peak Hour Traffic Volumes

Largest Traffic Volumes

Westbound Thru	1324
Eastbound Thru	1205
Southbound Thru	882
Northbound Thru	874
Northbound Left	764

CAP-X Results Summary

Research Forest Drive and Grogans Mill Road – At Grade CAP-X

2030 At-Grade CAP-X Results - Research Forest Drive

At Grade Alternatives	AM Peak Hour						PM Peak Hour						Evaluation Status	Reason for Recommendation
	Zone 1 (N)	Zone 2 (S)	Zone 3 (E)	Zone 4 (W)	Zone 5 (Center)	Overall v/c	Zone 1 (N)	Zone 2 (S)	Zone 3 (E)	Zone 4 (W)	Zone 5 (Center)	Overall v/c		
Conventional (6-lane RFD)					0.80	0.80					0.82	0.82	Additional Modeling Recommended	
Conventional Shared RT LN (6-lane RFD)					0.83	0.83					0.88	0.88	Consider Dismissal by Project Team	Conventional provides better operations
Quadrant Roadway SW		0.57		0.55	0.63	0.63		0.71		0.62	0.61	0.71	Additional Modeling Recommended	
Quadrant Roadway NE	0.61		0.65		0.65	0.65	0.62		0.59		0.77	0.77	Consider Dismissal by Project Team	Large anticipated real estate impacts
Quadrant Roadway SE		0.57	0.57		0.70	0.70		0.81	0.81		0.70	0.81	Consider Dismissal by Project Team	Large anticipated real estate impacts
Quadrant Roadway NW	0.53			0.51	0.70	0.70	0.60			0.70	0.66	0.70	Consider Dismissal by Project Team	Large anticipated real estate impacts
Partial Displaced LT N-S	0.29	0.52			0.71	0.71	0.30	0.49			0.67	0.67	Additional Modeling Recommended	
Partial Displaced LT E-W			0.47	0.52	0.66	0.66			0.39	0.59	0.70	0.70	Consider Dismissal by Project Team	Partial DLT N-S provides better accomodation for heavy NBL
Displaced LT	0.17	0.39	0.61	0.52	0.51	0.61	0.18	0.59	0.46	0.59	0.79	0.79	Consider Dismissal by Project Team	Large anticipated real estate impacts and Partial DLT (N-S) acceptable operations operations
Restricted Crossing U-Turn N-S	0.96	0.88	1.84	1.26		1.84	0.89	1.03	1.80	1.20		1.80	Consider Dismissal by Project Team	Overall LOS greater than 1.00
Restricted Crossing U-Turn E-W	0.59	0.51	0.67	0.63		0.67	0.70	0.63	0.77	0.54		0.77	Consider Dismissal by Project Team	Median U-turn provides better operations
Median U-Turn N-S	0.44	0.41			0.51	0.51	0.54	0.59			0.70	0.70	Additional Modeling Recommended	
Median U-Turn E-W			0.66	0.69	0.59	0.69			0.75	0.54	0.75	0.75	Consider Dismissal by Project Team	Median U-turn N-S provides better operations
Partial Median U-Turn N-S	0.28	0.26			0.68	0.68	0.46	0.45			0.83	0.83	Consider Dismissal by Project Team	Median U-turn provides better operations
Partial Median U-Turn E-W			0.56	0.66	0.68	0.68			0.48	0.50	0.83	0.83	Consider Dismissal by Project Team	Median U-turn provides better operations

2045 At-Grade CAP-X Results - Research Forest Drive

At Grade Alternatives	AM Peak Hour						PM Peak Hour						Evaluation Status	Reason for Recommendation
	Zone 1 (N)	Zone 2 (S)	Zone 3 (E)	Zone 4 (W)	Zone 5 (Center)	Overall v/c	Zone 1 (N)	Zone 2 (S)	Zone 3 (E)	Zone 4 (W)	Zone 5 (Center)	Overall v/c		
Conventional (6-lane RFD)					0.81	0.81					0.89	0.89	Additional Modeling Recommended	
Conventional Shared RT LN (6-lane RFD)					0.93	0.93					1.00	1.00	Consider Dismissal by Project Team	Overall LOS greater than 1.00
Quadrant Roadway SW		0.64		0.61	0.71	0.71		0.81		0.70	0.69	0.81	Additional Modeling Recommended	
Quadrant Roadway NE	0.70		0.73		0.74	0.74	0.70		0.66		0.87	0.87	Consider Dismissal by Project Team	Large anticipated real estate impacts
Quadrant Roadway SE		0.64	0.64		0.79	0.79		0.91	0.91		0.78	0.91	Consider Dismissal by Project Team	Large anticipated real estate impacts
Quadrant Roadway NW	0.60			0.58	0.80	0.80	0.68			0.79	0.75	0.79	Consider Dismissal by Project Team	Large anticipated real estate impacts
Partial Displaced LT N-S	0.33	0.59			0.80	0.80	0.35	0.56			0.76	0.76	Additional Modeling Recommended	
Partial Displaced LT E-W			0.53	0.58	0.75	0.75			0.44	0.66	0.79	0.79	Consider Dismissal by Project Team	Partial DLT N-S provides better accomodation for heavy NBL
Displaced LT	0.19	0.35	0.68	0.58	0.55	0.68	0.20	0.41	0.51	0.66	0.63	0.66	Consider Dismissal by Project Team	Large anticipated real estate impacts and Partial DLT (N-S) acceptable operations operations
Restricted Crossing U-Turn N-S	1.08	0.99	2.05	1.40		2.05	1.00	1.16	2.01	1.33		2.01	Consider Dismissal by Project Team	Overall LOS greater than 1.00
Restricted Crossing U-Turn E-W	0.67	0.58	0.75	0.71		0.75	0.79	0.71	0.87	0.61		0.87	Consider Dismissal by Project Team	Median U-turn provides better operations
Median U-Turn N-S	0.50	0.47			0.58	0.58	0.61	0.67			0.79	0.79	Additional Modeling Recommended	
Median U-Turn E-W			0.74	0.77	0.67	0.77			0.84	0.60	0.84	0.84	Consider Dismissal by Project Team	Median U-turn N-S provides better operations
Partial Median U-Turn N-S	0.32	0.30			0.76	0.76	0.52	0.52			0.93	0.93	Consider Dismissal by Project Team	Median U-turn provides better operations
Partial Median U-Turn E-W			0.62	0.74	0.76	0.76			0.53	0.57	0.93	0.93	Consider Dismissal by Project Team	Median U-turn provides better operations

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Research Forest Drive and Grogans Mill Road – Grade Sep CAP-X

2045 Grade Separated CAP-X Results - Research Forest Drive																	
	AM Peak Hour							PM Peak Hour									
At Grade Alternatives	Zone 1 (Rt Mrg)	Zone 2 (Lt Mrg)	Zone 3 (Ctr. 1)	Zone 4 (Ctr. 2)	Zone 5 (Lt Mrg)	Zone 6 (Lt Mrg)	Overall v/c	Zone 1 (Rt Mrg)	Zone 2 (Lt Mrg)	Zone 3 (Ctr. 1)	Zone 4 (Ctr. 2)	Zone 5 (Lt Mrg)	Zone 6 (Lt Mrg)	Overall v/c	Evaluation Status	Reason for Recommendation
Diamond N-S			0.70	0.68			0.70			0.70	0.52			0.70	Additional Modeling Recommended	
Diamond E-W			0.62	0.64			0.64			0.75	0.67			0.75	Consider Dismissal by Project Team	Does not remove heavy RFD thru traffic from signals
Double Crossover Diamond N-S	0.36	0.43	0.26	0.42	0.31	0.49	0.49	0.26	0.26	0.25	0.48	0.46	0.30	0.48	Additional Modeling Recommended	
Double Crossover Diamond E-W	0.62	0.84	0.45	0.57	0.84	0.54	0.84	0.78	0.92	0.44	0.68	0.78	0.63	0.92	Consider Dismissal by Project Team	Does not remove heavy RFD thru traffic from signals
Single Point N-S	0.52		0.51			0.52	0.52	0.42		0.81			0.32	0.81	Consider Dismissal by Project Team	Diamond and DCD provide better operations
Single Point E-W	0.62		0.79			0.54	0.79	0.78		0.78			0.63	0.78	Consider Dismissal by Project Team	Does not remove heavy RFD thru traffic from signals

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Lake Woodlands Drive and Grogans Mill Road – At Grade CAP-X

2030 At-Grade CAP-X Results - Lake Woodlands Drive

At Grade Alternatives	AM Peak Hour						PM Peak Hour						Evaluation Status	Reason for Recommendation
	Zone 1 (N)	Zone 2 (S)	Zone 3 (E)	Zone 4 (W)	Zone 5 (Center)	Overall v/c	Zone 1 (N)	Zone 2 (S)	Zone 3 (E)	Zone 4 (W)	Zone 5 (Center)	Overall v/c		
Conventional (4-lane LWB)					0.76	0.76					0.92	0.92	Additional Modeling Recommended	
Conventional Shared RT LN (4-lane LWB)					1.05	1.05					1.22	1.22	Consider Dismissal by Project Team	Overall LOS greater than 1.00
Quadrant Roadway SW		0.44		0.53	0.70	0.70		0.58		0.76	0.79	0.79	Consider Dismissal by Project Team	Large anticipated real estate impacts
Quadrant Roadway NE	0.67		0.54		0.90	0.90	0.57		0.72		1.06	1.06	Consider Dismissal by Project Team	Overall LOS greater than 1.00
Quadrant Roadway SE		0.45	0.45		0.78	0.78		0.62	0.62		0.93	0.93	Consider Dismissal by Project Team	Quadrant SW provides better operations
Quadrant Roadway NW	0.47			0.55	0.83	0.83	0.54			0.86	0.95	0.95	Consider Dismissal by Project Team	Quadrant SW provides better operations
Partial Displaced LT N-S	0.36	0.37			0.70	0.70	0.41	0.55			0.70	0.70	Additional Modeling Recommended	
Partial Displaced LT E-W			0.33	0.56	0.71	0.71			0.52	0.63	0.86	0.86	Consider Dismissal by Project Team	Partial DLT (N-S) provides better operations
Displaced LT	0.36	0.37	0.38	0.56	0.66	0.66	0.41	0.55	0.61	0.63	0.63	0.63	Consider Dismissal by Project Team	Large anticipated real estate impacts and Partial DLT (N-S) provides similar operations
Restricted Crossing U-Turn N-S	0.78	0.80	1.19	1.25		1.25	0.95	1.03	1.53	1.48		1.53	Consider Dismissal by Project Team	Overall LOS greater than 1.00
Restricted Crossing U-Turn E-W	0.70	0.76	1.08	0.69		1.08	0.90	0.98	1.08	0.98		1.08	Consider Dismissal by Project Team	Overall LOS greater than 1.00
Median U-Turn N-S	0.46	0.54			0.78	0.78	0.73	0.68			0.86	0.86	Consider Dismissal by Project Team	Median U-turn E-W is a better fit for existing R/W
Median U-Turn E-W			0.77	0.51	0.70	0.77			0.80	0.78	0.87	0.87	Additional Modeling Recommended	
Partial Median U-Turn N-S	0.40	0.55			0.76	0.76	0.63	0.77			0.94	0.94	Consider Dismissal by Project Team	Median U-turn provides better operations
Partial Median U-Turn E-W			0.64	0.53	0.76	0.76			0.54	0.78	0.94	0.94	Consider Dismissal by Project Team	Median U-turn provides better operations

2045 At-Grade CAP-X Results - Lake Woodlands Drive

At Grade Alternatives	AM Peak Hour						PM Peak Hour						Evaluation Status	Reason for Dismissal
	Zone 1 (N)	Zone 2 (S)	Zone 3 (E)	Zone 4 (W)	Zone 5 (Center)	Overall v/c	Zone 1 (N)	Zone 2 (S)	Zone 3 (E)	Zone 4 (W)	Zone 5 (Center)	Overall v/c		
Conventional (6-lane LWB)					0.77	0.77					0.93	0.93	Additional Modeling Recommended	
Conventional Shared RT LN (6-lane LWB)					0.97	0.97					1.14	1.14	Consider Dismissal by Project Team	Overall LOS greater than 1.00
Quadrant Roadway SW		0.50		0.50	0.78	0.78		0.81		0.82	0.87	0.87	Consider Dismissal by Project Team	Large anticipated real estate impacts
Quadrant Roadway NE	0.76		0.59		1.00	1.00	0.65		0.78		1.18	1.18	Consider Dismissal by Project Team	Overall LOS greater than 1.00
Quadrant Roadway SE		0.51	0.51		0.86	0.86		0.70	0.70		1.03	1.03	Consider Dismissal by Project Team	Overall LOS greater than 1.00
Quadrant Roadway NW	0.53			0.59	0.92	0.92	0.59			0.93	1.07	1.07	Consider Dismissal by Project Team	Overall LOS greater than 1.00
Partial Displaced LT N-S	0.42	0.42			0.78	0.78	0.47	0.62			0.76	0.76	Additional Modeling Recommended	
Partial Displaced LT E-W			0.35	0.60	0.78	0.78			0.56	0.68	0.95	0.95	Consider Dismissal by Project Team	Partial DLT (N-S) provides better operations
Displaced LT	0.42	0.42	0.41	0.60	0.72	0.72	0.47	0.62	0.65	0.68	0.70	0.70	Consider Dismissal by Project Team	Large anticipated real estate impacts and Partial DLT (N-S) provides similar operations
Restricted Crossing U-Turn N-S	0.85	0.88	1.28	1.34		1.34	1.04	1.13	1.63	1.58		1.63	Consider Dismissal by Project Team	Overall LOS greater than 1.00
Restricted Crossing U-Turn E-W	0.76	0.86	1.19	0.76		1.19	0.98	1.11	1.20	1.08		1.20	Consider Dismissal by Project Team	Overall LOS greater than 1.00
Median U-Turn N-S	0.52	0.61			0.86	0.86	0.82	0.77			0.94	0.94	Consider Dismissal by Project Team	Median U-turn E-W is a better fit for existing R/W
Median U-Turn E-W			0.83	0.55	0.78	0.83			0.87	0.84	0.94	0.94	Additional Modeling Recommended	
Partial Median U-Turn N-S	0.45	0.63			0.83	0.83	0.71	0.87			1.04	1.04	Consider Dismissal by Project Team	Overall LOS greater than 1.00
Partial Median U-Turn E-W			0.69	0.57	0.83	0.83			0.58	0.84	1.04	1.04	Consider Dismissal by Project Team	Overall LOS greater than 1.00

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Lake Woodlands Drive and Grogans Mill Road – Grade Sep CAP-X

2045 Grade Separated CAP-X Results - Lake Woodlands Drive																	
	AM Peak Hour							PM Peak Hour									
At Grade Alternatives	Zone 1 (Rt Mrg)	Zone 2 (Lt Mrg)	Zone 3 (Ctr. 1)	Zone 4 (Ctr. 2)	Zone 5 (Lt Mrg)	Zone 6 (Lt Mrg)	Overall v/c	Zone 1 (Rt Mrg)	Zone 2 (Lt Mrg)	Zone 3 (Ctr. 1)	Zone 4 (Ctr. 2)	Zone 5 (Lt Mrg)	Zone 6 (Lt Mrg)	Overall v/c	Evaluation Status	Reason for Recommendation
Diamond N-S			0.54	0.43			0.54			0.71	0.57			0.71	Consider Dismissal by Project Team	
Diamond E-W			0.49	0.64			0.64			0.74	0.84			0.84	Consider Dismissal by Project Team	Does not remove heavy LWD thru traffic from signals
Double Crossover Diamond N-S	0.57	0.37	0.49	0.58	0.36	0.44	0.58	0.29	0.55	0.56	0.71	0.36	0.61	0.71	Consider Dismissal by Project Team	Diamond and Single Point provide better operations.
Double Crossover Diamond E-W	0.40	0.64	0.36	0.45	0.60	0.48	0.64	0.54	0.83	0.58	0.59	0.81	0.77	0.83	Consider Dismissal by Project Team	Does not remove heavy LWD thru traffic from signals
Single Point N-S	0.72		0.52			0.46	0.72	0.40		0.62			0.64	0.64	Additional Modeling Recommended	
Single Point E-W	0.58		0.61			0.48	0.61	0.76		0.76			0.77	0.77	Consider Dismissal by Project Team	Does not remove heavy LWD thru traffic from signals

Synchro Results Summary

Research Forest Drive and Grogans Mill Road – Synchro

2030 Alternatives Synchro LOS - Research Forest Drive

Alternatives	AM Peak Hour							PM Peak Hour						
	Overall Delay (sec) & LOS		E/W Roadway		N/S Roadway		Residual Capacity to LOS F	Overall Delay (sec) & LOS		E/W Roadway		N/S Roadway		Residual Capacity to LOS F
			# of Thru Lanes	Approach Width (ft)	# of Thru Lanes	Approach Width (ft)				# of Thru Lanes	Approach Width (ft)	# of Thru Lanes	Approach Width (ft)	
Conventional (6-lane RFD, 4-lane GMR)	43.1	D	6	118	4	94	---	44.9	D	6	118	4	94	---
Quadrant Roadway SW (6-lane RFD, 4-lane GMR)	35.4	D	6	130	4	70	---	39.1	D	6	130	4	70	---
Partial Displaced LT N-S (6-lane RFD, 4-lane GMR)	27.1	C	6	118	4	126	---	22.2	C	6	118	4	126	---
Median U-Turn N-S (6-lane RFD, 4-lane GMR)	28.5	C	6	106	4	106	---	34.5	C	6	106	4	106	---
Diamond N-S (6-lane RFD, 4-lane GMR)	38.7	D	4	124	4	94	---	36.3	D	4	124	4	94	---
Diverging Diamond N-S (6-lane RFD, 4-lane GMR)	19.6	B	4	124	4	80	---	14.3	B	4	124	4	80	---

2045 w/2030 Alternatives Synchro LOS - Research Forest Drive

Alternatives	AM Peak Hour							PM Peak Hour						
	Overall Delay (sec) & LOS		E/W Roadway		N/S Roadway		Residual Capacity to LOS F	Overall Delay (sec) & LOS		E/W Roadway		N/S Roadway		Residual Capacity to LOS F
			# of Thru Lanes	Approach Width (ft)	# of Thru Lanes	Approach Width (ft)				# of Thru Lanes	Approach Width (ft)	# of Thru Lanes	Approach Width (ft)	
Conventional (6-lane RFD, 4-lane GMR)	50.5	D	6	118	4	94	---	62.4	E	6	118	4	94	---
Quadrant Roadway SW (6-lane RFD, 4-lane GMR)	40.5	D	6	130	4	70	---	47.5	D	6	130	4	70	---
Partial Displaced LT N-S (6-lane RFD, 4-lane GMR)	36.3	D	6	118	4	126	---	25.9	C	6	118	4	126	---
Median U-Turn N-S (6-lane RFD, 4-lane GMR)	29.1	C	6	106	4	106	---	38.1	D	6	106	4	106	---
Diamond N-S (6-lane RFD, 4-lane GMR)	41.7	D	4	124	4	94	---	36.6	D	4	124	4	94	---
Diverging Diamond N-S (6-lane RFD, 4-lane GMR)	21.3	C	4	124	4	80	---	15.4	B	4	124	4	80	---

2045 Alternatives Synchro LOS - Research Forest Drive

Alternatives	AM Peak Hour							PM Peak Hour						
	Overall Delay (sec) & LOS		E/W Roadway		N/S Roadway		Residual Capacity to LOS F	Overall Delay (sec) & LOS		E/W Roadway		N/S Roadway		Residual Capacity to LOS F
			# of Thru Lanes	Approach Width (ft)	# of Thru Lanes	Approach Width (ft)				# of Thru Lanes	Approach Width (ft)	# of Thru Lanes	Approach Width (ft)	
Conventional (8-lane RFD, 4-lane GMR)	43.0	D	8	142	4	94	20%	46.1	D	8	142	4	94	20%
Quadrant Roadway SW (6-lane RFD, 4-lane GMR)	35.4	D	6	130	4	106	40%	39.5	D	6	130	4	106	25%
Partial Displaced LT N-S (6-lane RFD, 4-lane GMR)	25.0	C	6	130	4	138	35%	21.9	C	6	130	4	138	30%
Median U-Turn N-S (6-lane RFD, 4-lane GMR)	28.3	C	6	106	4	106	60%	37.7	D	6	106	4	106	25%
Diamond N-S (6-lane RFD, 4-lane GMR)	39.1	D	6	148	4	94	60%	38.2	D	6	148	4	94	65%
Diverging Diamond N-S (6-lane RFD, 4-lane GMR)	22.1	C	6	148	4	80	60%	17.5	B	6	148	4	80	65%

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Lake Woodlands Drive and Grogans Mill Road – Synchro

2030 Alternatives Synchro LOS - Research Forest Drive

Alternatives	AM Peak Hour							PM Peak Hour						
	Overall Delay (sec) & LOS		E/W Roadway		N/S Roadway		Residual Capacity to LOS F	Overall Delay (sec) & LOS		E/W Roadway		N/S Roadway		Residual Capacity to LOS F
			# of Thru Lanes	Approach Width (ft)	# of Thru Lanes	Approach Width (ft)				# of Thru Lanes	Approach Width (ft)	# of Thru Lanes	Approach Width (ft)	
Conventional (4-lane LWD, 4-lane GMR)	46.2	D	4	94	4	94	---	69.5	E	4	94	4	94	---
Partial Displaced LT N-S (4-lane LWD, 4-lane GMR)	36.1	D	4	106	4	138	---	34.7	C	4	106	4	138	---
Median U-Turn E-W (4-lane LWD, 4-lane GMR)	40.8	D	4	106	4	82	---	57.9	E	4	106	4	82	---
Diamond N-S (4-lane LWD, 4-lane GMR)	33.8	C	4	124	4	106	---	37.1	D	4	124	4	106	---
Single Point N-S (4-lane LWD, 4-lane GMR)	30.8	C	4	124	4	94	---	30.8	C	4	124	4	94	---

2045 w/2030 Alternatives Synchro LOS - Research Forest Drive

Alternatives	AM Peak Hour							PM Peak Hour						
	Overall Delay (sec) & LOS		E/W Roadway		N/S Roadway		Residual Capacity to LOS F	Overall Delay (sec) & LOS		E/W Roadway		N/S Roadway		Residual Capacity to LOS F
			# of Thru Lanes	Approach Width (ft)	# of Thru Lanes	Approach Width (ft)				# of Thru Lanes	Approach Width (ft)	# of Thru Lanes	Approach Width (ft)	
Conventional (4-lane LWD, 4-lane GMR)	67.9	E	4	94	4	94	---	90.4	F	4	94	4	94	---
Partial Displaced LT N-S (4-lane LWD, 4-lane GMR)	50.1	D	4	106	4	138	---	44.7	D	4	106	4	138	---
Median U-Turn E-W (4-lane LWD, 4-lane GMR)	53.1	D	4	106	4	82	---	62.8	E	4	106	4	82	---
Diamond N-S (4-lane LWD, 4-lane GMR)	36.0	D	4	124	4	106	---	38.2	D	4	124	4	106	---
Single Point N-S (4-lane LWD, 4-lane GMR)	32.2	C	4	124	4	94	---	33.0	C	4	124	4	94	---

2045 Alternatives Synchro LOS - Research Forest Drive

Alternatives	AM Peak Hour							PM Peak Hour						
	Overall Delay (sec) & LOS		E/W Roadway		N/S Roadway		Residual Capacity to LOS F	Overall Delay (sec) & LOS		E/W Roadway		N/S Roadway		Residual Capacity to LOS F
			# of Thru Lanes	Approach Width (ft)	# of Thru Lanes	Approach Width (ft)				# of Thru Lanes	Approach Width (ft)	# of Thru Lanes	Approach Width (ft)	
Conventional (6-lane LWD, 6-lane GMR)	32.5	C	6	118	6	118	30%	43.7	D	6	118	6	118	20%
Partial Displaced LT N-S (6-lane LWD, 6-lane GMR)	26.5	C	6	130	6	162	55%	22.1	C	6	130	6	162	55%
Median U-Turn E-W (6-lane LWD, 6-lane GMR)	30.5	C	6	130	6	106	50%	47.2	D	6	130	6	106	20%
Diamond N-S (4-lane LWD, 6-lane GMR)	31.6	C	6	148	6	130	70%	34.9	C	6	148	6	130	40%
Single Point N-S (4-lane LWD, 4-lane GMR)	32.7	C	6	148	4	94	50%	33.5	C	6	148	4	94	35%

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Synchro Summary

Alternatives Comparsion - Research Forest Drive 2045 Operations				
	Overall Intersection Area Delay	Individual LOS E/F Movements	Residual Capacity	Alternative Notes
Existing Geometry (6-lane RFD, 4-lane GMR)	LOS D/LOS E	5 - AM Peak 8 - PM Peak	0%	Existing intersection geometry fails at 2045 horizon year.
Conventional Expansion (**8-lane RFD**, 4-lane GMR)	LOS D/LOS D	3 - AM Peak 4 - PM Peak	20%	Poor turning operations, requires **8-lane RFD** to not have overall interseciton failure.
Quadrant Roadway SW (6-lane RFD, 4-lane GMR)	LOS D/LOS D	4- AM Peak 4- PM Peak	25%	Overall operations acceptable, all left-turn operate at effective LOS E/F.
Partial Displaced LT N-S (6-lane RFD, 4-lane GMR)	LOS C/LOS C	0 - AM Peak 0- PM Peak	30%	Best operations of at-grade alternatives with largest footprint and access impacts.
Median U-Turn N-S (6-lane RFD, 4-lane GMR)	LOS C/LOS D	4- AM Peak 4- PM Peak	25%	Overall operations acceptable, all left-turns operate at effective LOS E/F.
Diamond N-S (6-lane RFD, 4-lane GMR)	LOS D/LOS D	0 - AM Peak 1- PM Peak	60%	Provides LOS D operations with one LOS E movement. Has significant residual capacity.
Diverging Diamond N-S (6-lane RFD, 4-lane GMR)	LOS C/LOS B	0 - AM Peak 0- PM Peak	60%	Operates at LOS B/C and provides significant residual capacity.

Alternatives Comparsion - Lake Woodlands Drive 2045 Operations				
	Overall Intersection Area Delay	Individual LOS E/F Movements	Residual Capacity	Reason for Recommendation
Existing Geometry (4-lane LWD, 4-lane GMR)	LOS F/LOS F	6 - AM Peak 9 - PM Peak	0%	Existing intersection geometry fails at 2045 horizon year.
Conventional (**6-lane LWD**, 6-lane GMR)	LOS C/LOS D	4 - AM Peak 4 - PM Peak	20%	Overal LOS is accetpable, however may LOS E/F movements.
Partial Displaced LT N-S (**6-lane LWD**, 6-lane GMR)	LOS C/LOS C	2 - AM Peak 2 - PM Peak	55%	Large intersction size and would require rework of nearby Lake Woodland Drive signals.
Median U-Turn E-W (**6-lane LWD**, 6-lane GMR)	LOS C/LOS D	4 - AM Peak 4 - PM Peak	20%	Highest delay of at-grade. Left-turns operate at LOS E/F.
Diamond N-S (4-lane LWD, 6-lane GMR)	LOS C/LOS C	0 - AM Peak 0 - PM Peak	40%	Additional lanes on GMR provide 5% more residual capacity.
Single Point N-S (4-lane LWD, 4-lane GMR)	LOS C/LOS C	0 - AM Peak 0 - PM Peak	35%	Similar operations with smaller footprint vs. tight diamond.

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