ORIGINAL TO GENERAL FILES

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

INTERDEPARTMENT CORRESPONDENCE

FILE P. I. No. 0007311, Fulton County
CSHPP-0007-00(311)
CR 3266/Bell Road at CR 72/Boles Road-
Intersection Improvement

OFFICE Program Control

DATE July 20, 2009

FROM Genetha Rice-Singleton, Program Control Administrator

TO SEE DISTRIBUTION

SUBJECT APPROVED PROJECT CONCEPT REPORT

Attached for your files is the approval for subject project.

Attachment

DISTRIBUTION:

Ron Wishon
Glenn Bowman
Ken Thompson
Michael Henry
Keith Golden
Angela Alexander
Paul Liles
Scott Lee
Joshua Higgins
Rachel Brown
Mike Lobdell
BOARD MEMBER

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

INTERDEPARTMENTAL CORRESPONDENCE

FILE: P.I. No. 0007311, Fulton County
CSHPP-0007-00(311)
CR 3266/Bell Road at CR 72/Boles Road-
Intersection Improvements

OFFICE: Program Control

DATE: July 15, 2009

FROM: Genetha Rice-Singleton, Program Control Administrator

TO: Gerald M. Ross, P.E., Chief Engineer

SUBJECT: ***PROJECT CONCEPT REPORT***

This project is the intersection improvements to CR 3266/Bell Road at CR 72/Boles Road in the City of Johns Creek, Georgia. The improvement includes the creation of a roundabout. The existing T-intersection consists of Bell Road to the north with southbound traffic terminating at a stop condition. Bell Road continues to the east of the intersection and Boles Road to the west. Eastbound and westbound traffic are free-flow with no stop condition. Bells Road and Boles Road are currently two lane facilities with no turn lanes at the intersection and narrow shoulders. Congestion at the intersection is caused by the southbound left and right turn movements from Bell Road, which is operating at Level-of-Service (LOS) "E" & "F". The proposed roundabout will effectively reduce congestion by allowing traffic from each direction to flow through the intersection. The implementation of the proposed roundabout in the build year 2011 will improve the overall LOS of the intersection to LOS "B" through the design year 2031.

The proposed project consists of constructing a three leg single lane roundabout with flares extending along each leg from the center of the intersection. The proposed typical section for Bell Road consists of two, 11' lanes, a 10' urban shoulder with a 5' sidewalk on the west side, and a 10' multi-use trail on the east side. Boles/Bell Road will consist of two, 11' lanes, a 10' urban shoulder with a 5' sidewalk on the north side, and a 10' multi-use trail on the south side. The roundabout will have a center island with a radius of 36', a 6' wide concrete apron around the island, an 18' travel lane around the island, and a 10' multi-use path. Traffic will be maintained during construction.

Environmental concerns include requiring a Categorical Exclusion be prepared; a Public hearing is not required; Time saving procedures are appropriate.

The estimated costs for this project are:

	PROPOSED	APPROVED	FUNDING	PROG DATE
Construction (includes E&C)	$ 651,000	$ 960,000	Q92	2011(Proposed)
Right-of-way & Utilities*	Local	Local		

* Johns Creek signed PFA on 6-12-2007 for ROW, UTIL, 20% PE, & 20% CST.

I recommend this project concept be approved.

GRS: JDQ
Attachment

CONCUR _____
Director of Preconstruction

APPROVED _____
Gerald M. Ross, P.E., Chief Engineer

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

INTERDEPARTMENT CORRESPONDENCE

FILE: P.I. No. 0007311 **OFFICE:** Environment/Location

PROJECT No. **CSHPP-0007-00(311) / FULTON County** **DATE:** 6/19/09

No description

FROM: Glenn Bowman, P.E., State Environmental/Location Engineer

TO: Genetha Rice-Singleton, Assistant Director of Preconstruction

SUBJECT: PROJECT CONCEPT REPORT REVIEW

The Concept Report for the above project has been reviewed and appears satisfactory subject to the following comment:

1. This project is location in an ozone & PM 2.5 non-attainment area. It will require interagency consultation for PM 2.5.

If you have any questions, please contact Glenn Bowman at (404) 699-4401.

GB:lc

cc: Ron Wishon
Angela Whitworth
Keith Golden
Angela Alexander
Bryant Poole

RECEIVED
JUN 22 2009

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA
DISTRICT SEVEN PRECONSTRUCTION
INTERSECTION IMPROVEMENT FOR BELL ROAD AND BOLES ROAD
PROJECT CONCEPT REPORT

Project Number: CSHPP-0007-00(311)
County: Fulton
P.I. Number: 0007311

Federal Route Number: N/A
State Route Number: N/A
SEE PAGE 2 FOR LOCATION SKETCH

Recommendation for approval:

DATE 5/14/09 _____
Project Manager

DATE 05-14-09 _____
District Engineer

The concept as presented herein and submitted for approval is consistent with that which is included in the Regional Transportation Plan (RTP) and the State Transportation Improvement Program (STIP).

DATE _____ _____
State Transportation Planning Administrator

DATE _____ _____
State Transportation Financial Management Administrator

DATE 6/19/09 _____
State Environment/Location Engineer

DATE _____ _____
State Traffic Safety & Design Engineer

DATE _____ _____
Project Review Engineer

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA
DISTRICT SEVEN PRECONSTRUCTION
INTERSECTION IMPROVEMENT FOR BELL ROAD AND BOLES ROAD
PROJECT CONCEPT REPORT

Project Number: CSHPP-0007-00(311)
County: Fulton
P.I. Number: 0007311

Federal Route Number: N/A
State Route Number: N/A
SEE PAGE 2 FOR LOCATION SKETCH

RECEIVED
MAY 27 2009

Recommendation for approval:

DATE 5/14/09 _____
Project Manager

DATE 05-14-09 _____
District Engineer

The concept as presented herein and submitted for approval is consistent with that which is included in the Regional Transportation Plan (RTP) and the State Transportation Improvement Program (STIP).

DATE 5-21-09 _____
State Transportation Planning Administrator

DATE _____ _____
State Transportation Financial Management Administrator

DATE _____ _____
State Environment/Location Engineer

DATE _____ _____
State Traffic Safety & Design Engineer

DATE _____ _____
Project Review Engineer

NOTICE OF LOCATION AND DESIGN APPROVAL

PROJECT NUMBER CSHPP-0007-00(311), FULTON COUNTY
P. I. NUMBER 0007311

Notice is hereby given in compliance with Georgia Code 22-2-109 that the Georgia Department of Transportation has approved the Location and Design of this project.

The date of location approval is July 20, 2009.

The proposed improvement is located in Land Lot District 11, Land Lots 411 and 414, within the City of Johns Creek in Fulton County. The intersection is approximately 1.5 miles southeast of the intersection of Medlock Bridge Road (SR 141) and Abbotts Bridge Road (SR 120). The surrounding areas in the vicinity of the intersection are currently used as single family residential.

This project involves constructing a three-leg single lane roundabout at the intersection of Bell Road and Boles Road. The proposed improvement is needed to reduce congestion and improve safety.

Drawings or maps or plats of the proposed project, as approved, are on file and are available for public inspection at the Georgia Department of Transportation:

Sebastian Nesbitt, Area Two Engineer
Georgia Department of Transportation
snesbitt@dot.ga.gov
1269 Kennestone Circle, Marietta, GA 30066
(770) 528-3238

Any interested party may obtain a copy of the drawings or maps or plats or portions thereof by paying a nominal fee and requesting in writing to:

Mike Lobdell, P.E., Project Manager
Georgia Department of Transportation
mlobdell@dot.ga.gov
5025 New Peachtree Rd., Chamblee, GA 30341
(770) 986-1257

Any written request or communication in reference to this project or notice SHOULD include the Project and P. I. Numbers as noted at the top of this notice.

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA
DISTRICT SEVEN PRECONSTRUCTION
INTERSECTION IMPROVEMENT FOR BELL ROAD AND BOLES ROAD
PROJECT CONCEPT REPORT

Project Number: CSHPP-0007-00(311)
County: Fulton
P.I. Number: 0007311

Federal Route Number: N/A
State Route Number: N/A
SEE PAGE 2 FOR LOCATION SKETCH

Recommendation for approval:

DATE 5/14/09 _____
Project Manager

DATE 05-14-09 _____
District Engineer

The concept as presented herein and submitted for approval is consistent with that which is included in the Regional Transportation Plan (RTP) and the State Transportation Improvement Program (STIP).

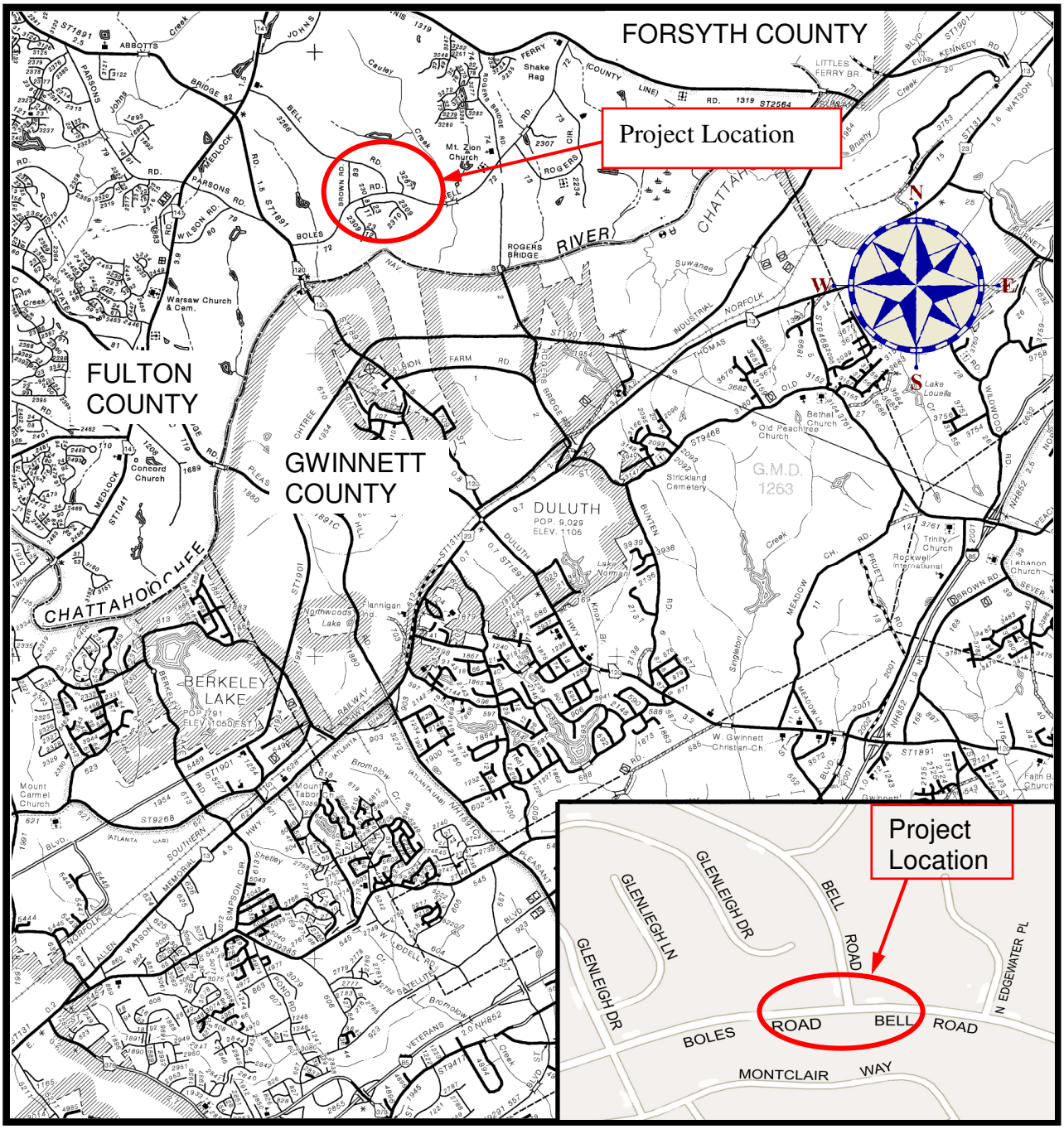
DATE _____ _____
State Transportation Planning Administrator

DATE _____ _____
State Transportation Financial Management Administrator

DATE _____ _____
State Environment/Location Engineer

DATE _____ _____
State Traffic Safety & Design Engineer

DATE _____ _____
Project Review Engineer



Location Map

CSHPP-0007-00(311), P.I. 0007311
Johns Creek, Ga.
Intersection improvement for Bell Road and Boles Road

Need and Purpose:

The proposed improvement at the intersection of Bell Road and Boles Road is needed to reduce congestion and improve safety. The project site is located in Land Lot District 11, Land Lots 411 and 414, within the City of Johns Creek in Fulton County. The intersection is approximately 1.5 miles southeast of the intersection of Medlock Bridge Road (SR 141) and Abbotts Bridge Road (SR 120). The surrounding areas in the vicinity of the intersection of Bell Road and Boles Road are currently used as single family residential. Bell Road and Boles Road are collectors for SR 120 to the southwest, SR 141 to the northwest, and McGinnis Ferry Road to the northeast. The existing T-intersection consists of Bell Road to the north with southbound traffic terminating at a stop condition. Bell Road continues to the east of the intersection and Boles Road is to the west. Eastbound and westbound traffic are free-flowing with no stop condition.

Congestion at the existing T-intersection is caused by the southbound left and right turn movements from Bell Road, which is currently operating at LOS E & F. A single lane roundabout is proposed to replace this existing intersection, which will remove the existing side street stop condition. The proposed roundabout will effectively reduce congestion by allowing traffic from each direction to flow through the intersection. The implementation of the proposed roundabout in the build year 2011 will improve the overall Level of Service of the intersection to a LOS B through the Design Year 2031. Levels of Service data tables for the intersection are provided below.

Opening Year 2011 Future No Build Levels of Service

Intersection				AM Peak Hour						PM Peak Hour					
				Movement			Overall			Movement			Overall		
#	Name	Control	Movement	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C
1	Bell Rd & Boles Rd	Side-street STOP	SB L+R	E	47.7	0.73	n/a	n/a	n/a	F	421.3	1.85	n/a	n/a	n/a
			EB L+T	A	5.6	0.22				A	3.1	0.12			

Design Year 2031 Future No Build Levels of Service

Intersection				AM Peak Hour						PM Peak Hour					
				Movement			Overall			Movement			Overall		
#	Name	Control	Movement	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C
1	Bell Rd & Boles Rd	Side-street STOP	SB L+R	F	99.0	0.97	n/a	n/a	n/a	F	651.1	2.36	n/a	n/a	n/a
			EB L+T	A	6.2	0.26				A	3.3	0.14			

Proposed Alternative - Opening Year 2011 Future Build Levels of Service

Intersection				AM Peak Hour						PM Peak Hour					
				Movement			Overall			Movement			Overall		
#	Name	Control	Movement	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C
1	Bell Rd & Boles Rd	Single-lane Round-about	SB L+R	A	7.2	0.25	A	7.9	0.44	B	12.2	0.66	B	10.1	0.53
			EB L+T	A	5.8	0.42				B	10.7	0.61			
			WB T+R	A	9.8	0.61				A	5.6	0.35			

Proposed Alternative - Design Year 2031 Future Build Levels of Service

Intersection				AM Peak Hour						PM Peak Hour					
				Movement			Overall			Movement			Overall		
#	Name	Control	Movement	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C
1	Bell Rd & Boles Rd	Single-lane Round-about	SB L+R	A	8.1	0.30	A	9.6	0.51	C	17.5	0.76	B	13.6	0.60
			EB L+T	A	6.4	0.47				B	14.3	0.70			
			WB T+R	B	12.6	0.69				A	6.0	0.39			

The proposed improvement will also serve to calm traffic and thus improve safety by requiring vehicles to reduce travel speed to negotiate the roundabout. In addition the FHWA has documented crash data from recently installed roundabouts which indicates that the number of crashes is expected to decrease by 51% after installation of a roundabout. Crash history data for this intersection is provided in the Attachment section of this report.

Proposed Project Description:

This project involves constructing a three-leg single lane roundabout to replace the existing T-intersection of Bell Road and Boles Road.

The termini of Bell Road are approximately 210 feet to the east and 200 feet to the north of the intersection with Boles Road. The terminus of Boles Road is approximately 380 feet to the west of the intersection of Bell Road. The roundabout will be elevated approximately four feet higher than the existing intersection to improve the vertical profile on Bell Road, reduce right of way impacts and to avoid having significant utility relocation cost. A temporary off-site detour that utilizes the surrounding arterials will be used during construction of this project.

The proposed typical section for Bell Road consists of two 11 foot lanes, a 10 ft urban shoulder with a 5 ft sidewalk on the west side, and a 16 ft urban shoulder with a 10 ft multiuse trail on the east side. The proposed typical section for Boles/Bell Road consists of two 11 foot lanes, a 10 ft urban shoulder with a 5 ft sidewalk on the north side, and a 16 ft urban shoulder with a 10 ft multiuse trail on the south side. Landscaping and lighting features will be included.

Is this Project in the Non-Attainment Area? Yes __X__ No _____

The proposed project consists of operational and safety improvements and does not add capacity.

PDP Classification: Major _____ Minor __X__

Federal Oversight: Full Oversight ( ), Exempt (X), State Funded ( ), Other ( )

Functional Classification: Bell Road– Urban Collector
Boles Road/Bell Road – Urban Collector

US Route Number(s) N/A **State Route Number(s)** N/A

Traffic (AADT):

Bell Road	Build Year: (2011) __5,531__	Design Year: (2031) __6,112
Boles/Bell Road	Build Year: (2011) __12,219__	Design Year: (2031) __13,501

Existing Design Features:
Bell Road

- Typical Section: (1) 11'-0" Wide Travel Lane in each Direction with mix of rural and urban shoulders
- Posted Speed Limit: 35 mph Minimum radius for curve: 760 ft.
- Maximum Super-elevation rate for curve: 6.00%
- Maximum Grade: 9.90%
- Width of Right of Way: 60 ft. corridor

Boles/Bell Road

- Typical Section: (1) 9'-0" Wide Travel Lane in each Direction with mix of rural and urban shoulders
- Posted Speed Limit: 45 mph Minimum radius for curve: 1950 ft.
- Maximum Super-elevation rate for curve: 4.00%
- Maximum Grade: 5.10%
- Width of Right of Way: 60 ft. corridor
- Major Structures: N/A
- Major Interchanges and Intersections: N/A

Proposed Design Features:
Roundabout

- Proposed Design Speed 15 mph
- Proposed Maximum Grade through roundabout 2.00%
- Proposed Inscribed Circle Diameter 120 ft
- Proposed Circulatory Roadway Width 18 ft

Bell Road

- Proposed typical section(s): (1) 11'-0" Wide Travel Lane in each Direction, a 10 ft urban shoulder with a 5 ft sidewalk on the west side, and a 16 ft urban shoulder with a 10 ft multiuse trail on the east side.
- Proposed Design Speed Mainline 35 mph
- Proposed Maximum Grade Mainline 9.19% Maximum Grade Allowable 10.00%
- Proposed Minimum Radius for Curve N/A Minimum radius allowable 340 ft.
- Proposed Maximum super-elevation rate for curve: NC
- Right of Way
  - Width: 60 ft.Corridor
  - Easements: Temporary ( ), Permanent (X), Utility ( ), Other ( ).
  - Type of access control: Full ( ), Partial ( ), By Permit (X), Other ( ).
  - Number of parcels: 2 Number of displacements: 0

Boles/Bell Road

- Proposed typical section(s): (1) 11'-0" Wide Travel Lane in each Direction, a 10 ft urban shoulder with a 5 ft sidewalk on the north side, and a 16 ft urban shoulder with a 10 ft multiuse trail on the south side.
- Proposed Design Speed Mainline 45 mph
- Proposed Maximum Grade Mainline 8.03 % Maximum Grade Allowable 9.0 %
- Proposed Minimum Radius for Curve 1950 ft. Minimum radius allowable 711 ft.
- Proposed Maximum super-elevation rate for curve: 4.0%
- Right of Way
  - Width: Corridor varies 85 ft to 115 ft.
  - Easements: Temporary ( ), Permanent (X), Utility ( ), Other ( ).
  - Type of access control: Full ( ), Partial ( ), By Permit (X), Other ( ).
  - Number of parcels: 4 Number of displacements: 0
- Design Exceptions to controlling criteria anticipated:

	UNDETERMINED	YES	NO
HORIZONTAL ALIGNMENT:	( )	( )	(X)
VERTICAL ALIGNMENT:	( )	( )	(X)
LANE WIDTH:	( )	( )	(X)
SHOULDER WIDTH:	( )	( )	(X)
VERTICAL GRADES:	( )	( )	(X)
CROSS SLOPES:	( )	( )	(X)
STOPPING SIGHT DISTANCE:	( )	( )	(X)
SUPERELEVATION RATES:	( )	( )	(X)
HORIZONTAL CLEARANCE:	( )	( )	(X)
SPEED DESIGN:	( )	( )	(X)
VERTICAL CLEARANCE:	( )	( )	(X)
BRIDGE WIDTH:	( )	( )	(X)
BRIDGE STRUCTURAL CAPACITY:	( )	( )	(X)

- Design Variances: Lane Widths
- Environmental Concerns: None anticipated
- Level of Environmental Analysis:
  - Are Time Savings Procedures appropriate? Yes (X), No ( ),
  - Categorical exclusion (X),

- Utility Involvement:
  - Georgia Power – Power
  - Sawnee EMC – Power
  - AT&T – Telecommunications
  - Comcast – Cable
  - Fulton County – Water & Sewer
  - Atlanta Gas Light – Gas

VE Study Required Yes( ) No(X)

Project Responsibilities:

- Design: City of Johns Creek
- Right of Way Acquisition: City of Johns Creek
- Relocation of Utilities: City of Johns Creek
- Letting Contract: City of Johns Creek
- Supervision of Construction: City of Johns Creek
- Providing Materials pits: Contractor
- Providing Detours: City of Johns Creek

Coordination:

- Initial Concept Team Meeting: 05/28/2008
- Concept Team Meeting date: 3/25/2009
- PAR meetings, dates and results: None Anticipated
- FEMA, USCG, and / or TVA: N/A
- Public Involvement: PIOH – To be scheduled
- Local Government comments: None

- Other Projects: 1.) Bell Road over Cauley Creek (Bridge Replacement);
  2.) Bell Road at Rogers Bridge (Intersection);
  3.) Bell Road at Rogers Circle (Intersection)
- Railroads: None

Scheduling – Responsible Parties' Estimate:

- Time to complete the environmental process: 9 months
- Time to complete preliminary construction plans: 6 months
- Time to complete right of way plans: 3 months
- Time to complete the Section 404 Permits: None anticipated
- Time to complete final construction plans: 6 months
- Time to purchase right of way: 12 months
- List other major items that will effect the project schedule: None anticipated

Other alternates considered:

Alternates 1, 2A, 2B, and 2C are related to alternate 2C in the attached traffic report.

Alternate 1 proposes improvements within a $650,000 construction cost at the request of the City of Johns Creek. This alternate includes a traffic signal and a left turn lane on Bell Road Southbound. No improvements are proposed for the vertical geometry or for shoulder improvements.

PROS:

- Construction cost within construction budget
- Reduced utility impacts/cost
- Subdivision entrance on east end of project will not be impacted
- Easily constructed since the existing profile is matched
- Low right of way cost

CONS:

- Does not satisfy capacity requirements
- Significantly longer traffic delays than the other alternates
- Existing vertical geometry does not meet 45 mph design speed

Alternate 2A is an intersection with a design exception. This alternate has a speed design of 35 mph. Alternate 2A proposes improvements with a design exception for a reduction in the desired speed design of 45mph to 35mph on Boles Road. This alternate proposes to add a traffic signal, a separate southbound left turn lane on Bell Road, a separate eastbound left turn lane on Boles Road, and a separate westbound right turn lane on Bell Road. The typical section for this alternate is an urban section, including curb & gutter, sidewalk improvements, and a 10 ft multiuse trail.

PROS:

- Improves vertical alignment design speed from 25mph to 35 mph
- Subdivision entrance on east end of project will not be impacted
- Does not add an additional through lane
- Reduces traffic delays

CONS:

- Significant utility impacts/cost
- Off-site detour required to simplify construction/staging due to profile grade changes
- The desired design speed of 45 mph is reduced to 35 mph to reduce cut and fill as well as right of way impacts. Design exception required
- Increased construction cost

Alternate 2B is similar to Alternate 2A except that it has a design speed of 30 mph.

PROS:

- Simplified construction/staging compared to alternate 2A due to minimal profile change.

- Reduced utility impacts/cost
- Off-site detour not necessary

CONS:

- Sag vertical curve desired design speed of 45 mph on Boles Road is reduced to 30 mph
- Vertical curve on Bell Road (N-S) set to match existing with a 35mph design except for near the intersection where there is a 25mph sag vertical curve

Alternate 2C proposes improvements without a design exception. This alternate proposes to add a traffic signal, a separate southbound left turn lane on Bell Road, a separate eastbound left turn lane on Boles Road, an additional westbound through lane on Bell Road, and a separate westbound right turn lane on Bell Road. The vertical geometry on both Bell and Boles Road are improved to 45mph design speed. The typical section for this alternate is an urban section, including curb & gutter, sidewalk improvements, and a 10 ft multiuse trail.

PROS:

- Satisfies capacity through design year 2031. LOS is B for the AM and PM peak hours
- Improves Boles Road and eastbound leg of Bell Road profile to 45mph

CONS:

- Off-site detour required to simplify construction/staging due to profile grade change on Boles Road
- Increased construction cost
- Significant right of way impacts/cost
- Requires additional through lane and there are no future corridor plans to add additional lanes
- Significant utility impacts/cost
- Subdivision entrance on east end of project will be impacted and right turn lane into subdivision will require reconstruction

Alternate 3 is a single lane roundabout however it results in significant impacts to utilities on Bell Road (N-S). The design speed approaching the roundabout is 35 mph.

PROS:

- Satisfies capacity requirements
- Reduced right of way impacts/cost
- Subdivision entrance on east end of project will not be impacted

CONS:

- Significant utility impacts/cost
- Off-site detour required to simplify construction/staging due to profile grade change on Bells Road (N-S)

Alternate 4 is similar to alternate 3 except that the intersection is raised to avoid cut on Bell Road (N-S). The construction length is reduced on Bell Road (N-S) and increased on Boles/Bell Road.

This resulted in higher construction and right of way cost however the net result is a reduced overall cost. The design speed approaching the roundabout is 35 mph. The typical section for this alternate is an urban section, including curb & gutter, sidewalk improvements, and a 10 ft multiuse trail.

PROS:

- Satisfies capacity requirements
- Reduced utility impacts/cost
- Subdivision entrance on east end of project will not be impacted

CONS:

- High right of way impacts/cost
- Off-site detour required to simplify construction/staging due to profile grade change on Boles/Bell Road

Alternate 5 is similar to alternates 2A and 2B, however the intersection was raised to reduce utility impacts as well as provide a design speed of 45 mph on Boles/Bell Road.

PROS:

- Improves vertical alignment design speed from 25mph to 45 mph
- Reduced utility impacts/cost
- Does not add an additional through lane
- Reduces traffic delays
- A design exception will not be required

CONS:

- Off-site detour required to simplify construction/staging due to profile grade changes
- High right of way impacts/cost
- Increased construction cost

Alternate 6 (recommended alternate) is similar to alternate 4 except that the three approaches to the roundabout have been minimized in length. This resulted in lower construction and right of way cost. The proposed design speeds for Bell Road and Boles/Bell Road are 35 mph and 45 mph, respectively. All approaches are slowed to 15 mph to navigate through the roundabout.

PROS:

- Satisfies capacity requirements
- Reduced right of way impacts
- Reduced utility impacts/cost
- Subdivision entrance on east end of project will not be impacted

CONS:

- Off-site detour required to simplify construction/staging due to profile grade change on Boles/Bell Road

Attachments:

1. Cost Estimates:
    a. Summary of cost including Engineering and Inspection Cost and Construction Contingencies
    b. Detailed Cost Estimate Report
    c. Fuel and Liquid AC adjustments
    d. Utility Cost
    e. Right of Way Cost Estimate
    f. Alternate Cost Comparison Matrix
2. Sketch location map
3. Typical sections
4. Accident summaries
5. Minutes of Initial Concept and Concept meetings
6. Minutes of any meetings that show support or objection to the concept
7. Location and Design Notice
8. Plan and Profiles
9. Capacity analysis (see attached traffic study)
10. BC Ratio

Summary of Costs

Project P.I. No.0007311

Subtotal Construction Cost		$ 537,416.92
• Engineering & Inspection	5%	$ 26,870.85
• Construction Contingency	6%	$ 32,245.02
• Total Fuel Adjustment		$ 17,606.31
• Total Liquid AC Adjustment		$ 35,962.14
Total Construction Cost		$ 650,101.24
• Right-of-Way – LOCAL		$ 626,838.84
• Reimbursable Utilities – LOCAL		$ 50,000.00
Total Project Cost		**$1,326,940.08**

Estimate Report for file "CSHPP-0007-00(311)"

Section ROADWAY

Item Number	Quantity	Units	Unit Price	Item Description	Cost
210-0100	1	LS	155941.00	GRADING COMPLETE -	155941.00
310-1101	1820	TN	20.53	GR AGGR BASE CRS, INCL MATL	37364.60
318-3000	60	TN	26.77	AGGR SURF CRS	1606.20
402-1812	225	TN	79.95	RECYCLED ASPH CONC LEVELING, INCL BITUM MATL & H LIME	17988.75
402-3113	275	TN	82.20	RECYCLED ASPH CONC 12.5 MM SUPERPAVE, GP 1 OR 2, INCL BITUM MATL & H LIME	22605.00
402-3121	443	TN	72.65	RECYCLED ASPH CONC 25 MM SUPERPAVE, GP 1 OR 2, INCL BITUM MATL & H LIME	32183.95
402-3190	295	TN	78.78	RECYCLED ASPH CONC 19 MM SUPERPAVE, GP 1 OR 2,INCL BITUM MATL & H LIME	23240.10
413-1000	395	GL	2.90	BITUM TACK COAT	1145.50
441-0014	95	SY	32.30	DRIVEWAY CONCRETE, 4 IN TK	3068.50
441-0104	1252	SY	38.85	CONC SIDEWALK, 4 IN	48640.20
441-6012	1454	LF	31.41	CONC CURB & GUTTER, 6 IN X 24 IN, TP 2	45670.14
441-6740	250	LF	19.12	CONC CURB & GUTTER, 8 IN X 30 IN, TP 7	4780.00
500-3800	12	CY	824.41	CLASS A CONCRETE, INCL REINF STEEL	9892.92
550-1180	220	LF	41.19	STORM DRAIN PIPE, 18 IN, H 1-10	9061.80
550-4218	1	EA	717.60	FLARED END SECTION 18 IN, STORM DRAIN	717.60
668-1100	1	EA	2841.65	CATCH BASIN, GP 1	2841.65
700-9300	450	SY	4.20	SOD	1890.00
				Section Sub Total:	**$418,637.91**

Section TRAFFIC SIGNING & MARKING

Item Number	Quantity	Units	Unit Price	Item Description	Cost
636-1020	250	SF	16.58	HIGHWAY SIGNS, TP 1 MATL, REFL SHEETING, TP 3	4145.00
636-1041	100	SF	45.22	HIGHWAY SIGNS, TP 2 MATL, REFL SHEETING, TP 9	4522.00
636-2090	200	LF	9.38	GALV STEEL POSTS, TP 9	1876.00
653-0120	6	EA	74.41	THERMOPLASTIC PVMT MARKING, ARROW, TP 2	446.46
653-0130	12	EA	99.68	THERMOPLASTIC PVMT MARKING, ARROW, TP 3	1196.16
653-1501	3000	LF	0.44	THERMOPLASTIC SOLID TRAF STRIPE, 5 IN, WHITE	1320.00
653-1502	2000	LF	0.45	THERMOPLASTIC SOLID TRAF STRIPE, 5 IN, YELLOW	900.00
653-1804	500	LF	1.67	THERMOPLASTIC SOLID TRAF STRIPE, 8 IN, WHITE	835.00
653-3501	200	GLF	0.34	THERMOPLASTIC SKIP TRAF STRIPE, 5 IN, WHITE	68.00
653-6006	500	SY	2.66	THERMOPLASTIC TRAF STRIPING, YELLOW	1330.00
				Section Sub Total:	**$16,638.62**

Section EROSION CONTROL

Item Number	Quantity	Units	Unit Price	Item Description	Cost
163-0232	1	AC	297.78	TEMPORARY GRASSING	297.78
163-0240	5	TN	164.44	MULCH	822.20
163-0300	3	EA	1177.73	CONSTRUCTION EXIT	3533.19
163-0503	2	EA	480.12	CONSTRUCT AND REMOVE SILT CONTROL GATE, TP 3	960.24
163-0520	20	LF	15.06	CONSTRUCT AND REMOVE TEMPORARY PIPE SLOPE DRAIN	301.20
163-0530	2500	LF	2.48	CONSTRUCT AND REMOVE BALED STRAW EROSION CHECK	6200.00
165-0030	1250	LF	0.72	MAINTENANCE OF TEMPORARY SILT FENCE, TP C	900.00
165-0070	1250	LF	2.69	MAINTENANCE OF BALED STRAW EROSION CHECK	3362.50
165-0087	2	EA	117.52	MAINTENANCE OF SILT CONTROL GATE, TP 3	235.04
165-0101	3	EA	482.32	MAINTENANCE OF CONSTRUCTION EXIT	1446.96
171-0030	2500	LF	3.64	TEMPORARY SILT FENCE, TYPE C	9100.00
603-2180	100	SY	29.74	STN DUMPED RIP RAP, TP 3, 12 IN	2974.00
700-6910	1	AC	754.08	PERMANENT GRASSING	754.08
700-7000	5	TN	65.07	AGRICULTURAL LIME	325.35
700-7010	10	GL	22.09	LIQUID LIME	220.90

700-8000	1	TN	470.95	FERTILIZER MIXED GRADE	470.95
700-8100	100	LB	2.36	FERTILIZER NITROGEN CONTENT	236.00
				Section Sub Total:	**$32,140.39**

Section LANDSCAPING & LIGHTING

Item Number	Quantity	Units	Unit Price	Item Description	Cost
000-0000	1	Lump Sum	10000.00	LANDSCAPING & LIGHTING	10000.00
				Section Sub Total:	**$10,000.00**

Section TRAFFIC CONTROL

Item Number	Quantity	Units	Unit Price	Item Description	Cost
150-1000	1	LS	60000.00	TRAFFIC CONTROL -	60000.00
				Section Sub Total:	**$60,000.00**

Total Estimated Cost: $537,416.92

Date 4/22/2009

P.I. Number *0007311 County Fulton

Project Number CSHPP-0007-00(311)

Special Provision, Section 109-Measurement and Payment

FUEL PRICE ADJUSTMENT (*ENGLISH 125% MAX)*

ENTER FPL DIESEL	2.373
ENTER FPM DIESEL	5.339

ENTER FPL UNLEADED	1.566
ENTER FPM UNLEADED	3.5235

http://www.dot.ga.gov/doingbusiness/Materials/Pages/asphaltcementindex.aspx

INCREASE ADJUSTMENT
125.00%

INCREASE ADJUSTMENT
125.00%

ROADWAY ITEMS	QUANTITY	DIESEL FACTOR	GALLONS DIESEL	UNLEADED FACTOR	GALLONS UNLEADED	REMARKS
Excavations paid as specified by Sections 205 **(CUBIC YARD)**	3600.000	0.29	1044.00	0.15	540.00	
Excavations paid as specified by Sections 206 **(CUBIC YARD)**		0.29		0.15		
GAB paid as specified by the ton under Section 310 **(TON)**	1811.000	0.29	525.19	0.24	434.64	
Hot Mix Asphalt paid as specified by the ton under Sections 400 **(TON)**		2.90		0.71		
Hot Mix Asphalt paid as specified by the ton under Sections 402 **(TON)**	1238.000	2.90	3590.20	0.71	878.98	
PCC Pavement paid as specified by the square yard under Section 430 **(SY)**		0.25		0.20		

BRIDGE ITEMS	Quantity	Unit Price	QF/1000	Diesel Factor	Gallons Diesel	Unleaded Factor	Gallons Unleaded	REMARKS
Bridge Excavation (CY) Section 211				8.00		1.50		
Class __Concrete (CY) Section 500	12.00	640.00	7.6800	8.00	61.44	1.50	11.52	
Class __Concrete (CY) Section 500				8.00		1.50		
Class __Concrete (CY) Section 500				8.00		1.50		
Superstru Con Class__(CY) Section 500				8.00		1.50		
Superstru Con Class__(CY) Section 500				8.00		1.50		
Superstru Con Class__(CY) Section 500				8.00		1.50		
Concrete Handrail (LF) Section 500				8.00		1.50		
Concrete Barrier (LF) Section 500				8.00		1.50		

BRIDGE ITEMS	Quantity	Unit Price	QF/1000	Diesel Factor	Gallons Diesel	Unleaded Factor	Gallons Unleaded	REMARKS
Stru Steel Plan Quantity(LB) Section 501				8.00		1.50		
Stru Steel Plan Quantity(LB) Section 501				8.00		1.50		
PSC Beams_____ (LF) Section 507				8.00		1.50		
PSC Beams_____ (LF) Section 507				8.00		1.50		
PSC Beams_____ (LF) Section 507				8.00		1.50		
Stru Reinf Plan Quantity(LB) Section 511				8.00		1.50		
Stru Reinf Plan Quantity(LB) Section 511				8.00		1.50		
Bar Reinf Steel (LB) Section 511				8.00		1.50		
Piling___inch (LF) Section 520				8.00		1.50		
Piling___inch (LF) Section 520				8.00		1.50		
Piling___inch (LF) Section 520				8.00		1.50		
Piling___inch (LF) Section 520				8.00		1.50		
Piling___inch (LF) Section 520				8.00		1.50		
Piling___inch (LF) Section 520				8.00		1.50		
Drilled Caisson,___ (LF) Section 524				8.00		1.50		
Drilled Caisson,___ (LF) Section 524				8.00		1.50		
Drilled Caisson,___ (LF) Section 524				8.00		1.50		
Pile Encasement,___(LF) Section 547				8.00		1.50		
Pile Encasement,___(LF) Section 547				8.00		1.50		

SUM QF DIESEL=	5220.83	SUM QF UNLEADED=	1865.14

DIESEL PRICE ADJUSTMENT($)	$14,247.38
UNLEADED PRICE ADJUSTMENT($)	$3,358.93

ASPHALT CEMENT PRICE ADJUSTMENT
(BITUMINOUS TACK COAT 125% MAX)

APPLICABLE TO CONTRACTS/PROJECTS CONTAINING THE 413 SPECIFICATION, SECTION 413.5.01 ADJUSTMENTS
ASPHALT PRICE ADJUSTMENT FOR BITUMINOUS TACK COAT

http://www.dot.ga.gov/doingbusiness/Materials/Pages/asphaltcementindex.aspx

ENTER APL 450 **ENTER APM** 1012.5

125.00%	INCREASE ADJUSTMENT

L.I.N.	TYPE	TACK (GALLONS)	TACK (TONS)	REMARKS
4131000	PG 58-22	395	1.6966	

TMT = 1.6966

PRICE ADJUSTMENT($)	$916.14

400 / 402 ASPHALT CEMENT PRICE ADJUSTMENT 125% MAX

ENTER APL 450 **ENTER APM** 1012.5

http://www.dot.ga.gov/doingbusiness/Materials/Pages/asphaltcementindex.aspx

125.00%	INCREASE ADJUSTMENT

L.I.N. / Spec Number	MIX TYPE	HMA	JMF AC%	AC	REMARKS
			5.00		
4021812		225	5.00	11.25	
4023121	25 mm SP	443	5.00	22.15	
4023190	19 mm SP	295	5.00	14.75	
4023113	12.5 mm SP	275	5.00	13.75	
3183000		60	5.00	3.00	
			5.00		
			5.00		
			5.00		
			5.00		
			5.00		
			5.00		
			5.00		
			5.00		
			5.00		
			TMT =	64.90	

PRICE ADJUSTMENT($)	$35,046.00

ASPHALT CEMENT PRICE ADJUSTMENT FOR BITUMINOUS TACK COAT(Surface Treatment 125% MAX)

APPLICABLE TO CONTRACTS CONTAINING THE 413 SPEC. SECTION 413.5.01 ADJUSTMENTS ASPHALT PRICE ADJUSTMENT FOR BITUMINOUS TACK COAT

http://www.dot.ga.gov/doingbusiness/Materials/Pages/asphaltcementindex.aspx

ENTER APL

ENTER APM

MISSING APL OR APM	MISSING APL OR APM

Use this side for Asphalt Emulsion Only		
L.I.N.	TYPE	ASPHALT EMULSION (GALLONS)
TMT =		
REMARKS:		

Use this side for Asphalt Cement Only		
L.I.N.	TYPE	TACK (GALLONS)
TMT =		
REMARKS:		

MONTHLY PRICE ADJUSTMENT($)	MISSING APL OR APM

ADJUSTMENT SUMMARY

FUEL PRICE ADJUSTMENT (*ENGLISH 125% MAX)*

DIESEL PRICE ADJUSTMENT($)	$14,247.38
UNLEADED PRICE ADJUSTMENT($)	$3,358.93
ASPHALT CEMENT PRICE ADJUSTMENT (BITUMINOUS TACK COAT 125% MAX)	$916.14
400 / 402 ASPHALT CEMENT PRICE ADJUSTMENT 125% MAX	$35,046.00
ASPHALT CEMENT PRICE ADJUSTMENT FOR BITUMINOUS TACK COAT(Surface Treatment 125% MAX)	MISSING APL OR APM

REMARKS:	

TOTAL ADJUSTMENTS	$53,568.46

DVM 10/08

CITY OF JOHNS CREEK
GEORGIA

To: Clyde Cunningham, District Seven Utilities

From: Kevin Dye, Right-of-Way/Utility Coordinator

Date: April 21, 2009

Subject: Bell Road at Boles Rd., P.I. # 0007311, CSHPP-0007-00(311)
Preliminary Utility Cost Estimates

This is an intersection improvement project located within the City of Johns Creek, Fulton County. This project involves constructing a three-leg single lane roundabout intersection to replace the existing T-intersection of Bell Road and Boles Road. Utilities in the immediate area along with their estimated cost for relocations are as follows:

AGL	$0.00 (franchise agreement)
AT&T	$0.00 (franchise agreement)
Comcast	$0.00 (franchise agreement)
Fulton Water and Sewer	$50,000.00
GA Power	$0.00 (franchise agreement)
Sawnee EMC	$0.00 (franchise agreement)
TOTAL	**$50,000.00**

Please contact me at 678-512-3254 if you have any questions concerning this estimate

Cc: Project File
Mac Cranford, GDOT District 7
Joshua Higgins, GDOT District 7
David Robbins, GDOT District 7
Rudolph Frampton, Heath & Lineback Engineers
Allen Krivsky, Heath & Lineback Engineers

Preliminary Right of Way Cost Estimate

Date: 03-10-09
Project: CSHPP-0007-00(311)
Existing/Required R/W: Variable/Variable
Project Termini: 210' east, 200' north and 380' west of the Bell at Boles intersection
Description: Bell at Boles Roundabout Intersection Improvement
Land:

P.I. Number: 007311
No. Parcels: 6

Residential
7,800 s.f @ $12.63 /s.f. = $98,514
Residential Permanent Easements
20,450 s.f @ $6.32 /s.f. = $129,244

TOTAL $227,758.00

Improvements: fencing, landscaping $25,000.00

Relocation:
Commercial @ $25,000/parcel = $ N/A
Residential @ $40,000/parcel = $ N/A
TOTAL $0.00

Damages: Proximity $ N/A
Consequential $ N/A
Cost to Cure $ N/A
TOTAL $0.00

SUB-TOTAL: $252,758.00

Net Cost		$252,758.00
Scheduling Contingency	55 %	$139,016.90
Adm/Court Cost	60 %	$235,064.94
TOTAL		$626,839.84

Total Cost $626,839.84

Prepared By: Kevin Dye
R/W Coordinator(City of Johns Creek)

Reviewed / Approved: Howard P. Copeland
R/W Administrator

Note: Accuracy of estimate is the sole responsibility of the Preparer.
Note: The Market Appreciation(40%) is not included is this Preliminary Cost Estimate.

REVISED: 2-8-08

PROJECT: STP-00-1238-00(007)
P.I. : 0007311
BELL ROAD AT BOLES ROAD INTERSECTION IMPROVEMENT

ALTERNATE MATRIX
for comparison purposes only

Alternate	Construction Cost (non-inflated)	E & I 5%	Construction Contengency 6%	Fuel Adjustment	Liquid AC Adjustment	**Total Construction Costs**	Utility Cost	Right of Way Cost	**Total Costs**
1	$326,822	$16,341	$19,609	$12,359	$23,553	$398,684	$25,000	$139,265	$562,949
2A	$1,052,333	$52,617	$63,140	$50,740	$65,178	$1,284,007	$1,122,472	$1,269,827	$3,676,306
2B	$958,176	$47,909	$57,491	$43,509	$64,047	$1,171,131	$50,000	$1,229,378	$2,450,509
2C	$1,586,896	$79,345	$95,214	$97,049	$119,893	$1,978,397	$1,700,000	$2,287,903	$5,966,300
3	$619,877	$30,994	$37,193	$35,677	$45,090	$768,831	$1,122,472	$590,352	$2,481,654
4	$922,804	$46,140	$55,368	$45,860	$65,518	$1,135,689	$50,000	$1,656,703	$2,842,393
5	$1,626,218	$81,311	$97,573	$97,625	$95,248	$1,997,975	$50,000	$2,911,537	$4,959,512
6 (Recommended Alternate)	$537,417	$26,871	$32,245	$17,606	$35,962	$650,101	$50,000	$626,840	$1,326,941

Alternate 1 - Intersection - Fiscally constrained

Alternate 2A - Signalized intersection with design exception (Design speed on Boles/Bell = 35 MPH)

Alternate 2B - Signalized intersection with design exception (Design speed Boles/Bell = 30 MPH)

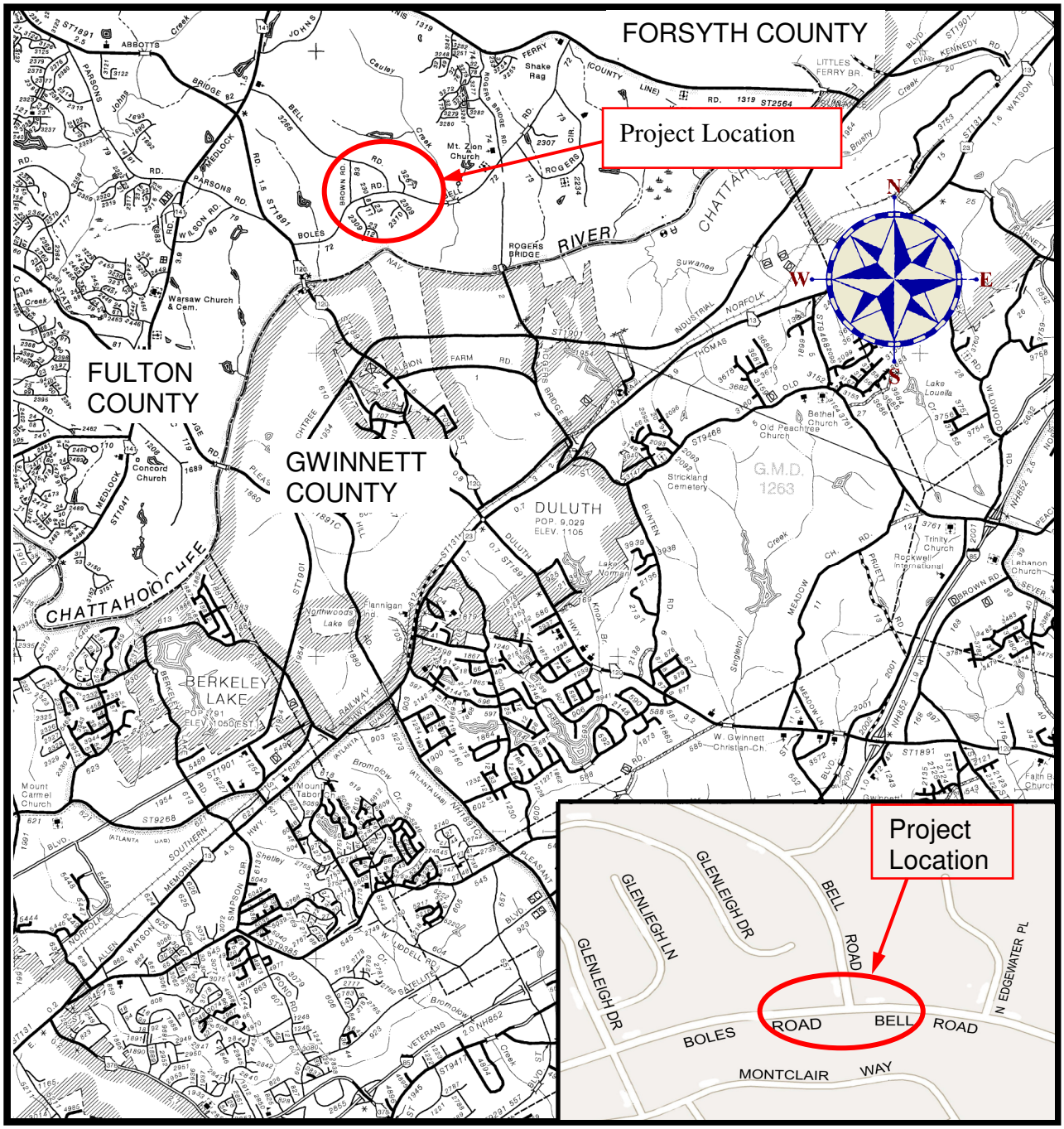
Alternate 2C - Signalized intersection without design exception (Design speed on Boles/Bell = 45 MPH)

Alternate 3 - Single lane roundabout (Significant utility impacts)

Alternate 4 - Single lane roundabout (Reduced utility impacts)

Alternate 5 - Raised signalized intersection without design exception (Reduced utility impacts)

Alternate 6 - Single lane roundabout (Reduced impacts)

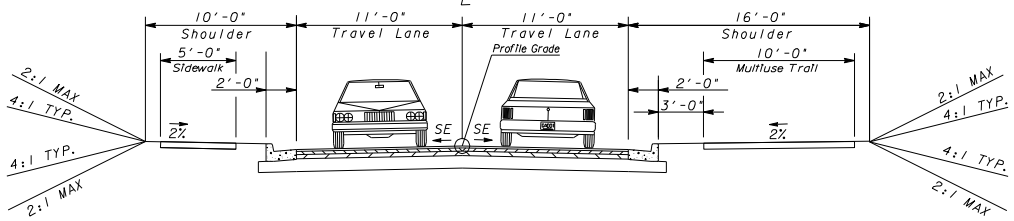


Location Map

CSHPP-0007-00(311), P.I. 0007311
Johns Creek, Ga.
Intersection improvement for Bell Road and Boles Road

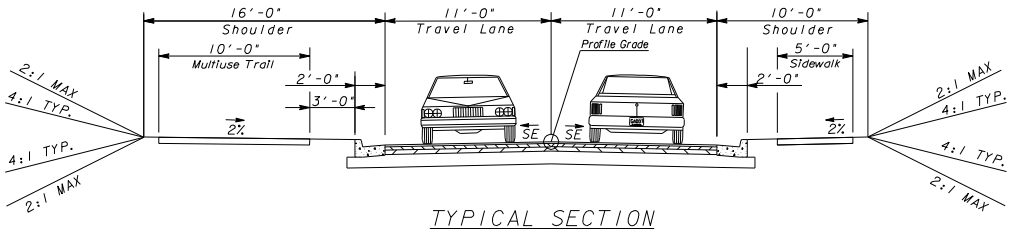
DATETIME$$$	TIME$$$	PRF	DGN	COUNTY	PROJECT NUMBER	SHEET NO.	TOTAL SHEETS
$USER$		$$PENTABLE$$		FULTON	CSHPP-0007-00(311)		

℄ BOLES/BELL ROAD



TYPICAL SECTION
BOLES/BELL ROAD

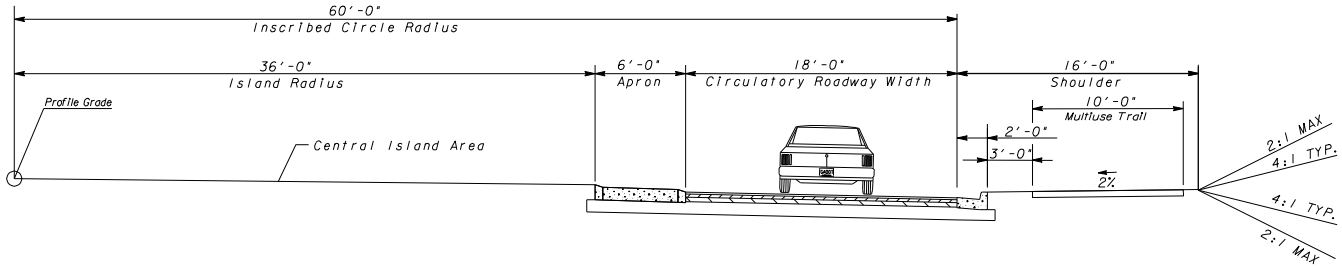
℄ BELL ROAD



TYPICAL SECTION
BELL ROAD

℄ BOLES/BELL ROAD =

℄ ROUNDABOUT



Heath & Lineback Engineers
INCORPORATED
2390 CANTON ROAD, BUILDING 200
MARIETTA, GEORGIA 30066-5393

REVISION DATES

STATE OF GEORGIA
DEPARTMENT OF TRANSPORTATION

OFFICE:

TYPICAL SECTIONS

DRAWING No.

BELL ROAD @ BOLES ROAD

GPLW

Crash History

Location	Case Number	First Harmful Event	Crash Severity	Event Location	Lighting Conditions	Road Condi-tion	Crash Date	Time	Direction of Travel 1	Direction of Travel 2	Maneuver 1	Maneuver 2
Intersection 1: Fulton CR 72 at Fulton CR 3266 - Milepost 0.94	51650201	11-Motor Vehicle in Motion	Non-Fatal Injury Crash	1-On Roadway	1-Daylight	1-Dry	4/11/2005	8:01 to 9:00 AM	1-North	2-South	01-Turning Left	05-Straight
	52250148	11-Motor Vehicle in Motion	PDO Crash	1-On Roadway	1-Daylight	1-Dry	5/2/2005	4:01 to 5:00 PM	3-East	2-South	01-Turning Left	05-Straight
	53810187	11-Motor Vehicle in Motion	Non-Fatal Injury Crash	1-On Roadway	1-Daylight	1-Dry	9/14/2005	5:01 to 6:00 PM	3-East	3-East	05-Straight	04-Stopped
	54350309	11-Motor Vehicle in Motion	PDO Crash	1-On Roadway	1-Daylight	1-Dry	7/31/2005	1:01 to 2:00 PM	3-East	4-West	01-Turning Left	05-Straight
	61360070	11-Motor Vehicle in Motion	PDO Crash	1-On Roadway	1-Daylight	1-Dry	3/24/2006	8:01 to 9:00 AM	2-South	2-South	09-Passing	05-Straight
	63030326	11-Motor Vehicle in Motion	PDO Crash	1-On Roadway	2-Dusk	1-Dry	7/21/2006	6:01 to 7:00 PM	3-East	3-East	02-Turning Right	04-Stopped
	63030549	28-Curb	PDO Crash	2-On Shoulder	5-Dark-Not Lighted	1-Dry	8/8/2006	5:01 to 6:00 AM	3-East	No second vehicle	10-Negotiating a Curve	No second vehicle
	63860187	11-Motor Vehicle in Motion	PDO Crash	3-Off Roadway	1-Daylight	1-Dry	10/10/2006	4:01 to 5:00 PM	1-North	1-North	05-Straight	04-Stopped
	64480162	11-Motor Vehicle in Motion	Non-Fatal Injury Crash	1-On Roadway	1-Daylight	1-Dry	10/23/2006	5:01 to 6:00 PM	1-North	2-South	01-Turning Left	05-Straight
	65070496	11-Motor Vehicle in Motion	PDO Crash	1-On Roadway	1-Daylight	2-Wet	11/30/2006	8:01 to 9:00 AM	2-South	2-South	05-Straight	04-Stopped
	70820180	11-Motor Vehicle in Motion	PDO Crash	1-On Roadway	1-Daylight	1-Dry	2/26/2007	7:01 to 8:00 AM	3-East	2-South	01-Turning Left	05-Straight
	73970191	11-Motor Vehicle in Motion	Non-Fatal Injury Crash	1-On Roadway	1-Daylight	1-Dry	8/24/2007	9:01 to 10:00 AM	2-South	1-North	09-Passing	01-Turning Left

Heath & Lineback Engineers

Memorandum

To:	File 2007053001.007
From:	Rudolph Frampton
CC:	Attendees
Date:	5-28-2008
Re:	Project No.: Intersection Improvement Project/Task Order #4 Initial Concept Meeting – Boles at Bell Road

---

This meeting was held to discuss studied alternatives and future milestones. The following was discussed:

1. Three alternatives were presented. 1) A fiscally constrained with a stop sign, 2) a desirable with a signal and 3) a roundabout.
2. A signal is warranted and therefore needed if a roundabout is not used.
3. A two lane roundabout is not desirable. HLE team shall evaluate a single lane roundabout.
4. Additional through lanes are not desirable. City does not have any plans to widen corridor. Citizens are against additional through lanes.
5. HLE to provide bullet points of pros and cons for each alternate.
6. There will be a council work session on July 14th to discuss the project. HLE shall attend.
7. Concept team meeting to be held after the work session in July.
8. Public meeting to be held after the concept team meeting.
9. Design year traffic volumes may not ever occur since widening of corridor is not anticipated.
10. HLE to show multi-use trails in plan.
11. Six weeks required for GDOT to manufacture signs for public meeting. City will likely handle signs.
12. HLE to provide updated traffic report and alternates with pros and cons in two weeks.

Attendees:

Cindy Jenkins – City of Johns Creek

Tom Udell – City of johns Creek

Ken Hildebrandt – City of johns Creek

Melvin Waldrop – GDOT District 7

Mac Cranford – GDOT District 7

Allen Krivsky – Heath & Lineback Engineers

Rudolph Frampton – Heath & Lineback Engineers

Danny Smith – Heath & Lineback Engineers

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Heath & Lineback Engineers

Memorandum

To:	File 2007.053.001.019
From:	Rudolph Frampton
CC:	Attendees
Date:	8-20-2008
Re:	Project No.: Intersection Improvement Project/Task Order #4 Roundabout Alternate – Boles at Bell Road

---

This meeting was held to discuss the traffic study as related to the roundabout alternate. The following was discussed:

1. No need to do a warrant study if a signal may not be used.
2. Signal not favored by residents and City wants to maintain rural character.
3. Roundabout alternate is the most context sensitive design.
4. The Design Manual guidance conflicts with the MOG for roundabouts. No decision on which guidance to follow. Use FHWA Guide for Roundabouts.
5. McGinnis Ferry project will take traffic of Boles and Bell when completed in 2010.
6. No way to put an exact number on the reduction in traffic without a global study.
7. Different growth rates could be used to account for the impacts from the project on McGinnis Ferry Road. Any flexibility in the lower growth rate and lesser design year must be approved by Keith Golden.
8. Requirements for of system roads are not as strict. A single lane roundabout operates sufficiently for the immediate future. The exact year it fails has not been determined.
9. Closing the northern leg of Bell road during construction could be an issue for emergency response time.
10. A design exception would be required for the sag at Bole Road if the project did not improve the sag.

Action Items:

1. Street Smarts to update traffic report with justifications for lower growth rate, lesser design year, and/or any other reasons worth noting. For example, neither Bole Road nor Bell Road will be 4-laned. The area has maxed out for growth and the roundabout results in some improvements in delay time. The actual design year is 10 – 15 years.
2. HLE to complete concept report once the traffic report has been accepted.

Attendees:

Cindy Jenkins – City of Johns Creek
Tom Udell – City of johns Creek
Mac Cranford – GDOT
Edlin Regis – GDOT
Randall Parker – Street Smarts
Julie Doyle – Street Smarts
Allen Krivsky – Heath & Lineback Engineers
Rudolph Frampton – Heath & Lineback Engineers

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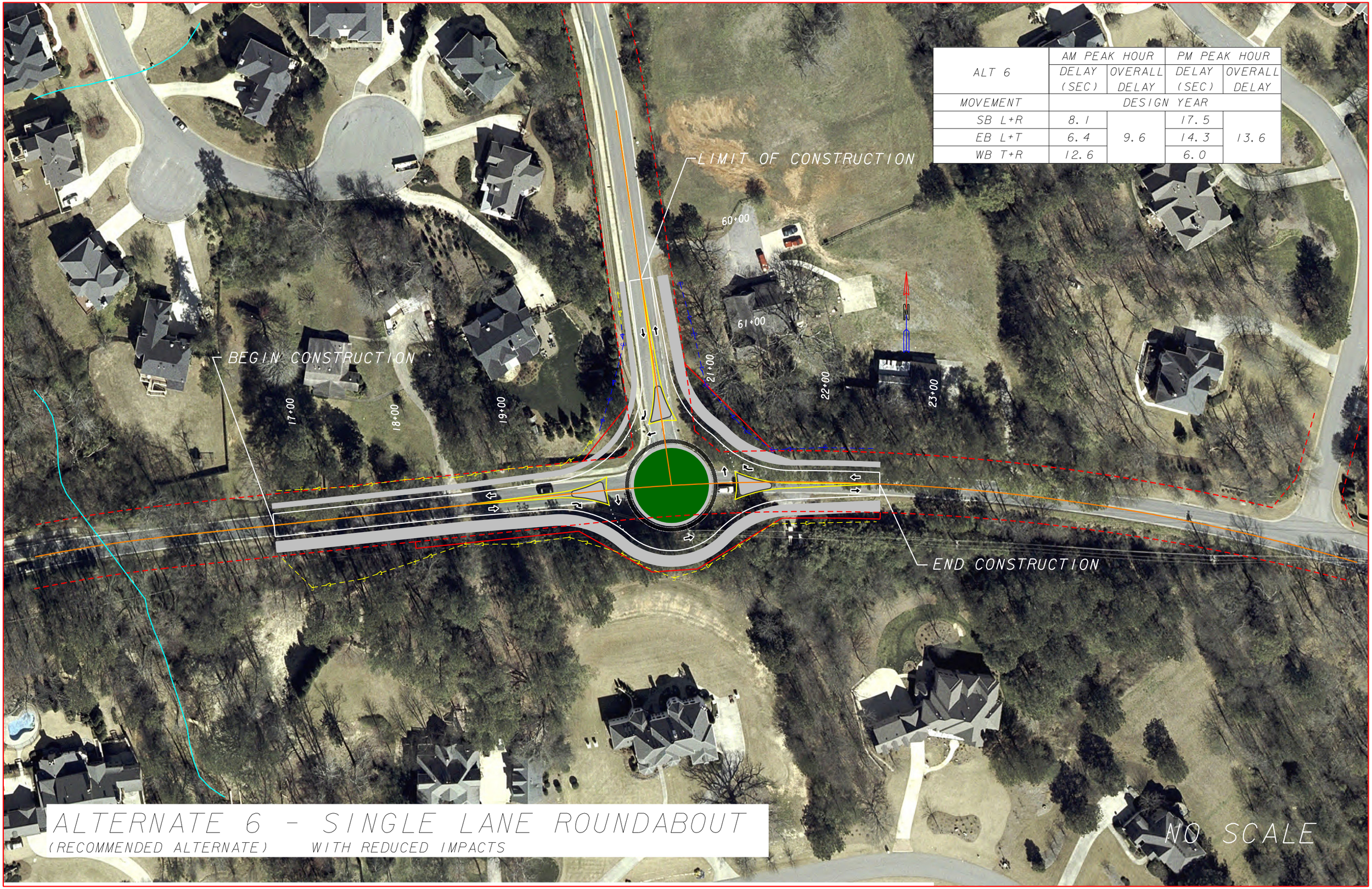
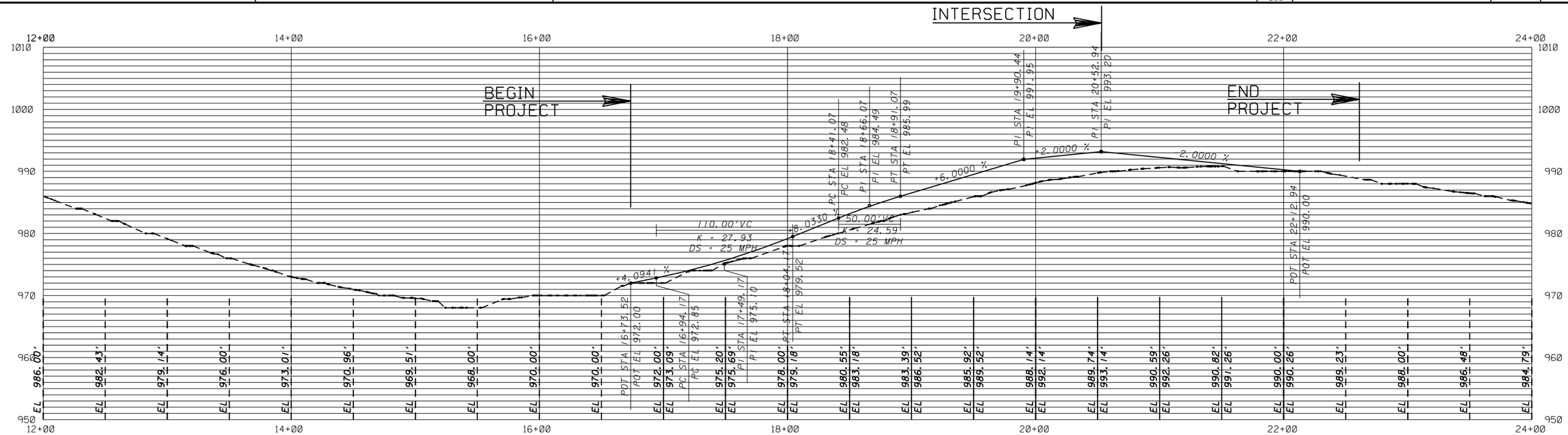


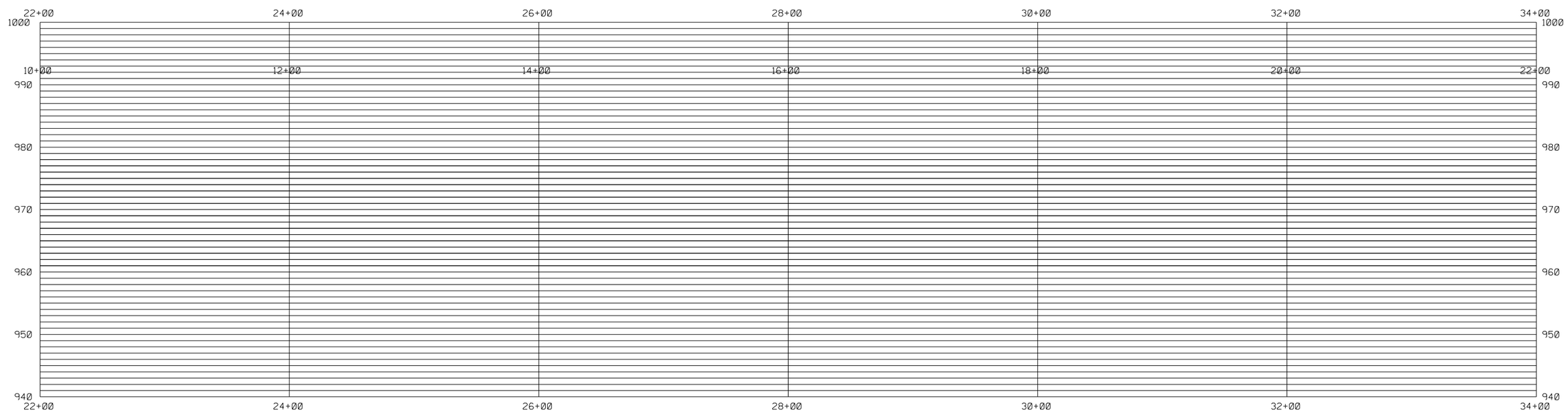
ALT 6	AM PEAK HOUR		PM PEAK HOUR	
	DELAY (SEC)	OVERALL DELAY	DELAY (SEC)	OVERALL DELAY
MOVEMENT	DESIGN YEAR			
SB L+R	8.1	9.6	17.5	13.6
EB L+T	6.4		14.3	
WB T+R	12.6		6.0	

ALTERNATE 6 - SINGLE LANE ROUNDABOUT

(RECOMMENDED ALTERNATE) WITH REDUCED IMPACTS

DATETIME$$$	TIME$$$	PRF	DGN	STATE	PROJECT NUMBER	SHEET NO.	TOTAL SHEETS
$USER$		$$PENTABLE$$		GA			





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INCORPORATED
2390 CANTON ROAD, BUILDING 200
MARIETTA, GEORGIA 30066-5393

GR220E

REVISION DATES		

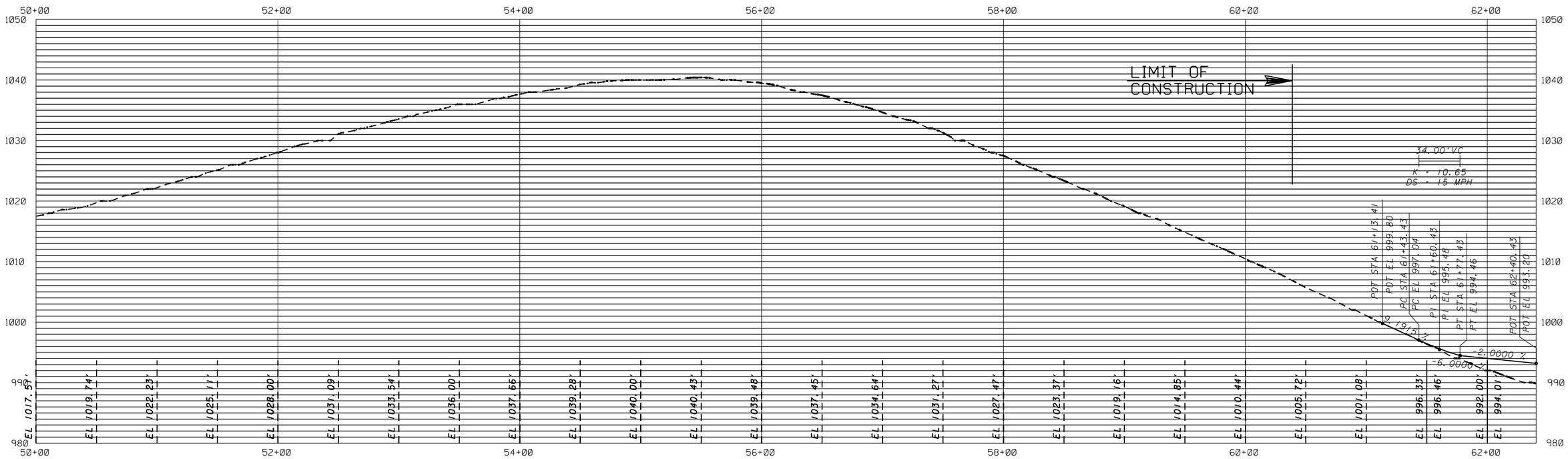
STATE OF GEORGIA
DEPARTMENT OF TRANSPORTATION

OFFICE:

BOLES ROAD PROFILE
ALTERNATE 6
(RECOMMENDED ALTERNATE)

DRAWING No.

DATETIME$$$	TIME$$$	PRF	DGN	STATE	PROJECT NUMBER	SHEET NO.	TOTAL SHEETS
$USER$		$$PENTABLE$$		GA			



REVISION DATES

Heath & Lineback Engineers
INCORPORATED
2390 CANTON ROAD, BUILDING 200
MARIETTA, GEORGIA 30066-5393

STATE OF GEORGIA
DEPARTMENT OF TRANSPORTATION

OFFICE:

BELL ROAD PROFILE
ALTERNATE 6
(RECOMMENDED ALTERNATE)

DRAWING No.

GR220E

CORRIDOR STUDY

for

BELL ROAD AND BOLES ROAD

City of Johns Creek, Georgia

Prepared for:
Heath & Lineback Engineers, Inc.

Prepared by Julie M. Doyle, P.E., PTOE, Street Smarts

Recommended by City of Johns Creek

Approved by _____

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REVISED October 2008

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PROJECT INFORMATION: Improvements are proposed for the intersection of Bell Road and Boles Road in the City of Johns Creek, Georgia. Three improvement "Alternatives" are being considered and are discussed below. Opening year of the intersection improvement is anticipated in 2011, and the design year of the project is 2031 (twenty years after opening).

The purpose of this study is to provide an analysis of the projected traffic conditions with and without construction of the proposed Bell Road and Boles Road intersection improvement project in the opening year 2011 and the design year 2031. Traffic volumes were developed without and with construction of the intersection improvements for a typical weekday when schools are in session. Analysis was conducted during the weekday AM and PM peak hours. Recommendations include intersection geometries and traffic controls, as well as lengths of proposed auxiliary turning lanes.

In addition to Future No Build conditions, three "Alternatives" were analyzed:

- **Alternative 1** – Alternative 1 would add lanes at the intersection, and the intersection would remain unsignalized.
- **Alternative 2** – Alternative 2 would add lanes and a traffic signal at the intersection.
- **Alternative 3** – Alternative 3 would add a roundabout at the intersection.

FINDINGS AND CONCLUSIONS: Design Year 2031 Future Traffic Control and Lane Configurations Figures are provided for Alternative 1 on page D.

Design Year 2031 Future Traffic Control and Lane Configurations Figures are provided for Alternative 2 on page E. Note that for Option 2B, in addition to the traffic signal, an eastbound left turn lane is shown as an improvement; however, adding a westbound right turn lane or a southbound left turn lane instead of the eastbound left turn lane would also be expected to provide adequate operating conditions for the overall intersection during both the AM and PM peak hours in the design year 2031.

Design Year 2031 Future Traffic Control and Lane Configurations Figures are provided for Alternative 3 on page F. A preliminary design sketch for Alternative 3 is shown on page G.

For Future No Build conditions in the opening year 2011, the side street approach of Bell Road is expected to operate inadequately during both the AM and PM peak hours. For

Future No Build conditions in the design year 2031, the side street approach of Bell Road is expected to operate inadequately during both the AM and PM peak hours.

The Levels of Service at the intersection of Bell Road and Boles Road were determined for Future Build conditions for the opening year 2011 and the design year 2031 under Alternatives 1, 2 and 3. For Alternatives 1 and 2, the Georgia Department of Transportation (GDOT) would require separate left and right turn lanes southbound on Bell Road, a separate left turn lane eastbound on Boles Road, and a separate right turn lane westbound on Bell Road based on the daily vehicular volume requirements. Therefore, the Levels of Service were determined with the lanes needed to achieve adequate AM and PM peak hour operating conditions and the lanes that would be required by GDOT.

For Alternative 1 Future Build conditions in the opening year 2011, if a separate southbound left turn lane were added on Bell Road (Option 1A), the southbound left turn movement on Bell Road would be expected to operate inadequately during both the AM and PM peak hours. The southbound right turn movement would be expected to operate adequately during both the AM and PM peak hours. No additional improvements, including the improvements shown under Option 1B, are expected to provide adequate operating conditions under unsignalized conditions.

For Alternative 1 Future Build conditions in the design year 2031, if a separate southbound left turn lane were added on Bell Road (Option 1A), the southbound left turn movement on Bell Road would be expected to operate inadequately during both the AM and PM peak hours. The southbound right turn movement would be expected to operate adequately during both the AM and PM peak hours. No additional improvements, including the improvements shown under Option1B, are expected to provide adequate operating conditions under unsignalized conditions.

For Alternative 2 Future Build conditions in the opening year 2011, a traffic signal (Option 2A) would be expected to provide adequate operating conditions for the overall intersection during both the AM and PM peak hours.

For Alternative 2 Future Build conditions in the design year 2031, if the addition of a traffic signal were the only improvement made at the intersection (Option 2A), adequate operating conditions would be expected for the overall intersection during the AM peak hour, and inadequate operating conditions would be expected during the PM peak hour. If, in addition to a traffic signal, a separate eastbound left turn lane on Boles Road or a separate westbound right turn lane on Bell Road or a separate southbound left turn lane on Bell Road were added (Option 2B – Lane Configuration Required for Capacity), adequate operating conditions would be expected for the overall intersection during both the AM and PM peak hours. If, in addition to a traffic signal, a separate southbound left turn lane on Bell Road, a separate eastbound left turn lane on Boles Road, and a separate westbound right turn lane on Bell Road were added (Option 2C – GDOT Required Turn Lanes), adequate operating conditions would be expected for the overall intersection during both the AM and PM peak hours.

For Alternative 2 Future Build conditions in the opening year 2011, Option 2A would be expected to provide adequate operating conditions for the overall intersection during both the AM and PM peak hours, but in the design year 2031, Option 2A would not be expected to provide adequate operating conditions for the overall intersection during both the AM and PM peak hours. Analysis was performed to determine in what year between the opening year 2011 and the design year 2031 Option 2A would no longer provide adequate operating conditions for the overall intersection during both the AM and PM peak hours. It was determined that in the year 2029, Option 2A would no longer provide adequate operating conditions for the overall intersection during both the AM and PM peak hours.

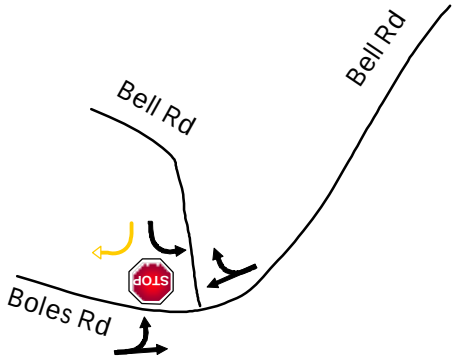
For Alternative 3 Future Build conditions in the opening year 2011, a single-lane roundabout with a single approach lane on each approach is expected to operate adequately.

For Alternative 3 Future Build conditions in the design year 2031, a single-lane roundabout with a single approach lane on each approach is expected to operate adequately.

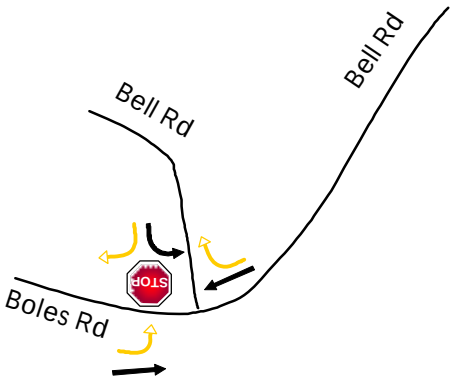
Based on information provided by Heath & Lineback Engineers, Inc., and the City of Johns Creek, a single-lane roundabout with a single approach lane on each approach (Alternative 3) is expected to have lower construction costs, lower maintenance costs, and lower right-of-way impacts than a traffic signal with turn lanes (Alternative 2).

Alternative 1 Design Year 2031 Future Traffic Control and Lane Configurations

Option 1A - Lane Configuration Required for Capacity



Option 1B - Lane Configuration Required for Capacity & GDOT Required Turn Lanes



NORTH

LEGEND

Existing Stop Sign Control

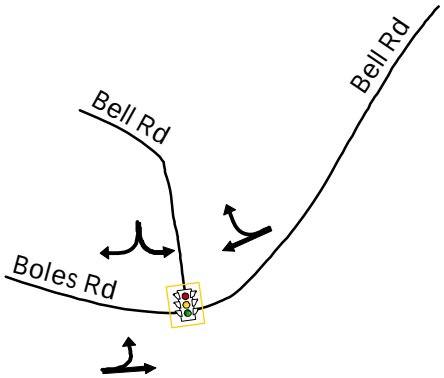
Existing Lane Configuration

Future Lane Configurations

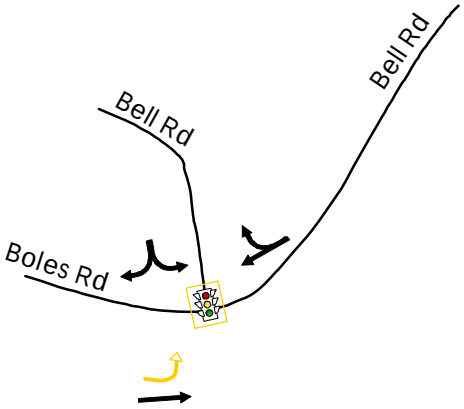
NOT DRAWN TO SCALE

Alternative 2 Design Year 2031 Future Traffic Control and Lane Configurations

Option 2A - Lane Configuration Required for Capacity with PM Level of Service E

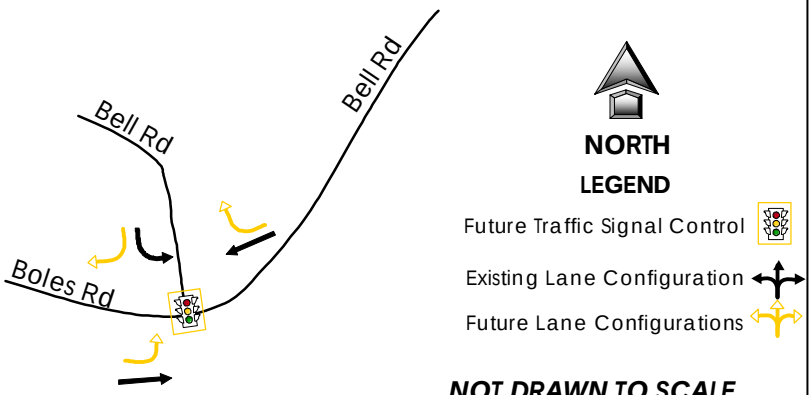


Option 2B - Lane Configuration Required for Capacity with Eastbound Left Turn Lane



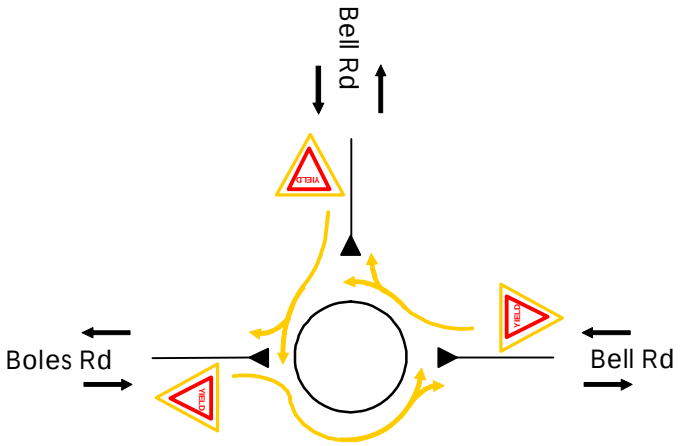
NOTE: Instead of an eastbound left turn lane, a westbound right turn lane or a southbound left turn lane would also be expected to provide adequate operating conditions during both the AM and PM peak hours

Option 2C - Lane Configuration Required for Capacity & GDOT Required Turn Lanes



NOT DRAWN TO SCALE

Alternative 3 Design Year 2031 Future Traffic Control and Lane Configurations



NORTH

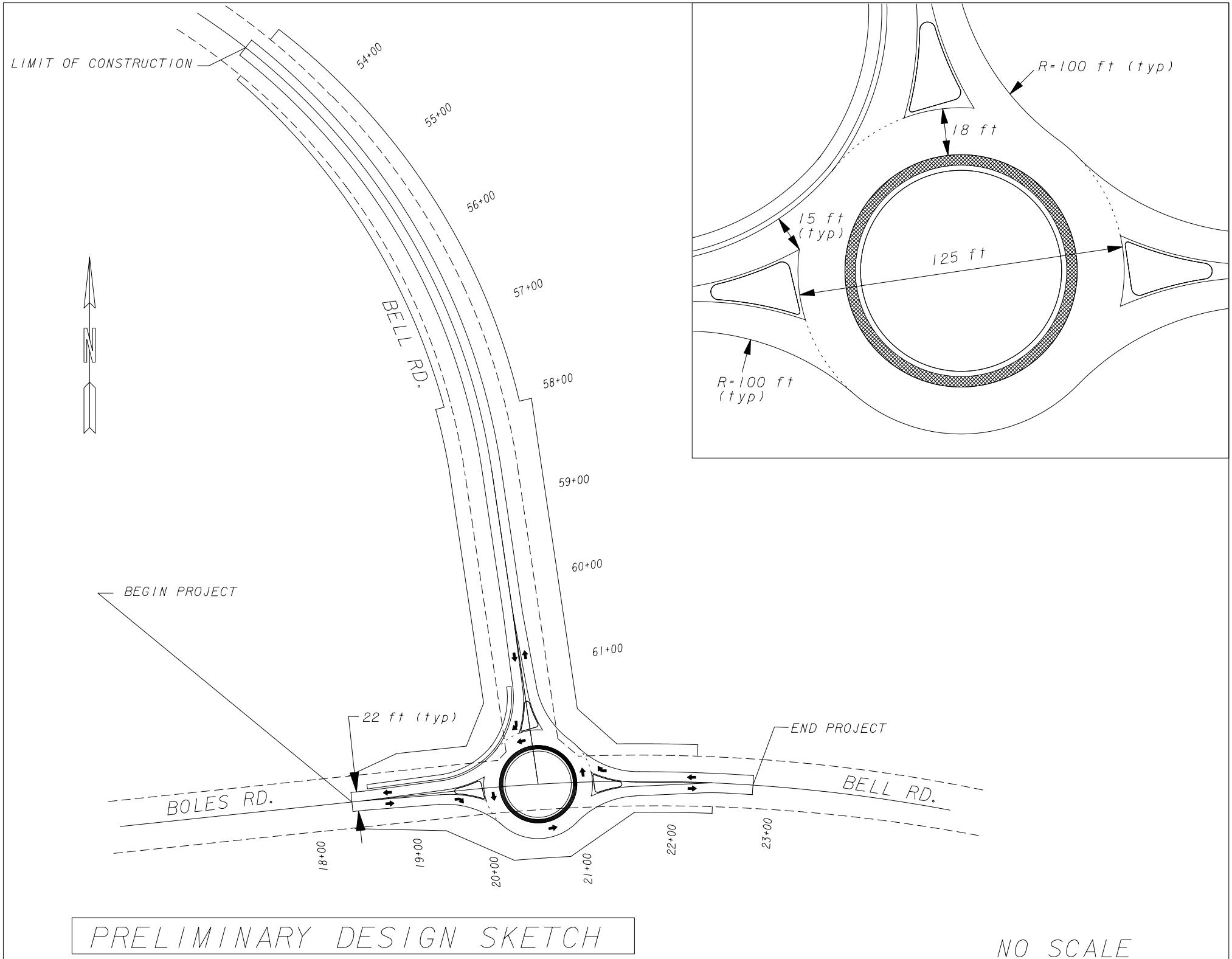
LEGEND

Existing Lane Configuration

Future Yield Sign Control

Future Lane Configurations

NOT DRAWN TO SCALE



PRELIMINARY DESIGN SKETCH

NO SCALE

1. INTRODUCTION

Description of Proposed Project

Improvements are proposed for the intersection of Bell Road and Boles Road in the City of Johns Creek, Georgia. Three improvement "Alternatives" are being considered and are discussed below. Opening year of the intersection improvement is anticipated in 2011, and the design year of the project is 2031 (twenty years after opening). The project location is shown in Figure 1.

In addition to Future No Build conditions, three "Alternatives" were analyzed:

- **Alternative 1** – Alternative 1 would add lanes at the intersection, and the intersection would remain unsignalized.

- **Alternative 2** – Alternative 2 would add lanes and a traffic signal at the intersection.

- **Alternative 3** – Alternative 3 would add a roundabout at the intersection.

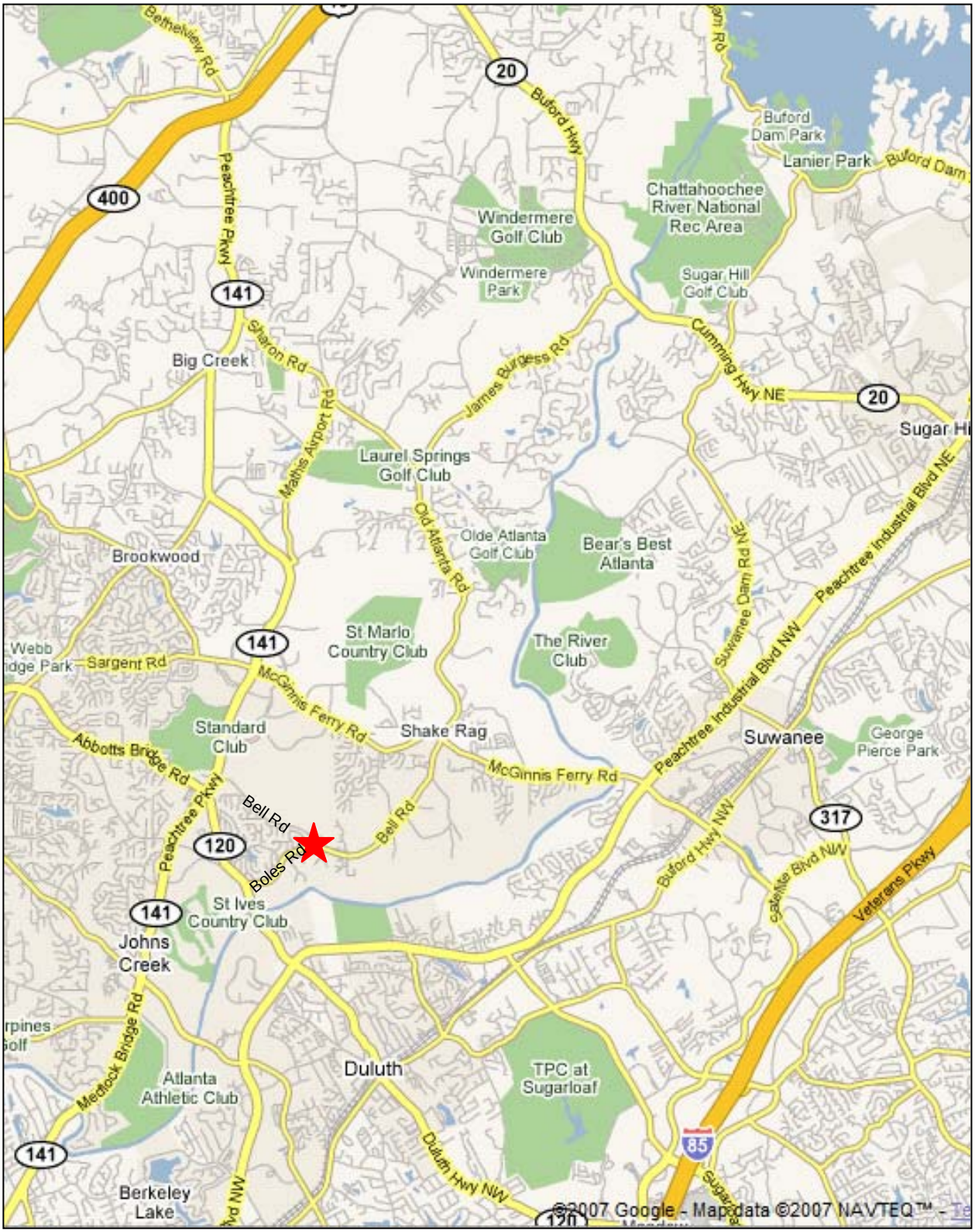
Purpose of Report

The purpose of this study is to provide an analysis of the projected traffic conditions with and without construction of the proposed Bell Road and Boles Road intersection improvement project in the opening year 2011 and the design year 2031. Traffic volumes were developed without and with construction of the intersection improvements for a typical weekday when schools are in session. Analysis was conducted during the weekday AM and PM peak hours. Recommendations include intersection geometries and traffic controls, as well as lengths of proposed auxiliary turning lanes.

This study included the following steps:

- Inventory of the existing roadway network;
- Collection of existing traffic data including traffic counts;
- Identification of background growth which will contribute traffic to the roadway network;
- Traffic volume development for Future No Build and Build conditions for weekday daily and AM and PM peak hour conditions for the years 2011 and 2031;
- Operational analysis of the roadway network with and without the proposed intersection improvement for the opening year 2011 and the design year 2031, for the Future No Build conditions, as well as the Future Build conditions;
- Turn lane requirements and lengths; and,
- Report of results and conclusions.

Figure 1. Site Location



Adjacent Roadway Description

A field review of the following roadways was conducted, and key factors that influence traffic flow and the capacity of the system were determined. The major roadways in the study area are described below:

- **Bell Road** is a two-lane undivided roadway with a 45 mph speed limit east of Boles Road and a 45 mph speed limit north of Boles Road. It runs roughly north-south from SR 120, where it aligns with Primrose Parkway, crossing SR 141, to Boles Road, where it turns east and then north, and runs to McGinnis Ferry Road, where it aligns with Old Atlanta Road. Bell Road forms the north and east legs of the intersection of Bell Road and Boles Road. The southbound approach of Bell Road is controlled by a stop sign. The westbound approach of Bell Road is uncontrolled. The adjacent land uses along Bell Road in the vicinity of Boles Road are primarily residential.

- **Boles Road** is a two-lane undivided roadway with a 45 mph speed limit. It runs roughly east-west from SR 120 to Bell Road, where it aligns with the eastern leg of Bell Road. Boles Road forms the west leg of the intersection of Bell Road and Boles Road. The eastbound approach of Boles Road is uncontrolled. The adjacent land uses along Boles Road in the vicinity of Bell Road are primarily residential.

Figure 2 shows the existing lane configurations and traffic control at the intersection of Bell Road and Boles Road. Figure 3 is an aerial of the existing conditions.

Existing Volumes

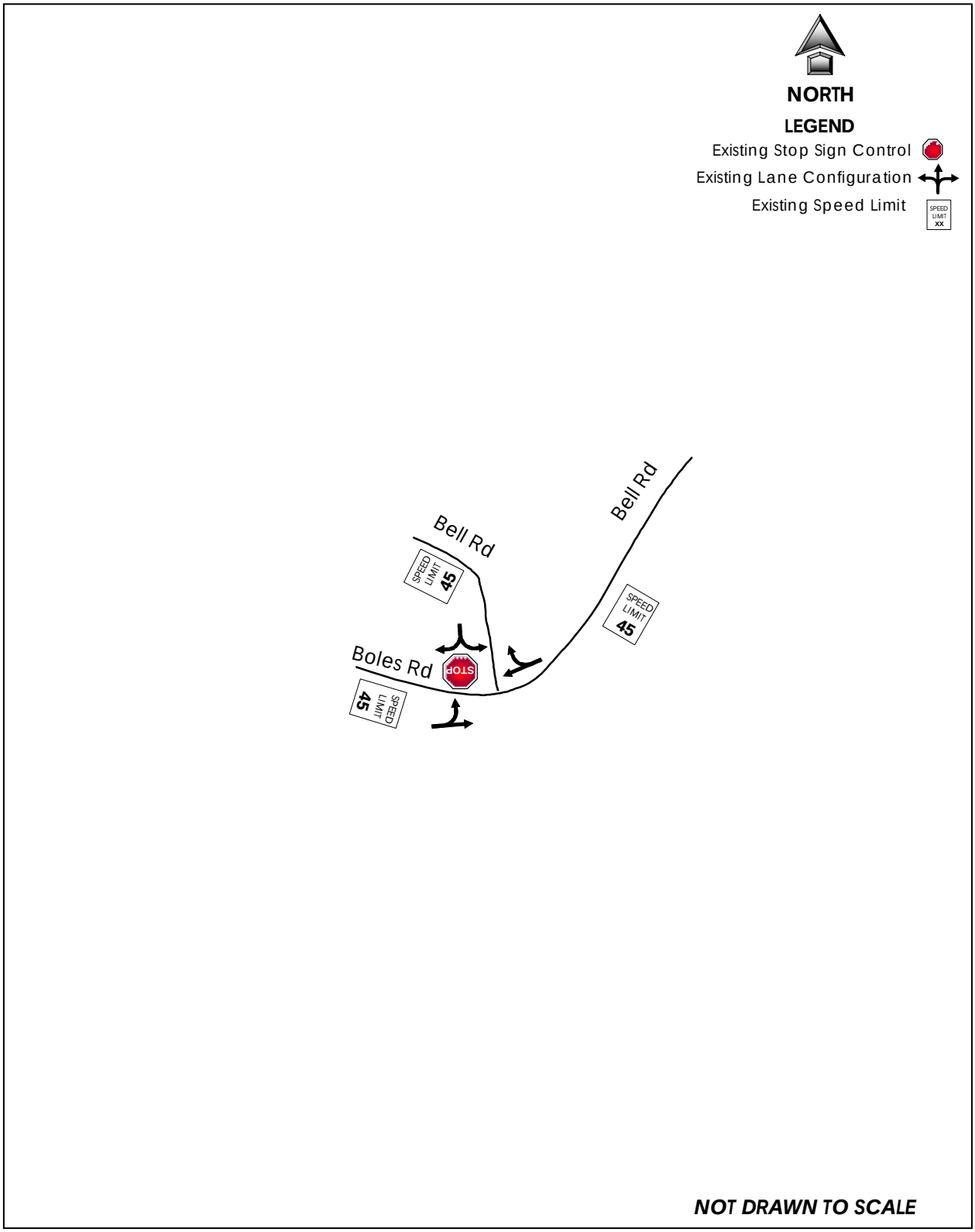
Weekday AM and PM peak hour turning movement counts were collected on Thursday, 11 October 2007, at the intersection of Bell Road and Boles Road.

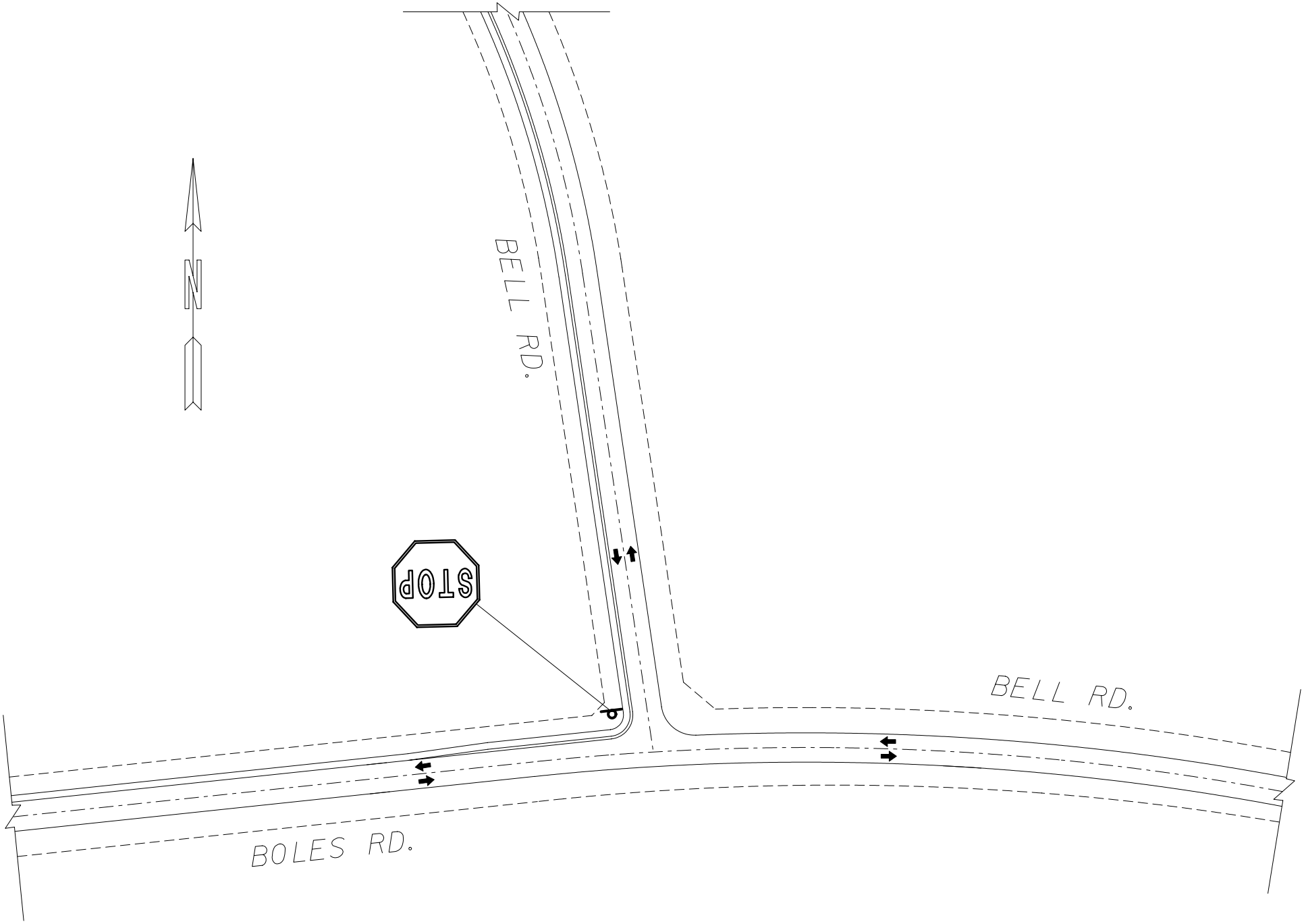
Weekday 24-hour directional volume counts were collected on Wednesday, 10 October 2007, on the following roadway segments:

- Bell Road east Boles Road;
- Bell Road north of Boles Road; and
- Boles Road west of Bell Road.

Figures 4 and 5 show the existing daily and AM and PM peak hour volumes at the intersection of Bell Road and Boles Road. The traffic count printouts are referenced as Appendix A.

Figure 2. Existing Traffic Control and Lane Configurations





EXISTING CONDITION SKETCH

NO SCALE

Figure 4. Existing Daily Traffic Volumes

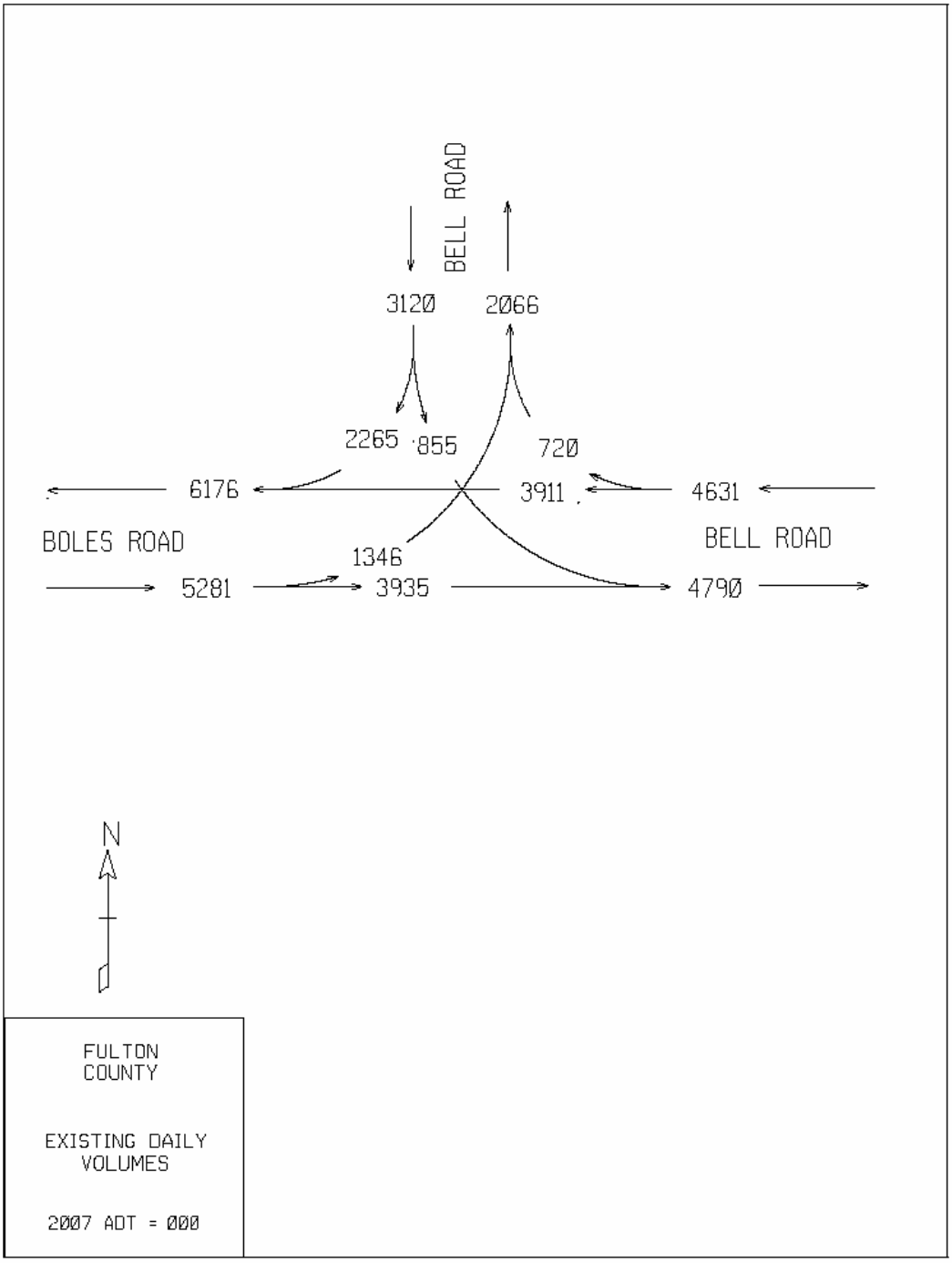
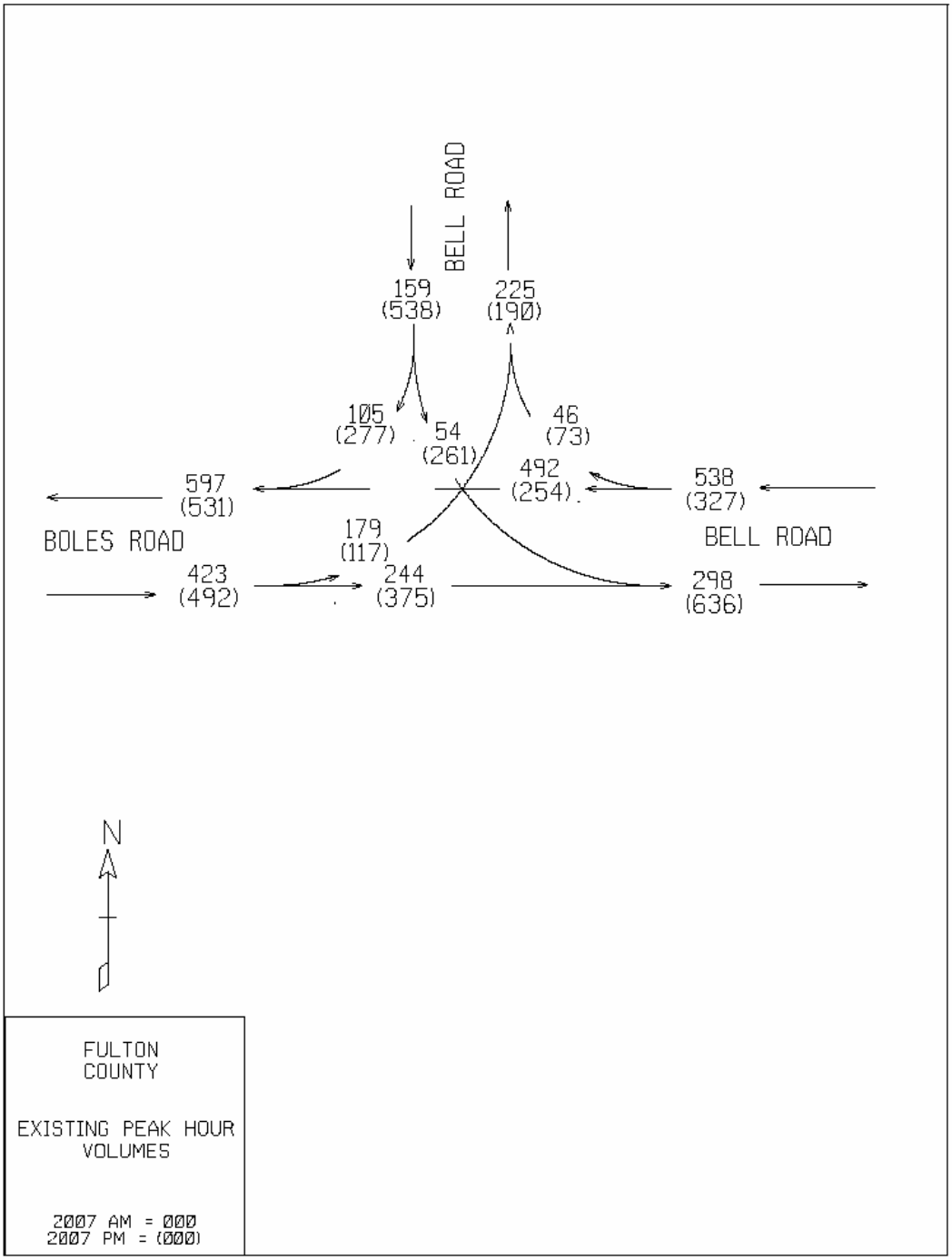


Figure 5. Existing AM and PM Peak Hour Traffic Volumes



The ratio of the existing volume on each leg of the intersection to the existing total volume at the intersection is shown in Table 1.

Table 1. Existing Volume Split

Leg	Daily	AM Peak Hour	PM Peak Hour
North (Bell Rd)	20%	17%	27%
East (Bell Rd)	36%	37%	35%
West (Boles Rd)	44%	46%	38%

Crash History

The crash history for the Years 2005, 2006, and 2007 at the intersection of Bell Road and Boles Road was obtained from the University of Alabama's Critical Analysis Reporting Environment 8 (CARE 8). The crash data is provided in Table 2 and in Appendix B.

Table 2. Crash History

Location	Case Number	First Harmful Event	Crash Severity	Event Location	Lighting Conditions	Road Condi-tion	Crash Date	Time	Direction of Travel 1	Direction of Travel 2	Maneuver 1	Maneuver 2
Intersection 1: Fulton CR 72 at Fulton CR 3266 - Milepost 0.94	51650201	11-Motor Vehicle in Motion	Non-Fatal Injury Crash	1-On Roadway	1-Daylight	1-Dry	4/11/2005	8:01 to 9:00 AM	1-North	2-South	01-Turning Left	05-Straight
	52250148	11-Motor Vehicle in Motion	PDO Crash	1-On Roadway	1-Daylight	1-Dry	5/2/2005	4:01 to 5:00 PM	3-East	2-South	01-Turning Left	05-Straight
	53810187	11-Motor Vehicle in Motion	Non-Fatal Injury Crash	1-On Roadway	1-Daylight	1-Dry	9/14/2005	5:01 to 6:00 PM	3-East	3-East	05-Straight	04-Stopped
	54350309	11-Motor Vehicle in Motion	PDO Crash	1-On Roadway	1-Daylight	1-Dry	7/31/2005	1:01 to 2:00 PM	3-East	4-West	01-Turning Left	05-Straight
	61360070	11-Motor Vehicle in Motion	PDO Crash	1-On Roadway	1-Daylight	1-Dry	3/24/2006	8:01 to 9:00 AM	2-South	2-South	09-Passing	05-Straight
	63030326	11-Motor Vehicle in Motion	PDO Crash	1-On Roadway	2-Dusk	1-Dry	7/21/2006	6:01 to 7:00 PM	3-East	3-East	02-Turning Right	04-Stopped
	63030549	28-Curb	PDO Crash	2-On Shoulder	5-Dark-Not Lighted	1-Dry	8/8/2006	5:01 to 6:00 AM	3-East	No second vehicle	10-Negotiating a Curve	No second vehicle
	63860187	11-Motor Vehicle in Motion	PDO Crash	3-Off Roadway	1-Daylight	1-Dry	10/10/2006	4:01 to 5:00 PM	1-North	1-North	05-Straight	04-Stopped
	64480162	11-Motor Vehicle in Motion	Non-Fatal Injury Crash	1-On Roadway	1-Daylight	1-Dry	10/23/2006	5:01 to 6:00 PM	1-North	2-South	01-Turning Left	05-Straight
	65070496	11-Motor Vehicle in Motion	PDO Crash	1-On Roadway	1-Daylight	2-Wet	11/30/2006	8:01 to 9:00 AM	2-South	2-South	05-Straight	04-Stopped
	70820180	11-Motor Vehicle in Motion	PDO Crash	1-On Roadway	1-Daylight	1-Dry	2/26/2007	7:01 to 8:00 AM	3-East	2-South	01-Turning Left	05-Straight
	73970191	11-Motor Vehicle in Motion	Non-Fatal Injury Crash	1-On Roadway	1-Daylight	1-Dry	8/24/2007	9:01 to 10:00 AM	2-South	1-North	09-Passing	01-Turning Left

The Future traffic volumes for the opening year 2011 and the design year 2031 were developed for the intersection of Bell Road and Boles Road.

Between the time this study is performed and the opening year 2011 and the design year 2031, the traffic volumes are expected to increase. This is due to development which will take place both in the study area by the opening year 2011 and the design year 2031, as well as growth outside of it. Growth of this nature can generally be determined by examining historic trends in the study area, and by applying those trends to the appropriate roadways.

McGinnis Ferry Road is currently being widened to four-lane divided from Sargent Road to the Chattahoochee River. The completion date is 2010. When the McGinnis Ferry Road widening is complete, the City of Johns Creek staff expect some of the traffic currently using Bell Road and Boles Road to use McGinnis Ferry Road instead.

Using historical Annual Average Daily Traffic (AADT) provided by the Georgia Department of Transportation (GDOT) at counting stations in the study area, a 2% per year growth rate was applied to the existing turning movement volumes for three years to develop the volumes expected at the intersection of Bell Road and Boles Road when the McGinnis Ferry Road widening is complete. After consultation with City of Johns Creek staff, a 0.5% per year growth rate was applied to the 2010 turning movement volumes for one year to develop the opening year 2011 volumes to reflect that a lower growth rate is expected along Bell Road and Boles Road when the McGinnis Ferry Road widening is complete. The 0.5% per year growth rate was applied to the opening year 2011 volumes for twenty years to develop the design year 2031 volumes.

Figures 6, 7 and 8 illustrate the Future opening year 2011 and design year 2031 daily traffic volumes, the opening year 2011 AM and PM peak hour traffic volumes, and the design year 2031 AM and PM peak hour traffic volumes.

The ratio of the opening year 2011 volume on each leg of the intersection to the opening year 2011 total volume at the intersection is shown in Table 3.

Table 3. Opening Year 2011 Volume Split

Leg	Daily	AM Peak Hour	PM Peak Hour
North (Bell Rd)	20%	17%	27%
East (Bell Rd)	36%	37%	35%
West (Boles Rd	44%	46%	38%

Figure 6. Opening Year 2011 and Design Year 2031 Daily Traffic Volumes

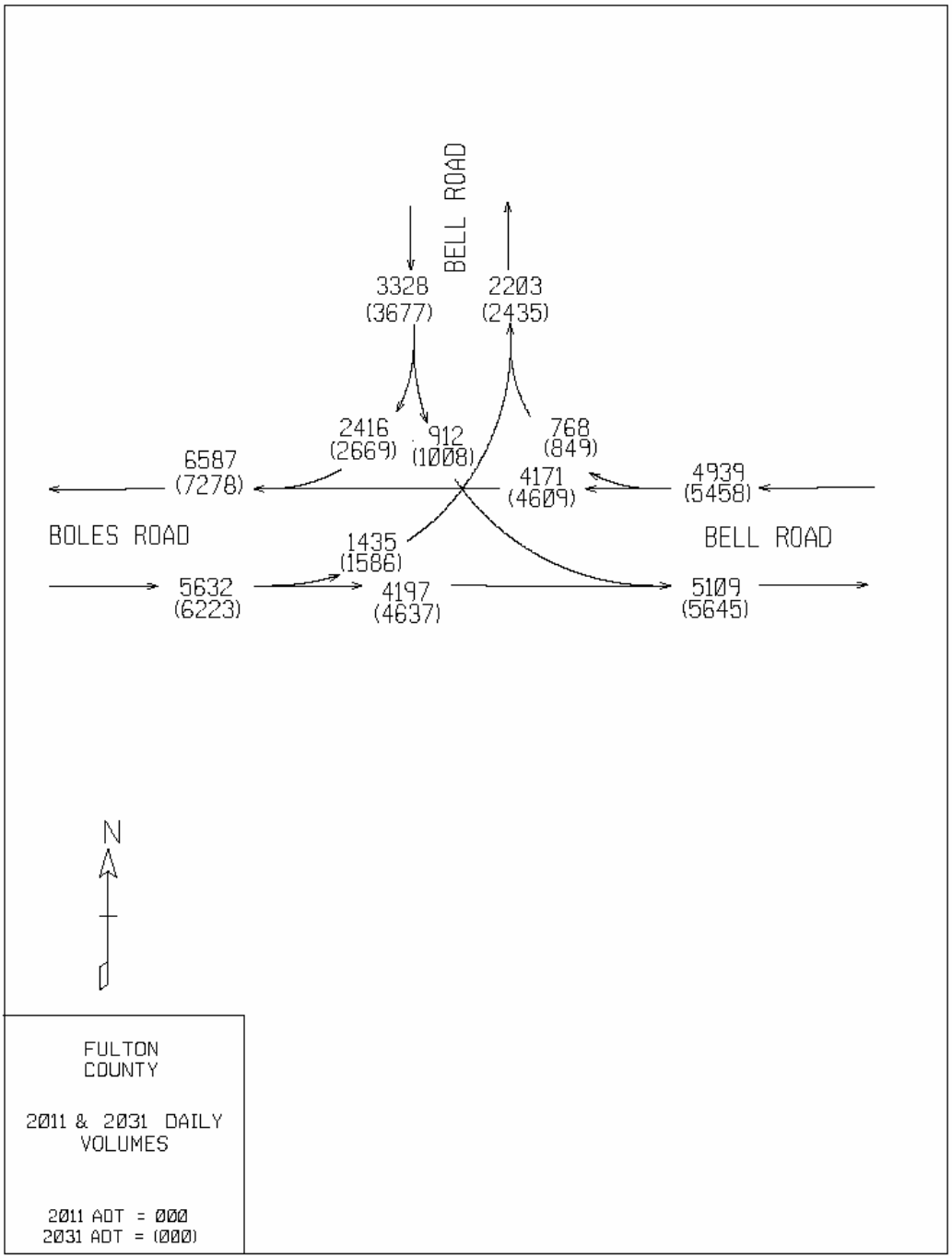


Figure 7. Opening Year 2011 AM and PM Peak Hour Traffic Volumes

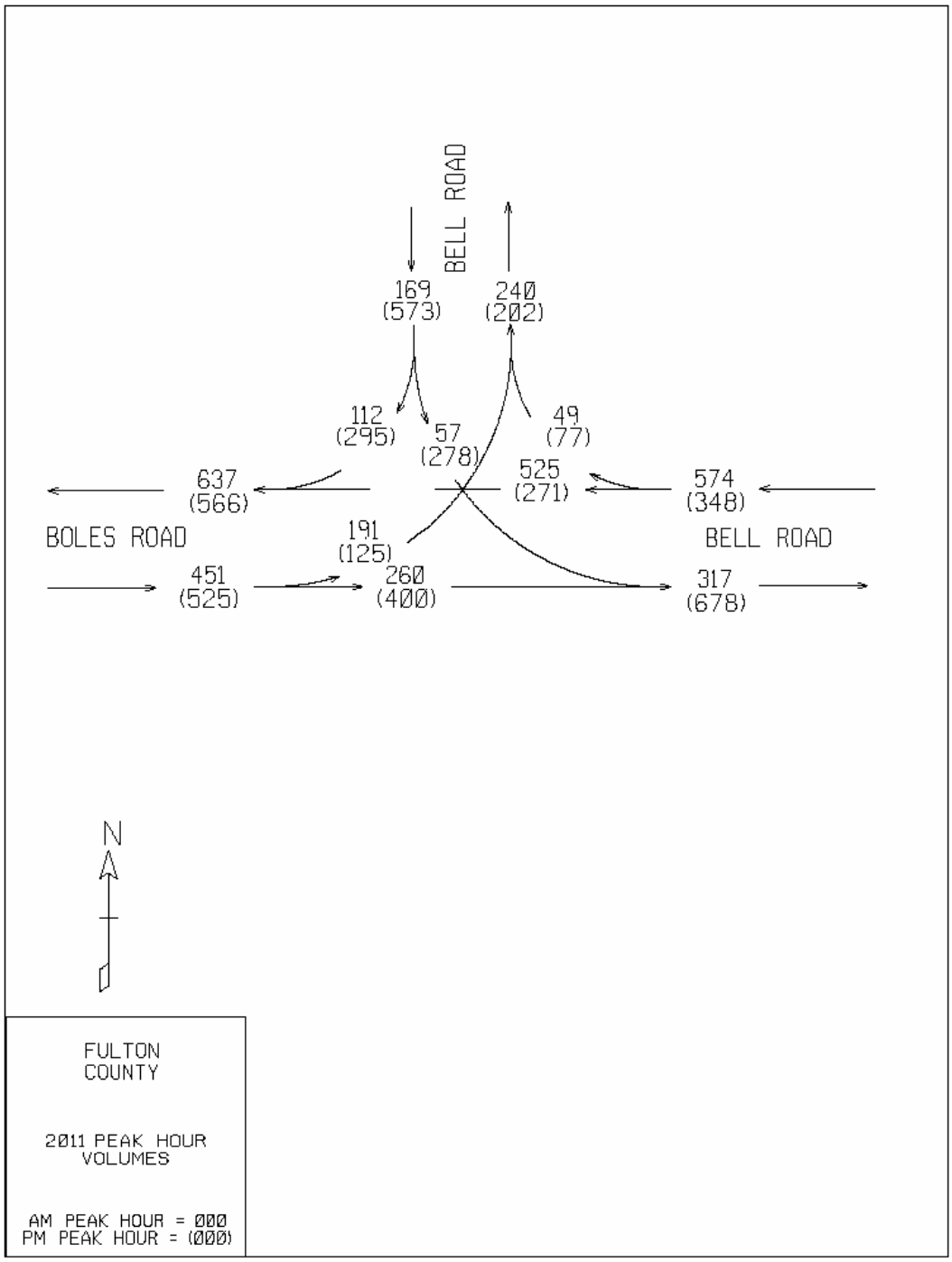
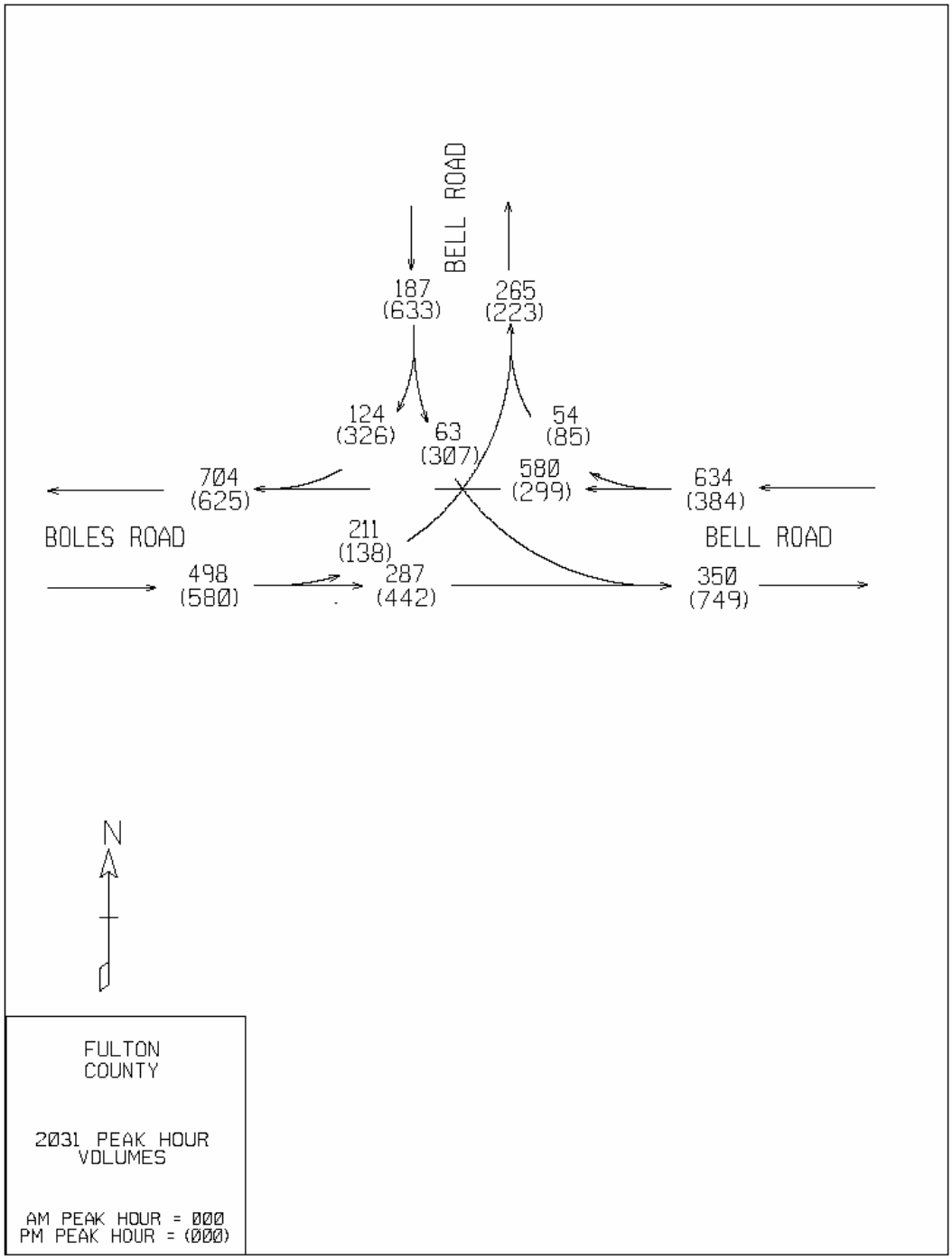


Figure 8. Design Year 2031 AM and PM Peak Hour Traffic Volumes



The ratio of the design year 2031 volume on each leg of the intersection to the design year 2031 total volume at the intersection is shown in Table 4.

Table 4. Design Year 2031 Volume Split

Leg	Daily	AM Peak Hour	PM Peak Hour
North (Bell Rd)	20%	17%	27%
East (Bell Rd)	36%	37%	35%
West (Boles Rd	44%	46%	38%

Table 5 summarizes the anticipated average daily traffic volumes (ADT's) for the existing conditions and the opening year 2011 and the design year 2031 conditions.

Table 5. Traffic Volume Summary

Condition	ADT	
	Bell Rd n. of Boles Rd	Bell Rd/Boles Rd
Existing 2007	5,186	11,457
Opening Year 2011	5,531	12,219
Design Year 2031	6,112	13,501

For the design year 2031, Table 6 summarizes the percentage of the ADT occurring during the design hour (K), the directional distribution of traffic during the peak hour (D), and percentage of trucks for roadway/pavement design purposes.

Table 6. Design Year 2031 Traffic Data Summary

K	10%
D	52%
% Trucks – Design Hour	2.2%
% Trucks – 24 Hour	5.9% (5.3% S.U./0.6% Comb.)

Using the methodologies described in the EXPLANATION OF LEVEL OF SERVICE Section, the Levels of Service (LOS) at the intersection of Bell Road and Boles Road were determined for the weekday AM peak hour and the weekday PM peak hour for Future No Build conditions for the opening year 2011 and the design year 2031, and for Future Build conditions for the opening year 2011 and the design year 2031 under Alternatives 1, 2 and 3.

Capacity Analysis: Future No Build Conditions

The Levels of Service at the intersection of Bell Road and Boles Road were determined for Future No Build conditions for the opening year 2011 and the design year 2031. The results are shown in Tables 7 and 8. The capacity analysis printouts are referenced as Appendix C.

As can be seen from Table 7, for Future No Build conditions in the opening year 2011, the side street approach of Bell Road is expected to operate inadequately during both the AM and PM peak hours.

As can be seen from Table 8, for Future No Build conditions in the design year 2031, the side street approach of Bell Road is expected to operate inadequately during both the AM and PM peak hours.

Capacity Analysis: Future Build Conditions

The Levels of Service at the intersection of Bell Road and Boles Road were determined for Future Build conditions for the opening year 2011 and the design year 2031 under Alternatives 1, 2 and 3. The results are shown in Tables 9 through 14.

As will be seen in the REQUIREMENTS FOR INSTALLATION OF DEDICATED TURN LANES section, for Alternatives 1 and 2, GDOT would require separate left and right turn lanes southbound on Bell Road, a separate left turn lane eastbound on Boles Road, and a separate right turn lane westbound on Bell Road. Therefore, Tables 9 through 14 show the lanes needed to achieve adequate AM and PM peak hour operating conditions and the lanes that would be required by GDOT.

Table 7. Opening Year 2011 Future No Build Levels of Service

Intersection				AM Peak Hour						PM Peak Hour					
				Movement			Overall			Movement			Overall		
#	Name	Control	Movement	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C
1	Bell Rd & Boles Rd	Side-street STOP	SB L+R	E	47.7	0.73	n/a	n/a	n/a	F	421.3	1.85	n/a	n/a	n/a
			EB L+T	A	5.6	0.22				A	3.1	0.12			

Table 8. Design Year 2031 Future No Build Levels of Service

Intersection				AM Peak Hour						PM Peak Hour					
				Movement			Overall			Movement			Overall		
#	Name	Control	Movement	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C
1	Bell Rd & Boles Rd	Side-street STOP	SB L+R	F	99.0	0.97	n/a	n/a	n/a	F	651.1	2.36	n/a	n/a	n/a
			EB L+T	A	6.2	0.26				A	3.3	0.14			

Table 9. Alternative 1 Opening Year 2011 Future Build Levels of Service

Intersection				AM Peak Hour						PM Peak Hour					
				Movement			Overall			Movement			Overall		
#	Name	Control	Movement	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C
1	Bell Rd & Boles Rd	Side-street STOP – Option 1A	SB L	F	54.5	0.48	n/a	n/a	n/a	F	246.6	1.40	n/a	n/a	n/a
			SB R	B	14.1	0.24				B	14.3	0.46			
			EB L+T	A	5.6	0.22				A	3.1	0.12			
		Side-street STOP – Option 1B	SB L	F	51.6	0.47	n/a	n/a	n/a	F	211.9	1.32	n/a	n/a	n/a
			SB R	B	13.7	0.24				B	13.5	0.43			
			EB L	A	9.7	0.22				A	8.5	0.12			

Option 1A – Lane configuration required for capacity.
Option 1B – Lane configuration required for capacity plus GDOT required turning lane configuration based on daily volumes.

Table 10. Alternative 1 Design Year 2031 Future Build Levels of Service

Intersection				AM Peak Hour						PM Peak Hour					
				Movement			Overall			Movement			Overall		
#	Name	Control	Movement	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C
1	Bell Rd & Boles Rd	Side-street STOP – Option 1A	SB L	F	91.5	0.68	n/a	n/a	n/a	F	439.9	1.83	n/a	n/a	n/a
			SB R	C	15.5	0.29				C	16.2	0.53			
			EB L+T	A	6.2	0.26				A	3.3	0.14			
		Side-street STOP – Option 1B	SB L	F	84.7	0.65	n/a	n/a	n/a	F	386.6	1.72	n/a	n/a	n/a
			SB R	B	14.9	0.28				B	14.9	0.50			
			EB L	B	10.2	0.26				A	8.6	0.14			

Option 1A – Lane configuration required for capacity.
Option 1B – Lane configuration required for capacity plus GDOT required turning lane configuration based on daily volumes.

Table 11. Alternative 2 Opening Year 2011 Future Build Levels of Service

Intersection				AM Peak Hour						PM Peak Hour					
				Movement			Overall			Movement			Overall		
#	Name	Control	Movement	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C
1	Bell Rd & Boles Rd	Signal – Option 2A	SB L+R	C	20.3	0.32	B	10.7	0.69	D	36.9	0.93	C	30.0	0.93
			EB L+T	B	13.4	0.79				D	35.7	0.94			
			WB T+R	A	5.3	0.51				B	10.2	0.46			
		Signal – Option 2C	SB L	B	11.2	0.17	A	7.3	0.47	A	9.6	0.50	A	8.9	0.56
			SB R	B	10.8	0.09				A	8.2	0.22			
			EB L	A	9.0	0.61				A	8.0	0.34			
			EB T	A	5.1	0.32				B	10.2	0.62			
			WB T	A	6.8	0.58				A	8.2	0.41			
			WB R	A	4.2	0.04				A	6.7	0.06			

Option 2A – Existing lane configuration.
Option 2C – With GDOT required turning lane configuration based on daily volumes.

Table 12. Alternative 2 Design Year 2031 Future Build Levels of Service

Intersection				AM Peak Hour						PM Peak Hour					
				Movement			Overall			Movement			Overall		
#	Name	Control	Movement	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C
1	Bell Rd & Boles Rd	Signal – Option 2A	SB L+R	C	30.4	0.52	B	15.5	0.81	F	83.9	1.09	E	58.6	1.07
			EB L+T	C	21.8	0.88				E	63.9	1.05			
			WB T+R	A	5.2	0.52				A	9.8	0.48			
		Signal – Option 2B	SB L+R	B	15.5	0.31	A	9.0	0.61	B	19.8	0.84	B	18.3	0.81
			EBL	B	13.8	0.72				C	20.2	0.68			
			EBT	A	4.8	0.32				B	18.8	0.77			
			WB T+R	A	7.2	0.63				B	14.7	0.65			
		Signal – Option 2C	SB L	B	13.2	0.21	A	7.9	0.54	B	10.5	0.55	A	9.6	0.61
			SB R	B	12.7	0.10				A	8.6	0.24			
			EB L	B	11.6	0.68				A	8.5	0.40			
			EB T	A	4.9	0.33				B	11.4	0.67			
			WB T	A	6.7	0.59				A	8.5	0.45			
			WB R	A	3.9	0.04				A	6.8	0.06			

Option 2A – Existing lane configuration.
Option 2B – Lane configuration required for capacity with eastbound left turn lane. Instead of an eastbound left turn lane, adding a westbound right turn lane or a southbound left turn lane would also be expected to provide adequate operating conditions for the overall intersection during both the AM and PM peak hours.
Option 2C – With GDOT required turning lane configuration based on daily volumes.

Table 13. Alternative 3 Opening Year 2011 Future Build Levels of Service

Intersection				AM Peak Hour						PM Peak Hour					
				Movement			Overall			Movement			Overall		
#	Name	Control	Movement	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C
1	Bell Rd & Boles Rd	Single-lane Round-about	SB L+R	A	7.2	0.25	A	7.9	0.44	B	12.2	0.66	B	10.1	0.53
			EB L+T	A	5.8	0.42				B	10.7	0.61			
			WB T+R	A	9.8	0.61				A	5.6	0.35			

Table 14. Alternative 3 Design Year 2031 Future Build Levels of Service

Intersection				AM Peak Hour						PM Peak Hour					
				Movement			Overall			Movement			Overall		
#	Name	Control	Movement	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C	LOS	Delay (sec)	V/C
1	Bell Rd & Boles Rd	Single-lane Round-about	SB L+R	A	8.1	0.30	A	9.6	0.51	C	17.5	0.76	B	13.6	0.60
			EB L+T	A	6.4	0.47				B	14.3	0.70			
			WB T+R	B	12.6	0.69				A	6.0	0.39			

As can be seen from Table 9, for Alternative 1 Future Build conditions in the opening year 2011, if a separate southbound left turn lane were added on Bell Road (Option 1A), the southbound left turn movement on Bell Road would be expected to operate inadequately during both the AM and PM peak hours. The southbound right turn movement would be expected to operate adequately during both the AM and PM peak hours. No additional improvements, including the improvements shown under Option 1B, are expected to provide adequate operating conditions under unsignalized conditions.

As can be seen from Table 10, for Alternative 1 Future Build conditions in the design year 2031, if a separate southbound left turn lane were added on Bell Road (Option 1A), the southbound left turn movement on Bell Road would be expected to operate inadequately during both the AM and PM peak hours. The southbound right turn movement would be expected to operate adequately during both the AM and PM peak hours. No additional improvements, including the improvements shown under Option 1B, are expected to provide adequate operating conditions under unsignalized conditions.

As can be seen from Table 11, for Alternative 2 Future Build conditions in the opening year 2011, a traffic signal (Option 2A) would be expected to provide adequate operating conditions for the overall intersection during both the AM and PM peak hours.

As can be seen from Table 12, for Alternative 2 Future Build conditions in the design year 2031, if the addition of a traffic signal were the only improvement made at the intersection (Option 2A), adequate operating conditions would be expected for the overall intersection during the AM peak hour, and inadequate operating conditions would be expected during the PM peak hour.

In the opening year 2011, Option 2A would be expected to provide adequate operating conditions for the overall intersection during both the AM and PM peak hours, but in the design year 2031, Option 2A would not be expected to provide adequate operating conditions for the overall intersection during both the AM and PM peak hours. Analysis was performed to determine in what year between the opening year 2011 and the design year 2031 Option 2A would no longer provide adequate operating conditions for the overall intersection during both the AM and PM peak hours. It was determined that in the year 2029, Option 2A would no longer provide adequate operating conditions for the overall intersection during both the AM and PM peak hours.

If, in addition to a traffic signal, a separate eastbound left turn lane on Boles Road or a separate westbound right turn lane on Bell Road or a separate southbound left turn lane on Bell Road were added (Option 2B – Lane Configuration Required for Capacity), adequate operating conditions would be expected for the overall intersection during both the AM and PM peak hours.

If, in addition to a traffic signal, a separate southbound left turn lane on Bell Road, a separate eastbound left turn lane on Boles Road, and a separate westbound right turn

lane on Bell Road were added (Option 2C – GDOT Required Turn Lanes), adequate operating conditions would be expected for the overall intersection during both the AM and PM peak hours.

As can be seen from Table 13, for Alternative 3 Future Build conditions in the opening year 2011, a single-lane roundabout with a single approach lane on each approach is expected to operate adequately during both the AM and PM peak hours.

As can be seen from Table 14, for Alternative 3 Future Build conditions in the design year 2031, a single-lane roundabout with a single approach lane on each approach is expected to operate adequately during both the AM and PM peak hours.

Requirements for Installation of Dedicated Turn Lanes

Turn lane requirements were calculated based upon the design year 2031 traffic volumes.

The *GDOT Design Policy Manual (Manual), Version 2.0,* revised 1 June 2007, provides information regarding installation of dedicated left and right turn lanes. The *GDOT Regulations for Driveway and Encroachment Control (Regulations), 2004*, revised 6 October 2006, provides requirements for minimum required storage lengths. The minimum storage length requirements are based on a combination of the posted speed limit, average daily traffic volumes (ADT) of the overall roadway, as well as either the left turn or right turn movement ADT, and the number of travel lanes.

Alternative calculations for storage lengths are provided for both signalized and unsignalized intersections. At unsignalized intersections, the calculated queue is based on the number of peak hour vehicles arriving during a two-minute period. At signalized intersections, the calculated queue is based on the number of peak hour vehicles arriving during 1.5 cycle lengths.

A summary of GDOT turn lane storage lengths, both minimum and calculated, as well as the recommended length to provide, is provided in Tables 15 and 16 for Alternatives 1 and 2, respectively. Note that Options 1A, 2A, and 2B are not shown since they do not include the turn lanes that would be required by GDOT.

The 95th percentile queue lengths expected at the intersection under Alternative 3 for a single-lane roundabout were calculated using the methodologies described in the EXPLANATION OF LEVEL OF SERVICE Section and are summarized in Table 17. The 95th percentile length is the queue length that is expected to be exceeded 5% of the time.

Table 15. Alternative 1 Design Year 2031 Dedicated Turn Lane Requirements

Intersection #	Intersection Name	Control	Movement	Turn Lane Required	GDOT Minimum Storage Length	Calculated Length	Length to Provide
1	Bell Rd & Boles Rd	Side-street STOP – Option 1B	SB L	Yes	160 ft	275 ft	275 ft
			SB R	Yes	100 ft	275 ft	275 ft
			EB L	Yes	235 ft	175 ft	235 ft
			WB R	Yes	175 ft	75 ft	175 ft

Table 16. Alternative 2 Design Year 2031 Dedicated Turn Lane Requirements

Intersection #	Intersection Name	Control	Movement	Turn Lane Required	GDOT Minimum Storage Length	Calculated Length	Length to Provide
1	Bell Rd & Boles Rd	Signal – Option 2C	SB L	Yes	160 ft	150 ft	160 ft
			SB R	Yes	100 ft	175 ft	175 ft
			EB L	Yes	235 ft	150 ft	235 ft
			WB R	Yes	175 ft	50 ft	175 ft

Table 17. Alternative 3 Design Year 2031 95th Percentile Queue Lengths

Intersection #	Intersection Name	Control	Movement	Calculated Length
1	Bell Rd & Boles Rd	Single-lane Roundabout	SB L+R	225 ft
			EB L+T	175 ft
			WB T+R	175 ft

5. CONCLUSIONS

The purpose of this study is to provide an analysis of the projected traffic conditions with and without construction of the proposed Bell Road and Boles Road intersection improvement project in the opening year 2011 and the design year 2031. Traffic volumes were developed without and with construction of the intersection improvements for a typical weekday when schools are in session. Analysis was conducted during the weekday AM and PM peak hours. Recommendations include intersection geometries and traffic controls, as well as lengths of proposed auxiliary turning lanes.

For Future No Build conditions in the opening year 2011, the side street approach of Bell Road is expected to operate inadequately during both the AM and PM peak hours. For Future No Build conditions in the design year 2031, the side street approach of Bell Road is expected to operate inadequately during both the AM and PM peak hours.

In addition to Future No Build conditions, three "Alternatives" were analyzed:

- **Alternative 1** – Alternative 1 would add lanes at the intersection, and the intersection would remain unsignalized.

- **Alternative 2** – Alternative 2 would add lanes and a traffic signal at the intersection.

- **Alternative 3** – Alternative 3 would add a roundabout at the intersection.

Figures of the recommended intersection traffic controls and lane configurations for each Alternative for the design year 2031 are provided in the Executive Summary.

The Levels of Service at the intersection of Bell Road and Boles Road were determined for Future Build conditions for the opening year 2011 and the design year 2031 under Alternatives 1, 2 and 3. For Alternatives 1 and 2, GDOT would require separate left and right turn lanes southbound on Bell Road, a separate left turn lane eastbound on Boles Road, and a separate right turn lane westbound on Bell Road. Therefore, the Levels of Service were determined with the lanes needed to achieve adequate AM and PM peak hour operating conditions and the lanes that would be required by GDOT.

For Alternative 1 Future Build conditions in the opening year 2011, if a separate southbound left turn lane were added on Bell Road (Option 1A), the southbound left turn movement on Bell Road would be expected to operate inadequately during both the AM and PM peak hours. The southbound right turn movement would be expected to operate adequately during both the AM and PM peak hours. No additional improvements, including the improvements shown under Option 1B, are expected to provide adequate operating conditions under unsignalized conditions.

For Alternative 1 Future Build conditions in the design year 2031, if a separate southbound left turn lane were added on Bell Road (Option 1A), the southbound left turn movement on Bell Road would be expected to operate inadequately during both the AM and PM peak hours. The southbound right turn movement would be expected to operate adequately during both the AM and PM peak hours. No additional improvements, including the improvements shown under Option 1B, are expected to provide adequate operating conditions under unsignalized conditions.

For Alternative 2 Future Build conditions in the opening year 2011, a traffic signal (Option 2A) would be expected to provide adequate operating conditions for the overall intersection during both the AM and PM peak hours.

For Alternative 2 Future Build conditions in the design year 2031, if the addition of a traffic signal were the only improvement made at the intersection (Option 2A), adequate operating conditions would be expected for the overall intersection during the AM peak hour, and inadequate operating conditions would be expected during the PM peak hour. If, in addition to a traffic signal, a separate eastbound left turn lane on Boles Road or a separate westbound right turn lane on Bell Road or a separate southbound left turn lane on Bell Road were added (Option 2B – Lane Configuration Required for Capacity), adequate operating conditions would be expected for the overall intersection during both the AM and PM peak hours. If, in addition to a traffic signal, a separate southbound left turn lane on Bell Road, a separate eastbound left turn lane on Boles Road, and a separate westbound right turn lane on Bell Road were added (Option 2C – GDOT Required Turn Lanes), adequate operating conditions would be expected for the overall intersection during both the AM and PM peak hours.

For Alternative 2 Future Build conditions in the opening year 2011, Option 2A would be expected to provide adequate operating conditions for the overall intersection during both the AM and PM peak hours, but in the design year 2031, Option 2A would not be expected to provide adequate operating conditions for the overall intersection during both the AM and PM peak hours. Analysis was performed to determine in what year between the opening year 2011 and the design year 2031 Option 2A would no longer provide adequate operating conditions for the overall intersection during both the AM and PM peak hours. It was determined that in the year 2029, Option 2A would no longer provide adequate operating conditions for the overall intersection during both the AM and PM peak hours.

For Alternative 3 Future Build conditions in the opening year 2011, a single-lane roundabout with a single approach lane on each approach is expected to operate adequately.

For Alternative 3 Future Build conditions in the design year 2031, a single-lane roundabout with a single approach lane on each approach is expected to operate adequately.

Based on information provided by Heath & Lineback Engineers, Inc., and the City of Johns Creek, a single-lane roundabout with a single approach lane on each approach (Alternative 3) is expected to have lower construction costs, lower maintenance costs, and lower right-of-way impacts than a traffic signal with turn lanes (Alternative 2).

GLOSSARY OF TERMS

Annual Average Daily Traffic (AADT): The total volume of traffic on a highway segment for one-year, divided by 365.
Capacity: The maximum traffic flow designation for a segment of roadway or a lane, within the control conditions for that particular segment of roadway or lane, usually expressed in persons per hour or vehicles per hour.
Congestion: Highway congestion results when traffic demand approaches or exceeds the available capacity of the transportation facility(ies).
Delay: Average delay per vehicle, usually expressed in seconds.
Impacts: The effects of a transportation project, including (a) direct (primary) effects; (b) indirection (secondary) effects; and (c) cumulative effects.
Internal Capture: Trips occurring within the subject site thereby reducing the number of new trips on the external roadway system.
K-Factor: The percentage of daily traffic volume traveling during the peak hour or design hour.
LOS (Level of Service): A qualitative assessment of a road's operating conditions, expressed in terms of A through F – 'A' being the best LOS.
Pass-by trips: Some of the trips are by people who would have been on the road anyway on their way to/from someplace else who stop by and visit the commercial establishment.
Peak Hour: The consecutive sixty minutes within a 24-hour period with the highest traffic volume. A peak hour is generally designated for both A.M. and P.M. traffic conditions.
Peak Hour Factor (PHF): The ratio of total traffic occurring during the peak hour to the peak 15-minute flow rate (4 times the maximum 15 minute volume) within the peak hour.
Volume: The number of persons or vehicles passing a point on a lane, roadway or other trafficway during some time interval, often taken to be one hour, expressed in vehicles.
Volume-to-Capacity ratio (v/c): The ratio of volume (v) to capacity (c) for a traffic facility.

EXPLANATION OF LEVEL OF SERVICE

Capacity analyses of the study intersections were completed using procedures in the Transportation Research Board's *Highway Capacity Manual (HCM), 2003*. This is the usual methodology for the analysis of traffic conditions. The software program *Synchro 6* (a nationally recognized computer software package for analyzing capacities and Levels of Service) was used to perform the actual capacity analyses for the key intersections.

Operating conditions at intersections are evaluated in terms of Levels of Service (LOS). LOS A through D are generally considered to be adequate peak hour operations. LOS E and F are generally considered inadequate conditions.

Levels of Service for signalized intersections are reported in composite fashion, i.e., one LOS for the entire intersection, and are based on average control delay. Individual turning movements at a signalized intersection may experience inadequate LOS, particularly where those volumes are relatively low, while the intersection as a whole has an adequate LOS. This is because the major movements on the major roadway are given priority in assigning signal green time.

Traffic conditions at unsignalized intersections, with STOP sign control on the minor street only, are evaluated for the minor street approach(es) and for the left turns from the major street. This is because the major street traffic is assumed to have no delay since there is no control (no STOP sign). Inadequate Levels of Service for minor street approaches to unsignalized intersections are not uncommon, as the continuous flow traffic will always get the priority.

The *Highway Capacity Manual* Level of Service criteria for signalized and unsignalized intersections are shown in the following table:

Highway Capacity Manual Intersection Level of Service Criteria

LOS	Control Delay (seconds per vehicle)	
	Signalized Intersection	**Unsignalized Intersection**
A	≤ 10	≤ 10
B	>10 and ≤20	>10 and ≤15
C	>20 and ≤35	>15 and ≤25
D	>35 and ≤55	>25 and ≤35
E	>55 and ≤80	>35 and ≤50
F	> 80	> 50

Source: Highway Capacity Manual

The effectiveness and operations analysis of a roundabout is measured differently than for a stop sign controlled intersection. The analysis methodology for roundabouts utilized for this project was based on information provided in the *NCHRP Report 572: Roundabouts in the United States*, information presented at the Federal Highway Administration's (FHWA's) "Roundabouts Workshop – Planning and Designing Intersections for Safety", and the FHWA's year 2000 *Roundabouts: An Informational Guide*. Specifically, capacity equations from the *NCHRP Report 572* and delay and queue equations from the *Roundabouts: An Informational Guide* were referenced to develop the roundabout operational analysis. The roundabout analysis methodology provides delays, volume-to-capacity (v/c) ratios, and queues for each approach to the roundabout dependent upon the geometric elements of the roundabout, the entry flow on each approach to the roundabout, and the circulating flow within the roundabout that conflicts with the entry flow from the subject approach. Based on empirical data, FHWA identified at the "Roundabouts Workshop – Planning and Designing Intersections for Safety" that roundabout locations with approaches anticipated to operate at more than 85% of their estimated capacity should be considered for multilane entries. Therefore, a single lane approach or the critical lane approach at a multilane entry with a v/c ratio of 0.85 or less is considered satisfactory (i.e., not needing additional lanes).

Based on the approach delay from the roundabout methodology, a Level of Service (LOS) for each approach, as well as the overall intersection, is provided based on the unsignalized Level of Service criteria presented in the Transportation Research Board's *Highway Capacity Manual (HCM), 2003*.

APPENDIX A: TRAFFIC COUNTS

Reliable Traffic Data Services, LLC

Tel: (770) 578-5158 Fax: (770) 578-8159
email: reliabletraffic@msn.com

TMC Data

File Name : 23930004
Site Code : 23930004
Start Date : 10/11/2007
Page No : 1

Groups Printed- Cars, Trucks & Buses

	Northbound				Bell Rd Southbound				Boles Rd Eastbound				Bell Rd Westbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
07:00 AM	0	0	0	0	7	0	17	24	35	43	0	78	0	122	7	129	231
07:15 AM	0	0	0	0	10	0	24	34	38	52	0	90	0	127	8	135	259
07:30 AM	0	0	0	0	14	0	31	45	42	56	0	98	0	128	11	139	282
07:45 AM	0	0	0	0	17	0	28	45	48	72	0	120	0	121	15	136	301
Total	0	0	0	0	48	0	100	148	163	223	0	386	0	498	41	539	1073
08:00 AM	0	0	0	0	13	0	22	35	51	64	0	115	0	116	12	128	278
08:15 AM	0	0	0	0	8	0	17	25	47	57	0	104	0	111	16	127	256
08:30 AM	0	0	0	0	7	0	16	23	38	51	0	89	0	108	13	121	233
08:45 AM	0	0	0	0	9	0	12	21	31	42	0	73	0	102	10	112	206
Total	0	0	0	0	37	0	67	104	167	214	0	381	0	437	51	488	973
*** BREAK ***																	
04:00 PM	0	0	0	0	55	0	61	116	26	83	0	109	0	53	12	65	290
04:15 PM	0	0	0	0	58	0	65	123	23	88	0	111	0	56	15	71	305
04:30 PM	0	0	0	0	64	0	68	132	27	96	0	123	0	61	18	79	334
04:45 PM	0	0	0	0	67	0	70	137	35	104	0	139	0	65	21	86	362
Total	0	0	0	0	244	0	264	508	111	371	0	482	0	235	66	301	1291
05:00 PM	0	0	0	0	72	0	74	146	32	87	0	119	0	72	19	91	356
05:15 PM	0	0	0	0	68	0	63	131	27	83	0	110	0	52	12	64	305
05:30 PM	0	0	0	0	59	0	67	126	33	75	0	108	0	49	10	59	293
05:45 PM	0	0	0	0	56	0	63	119	27	72	0	99	0	46	11	57	275
Total	0	0	0	0	255	0	267	522	119	317	0	436	0	219	52	271	1229
Grand Total	0	0	0	0	584	0	698	1282	560	1125	0	1685	0	1389	210	1599	4566
Apprch %	0	0	0		45.6	0	54.4		33.2	66.8	0		0	86.9	13.1		
Total %	0	0	0	0	12.8	0	15.3	28.1	12.3	24.6	0	36.9	0	30.4	4.6	35	

Reliable Traffic Data Services, LLC

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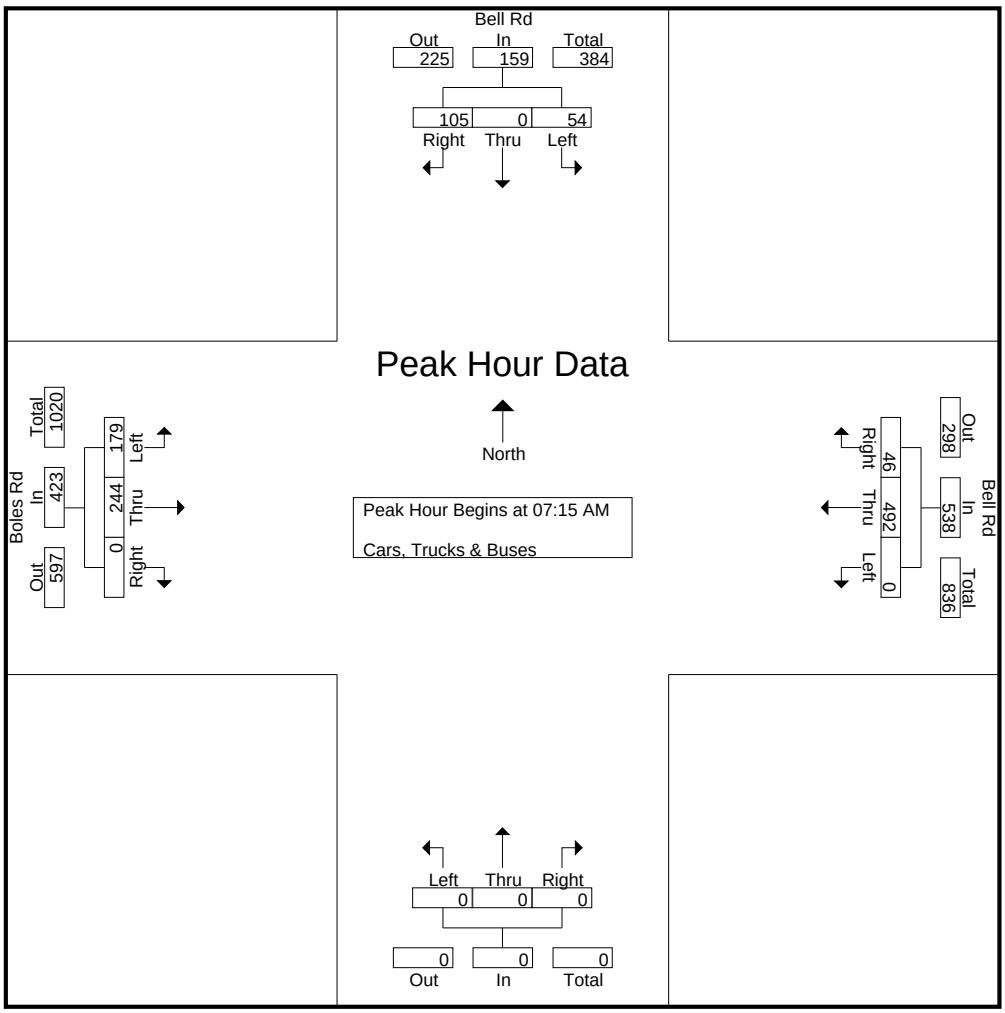
TMC Data

File Name : 23930004
Site Code : 23930004
Start Date : 10/11/2007
Page No : 2

	Northbound				Bell Rd Southbound				Boles Rd Eastbound				Bell Rd Westbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:15 AM																	
07:15 AM	0	0	0	0	10	0	24	34	38	52	0	90	0	127	8	135	259
07:30 AM	0	0	0	0	14	0	31	45	42	56	0	98	0	128	11	139	282
07:45 AM	0	0	0	0	17	0	28	45	48	72	0	120	0	121	15	136	301
08:00 AM	0	0	0	0	13	0	22	35	51	64	0	115	0	116	12	128	278
Total Volume	0	0	0	0	54	0	105	159	179	244	0	423	0	492	46	538	1120
% App. Total	0	0	0		34	0	66		42.3	57.7	0		0	91.4	8.6		
PHF	.000	.000	.000	.000	.794	.000	.847	.883	.877	.847	.000	.881	.000	.961	.767	.968	.930



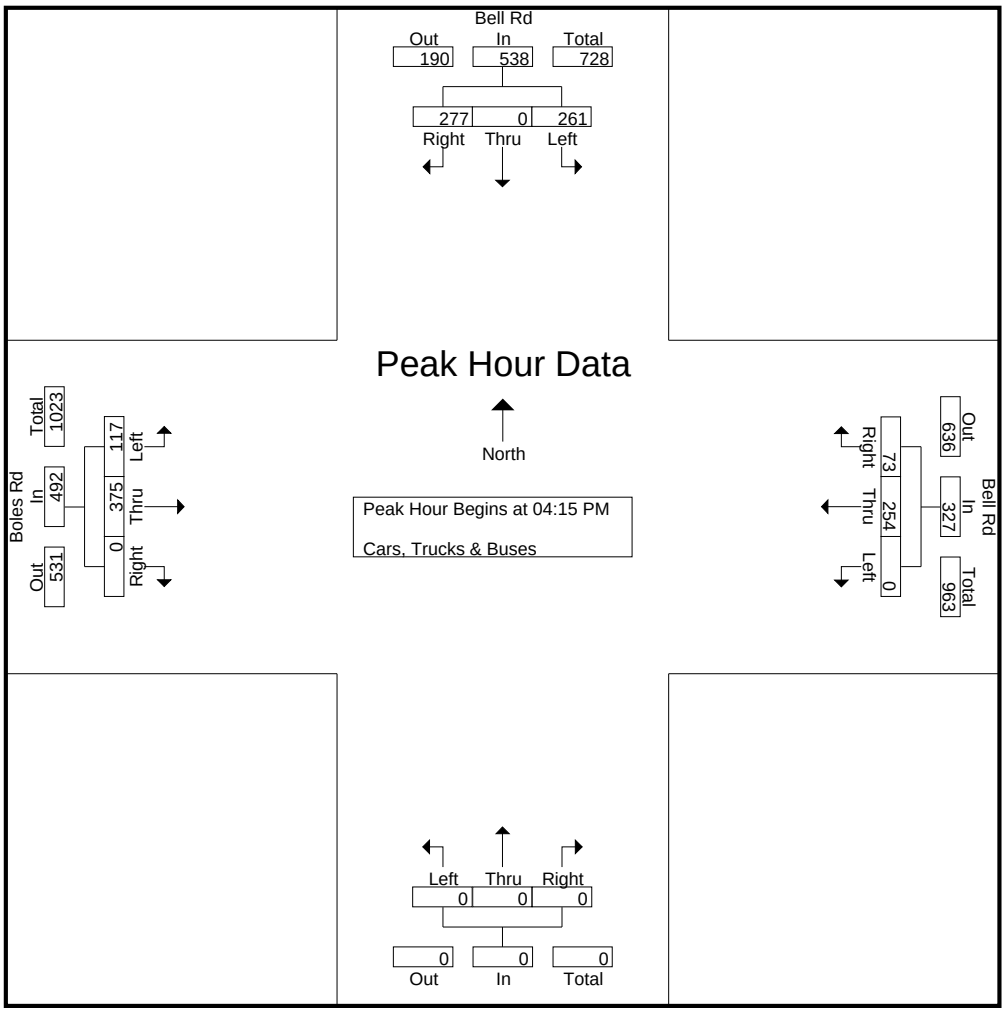
Reliable Traffic Data Services, LLC

Tel: (770) 578-5158 Fax: (770) 578-8159
email: reliabletraffic@msn.com

TMC Data

File Name : 23930004
Site Code : 23930004
Start Date : 10/11/2007
Page No : 3

	Northbound				Bell Rd Southbound				Boles Rd Eastbound				Bell Rd Westbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 04:15 PM																	
04:15 PM	0	0	0	0	58	0	65	123	23	88	0	111	0	56	15	71	305
04:30 PM	0	0	0	0	64	0	68	132	27	96	0	123	0	61	18	79	334
04:45 PM	0	0	0	0	67	0	70	137	35	104	0	139	0	65	21	86	362
05:00 PM	0	0	0	0	72	0	74	146	32	87	0	119	0	72	19	91	356
Total Volume	0	0	0	0	261	0	277	538	117	375	0	492	0	254	73	327	1357
% App. Total	0	0	0		48.5	0	51.5		23.8	76.2	0		0	77.7	22.3		
PHF	.000	.000	.000	.000	.906	.000	.936	.921	.836	.901	.000	.885	.000	.882	.869	.898	.937



Reliable Traffic Data Services, LLC
Tel: (770) 578-8158 Fax: (770)578-8159
email: reliabletraffic@msn.com

Site Code: 23930104
Station ID: 7132
Bell Rd Between McGinnis Ferry Rd
and Boles Rd
Latitude: 0' 0.000 Undefined

Start	10-Oct-07	Northbound		Hour Totals		Southbound		Hour Totals		Combined Totals	
Time	Wed	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon
12:00		8	70			12	71				
12:15		4	57			5	68				
12:30		1	86			3	69				
12:45		3	69	16	282	5	75	25	283	41	565
01:00		4	65			1	78				
01:15		0	85			1	68				
01:30		3	79			2	51				
01:45		4	70	11	299	0	55	4	252	15	551
02:00		0	79			1	64				
02:15		2	97			0	75				
02:30		1	78			0	59				
02:45		1	58	4	312	0	66	1	264	5	576
03:00		2	97			1	63				
03:15		2	107			0	62				
03:30		1	123			1	51				
03:45		3	124	8	451	2	55	4	231	12	682
04:00		2	115			1	52				
04:15		0	112			1	67				
04:30		3	104			5	62				
04:45		1	123	6	454	6	58	13	239	19	693
05:00		2	125			6	53				
05:15		6	117			8	59				
05:30		4	111			21	56				
05:45		7	107	19	460	20	53	55	221	74	681
06:00		15	111			43	55				
06:15		22	105			81	48				
06:30		28	98			103	51				
06:45		37	93	102	407	118	53	345	207	447	614
07:00		46	86			111	57				
07:15		54	81			119	47				
07:30		61	74			121	44				
07:45		65	40	226	281	120	39	471	187	697	468
08:00		69	47			114	41				
08:15		65	62			117	39				
08:30		61	51			123	40				
08:45		58	44	253	204	118	29	472	149	725	353
09:00		54	44			107	24				
09:15		64	40			116	29				
09:30		71	32			120	32				
09:45		64	16	253	132	113	25	456	110	709	242
10:00		45	20			92	19				
10:15		43	24			87	15				
10:30		55	31			71	12				
10:45		72	14	215	89	56	15	306	61	521	150
11:00		46	18			48	11				
11:15		58	18			61	8				
11:30		78	9			63	6				
11:45		71	7	253	52	46	4	218	29	471	81
Total		1366	3423			2370	2233			3736	5656
Percent		28.5%	71.5%			51.5%	48.5%			39.8%	60.2%
Grand Total		1366	3423			2370	2233			3736	5656
Percent		28.5%	71.5%			51.5%	48.5%			39.8%	60.2%

ADT Not Calculated

Reliable Traffic Data Services, LLC
Tel: (770) 578-8158 Fax: (770)578-8159
email: reliabletraffic@msn.com

Site Code: 23930105
Station ID: 7655
Bell Rd North of Boles Rd

Latitude: 0' 0.000 Undefined

Start Time	10-Oct-07 Wed	Northbound Morning	Northbound Afternoon	Hour Totals Morning	Hour Totals Afternoon	Southbound Morning	Southbound Afternoon	Hour Totals Morning	Hour Totals Afternoon	Combined Totals Morning	Combined Totals Afternoon
12:00		3	29			4	22				
12:15		2	26			1	29				
12:30		2	29			3	32				
12:45		1	23	8	107	0	30	8	113	16	220
01:00		1	31			0	50				
01:15		0	29			0	32				
01:30		0	22			0	36				
01:45		0	17	1	99	1	27	1	145	2	244
02:00		1	15			1	37				
02:15		0	18			1	44				
02:30		0	27			0	37				
02:45		0	22	1	82	0	42	2	160	3	242
03:00		0	33			0	54				
03:15		0	27			1	75				
03:30		0	35			0	75				
03:45		0	37	0	132	0	85	1	289	1	421
04:00		1	39			0	97				
04:15		0	38			0	124				
04:30		1	45			2	138				
04:45		1	47	3	169	1	144	3	503	6	672
05:00		0	45			1	136				
05:15		2	48			1	145				
05:30		4	43			5	131				
05:45		5	39	11	175	4	124	11	536	22	711
06:00		11	35			6	118				
06:15		20	32			14	107				
06:30		37	22			21	88				
06:45		42	23	110	112	26	73	67	386	177	498
07:00		46	43			32	69				
07:15		49	22			38	46				
07:30		54	25			34	26				
07:45		61	21	210	111	37	34	141	175	351	286
08:00		64	18			32	23				
08:15		57	16			22	16				
08:30		52	19			26	25				
08:45		48	14	221	67	31	12	111	76	332	143
09:00		41	11			29	11				
09:15		46	13			23	15				
09:30		44	10			21	14				
09:45		38	7	169	41	28	12	101	52	270	93
10:00		34	9			23	13				
10:15		25	8			25	11				
10:30		22	5			17	9				
10:45		24	6	105	28	24	8	89	41	194	69
11:00		22	4			21	7				
11:15		21	3			23	7				
11:30		22	3			20	4				
11:45		25	2	90	12	27	2	91	20	181	32
Total		929	1135			626	2496			1555	3631
Percent		45.0%	55.0%			20.1%	79.9%			30.0%	70.0%
Grand Total		929	1135			626	2496			1555	3631
Percent		45.0%	55.0%			20.1%	79.9%			30.0%	70.0%

ADT Not Calculated

Reliable Traffic Data Services, LLC
Tel: (770) 578-8158 Fax: (770)578-8159
email: reliabletraffic@msn.com

Site Code: 23930106
Station ID: SN:019474
Boles Rd West of Bell Rd

Latitude: 0' 0.000 Undefined

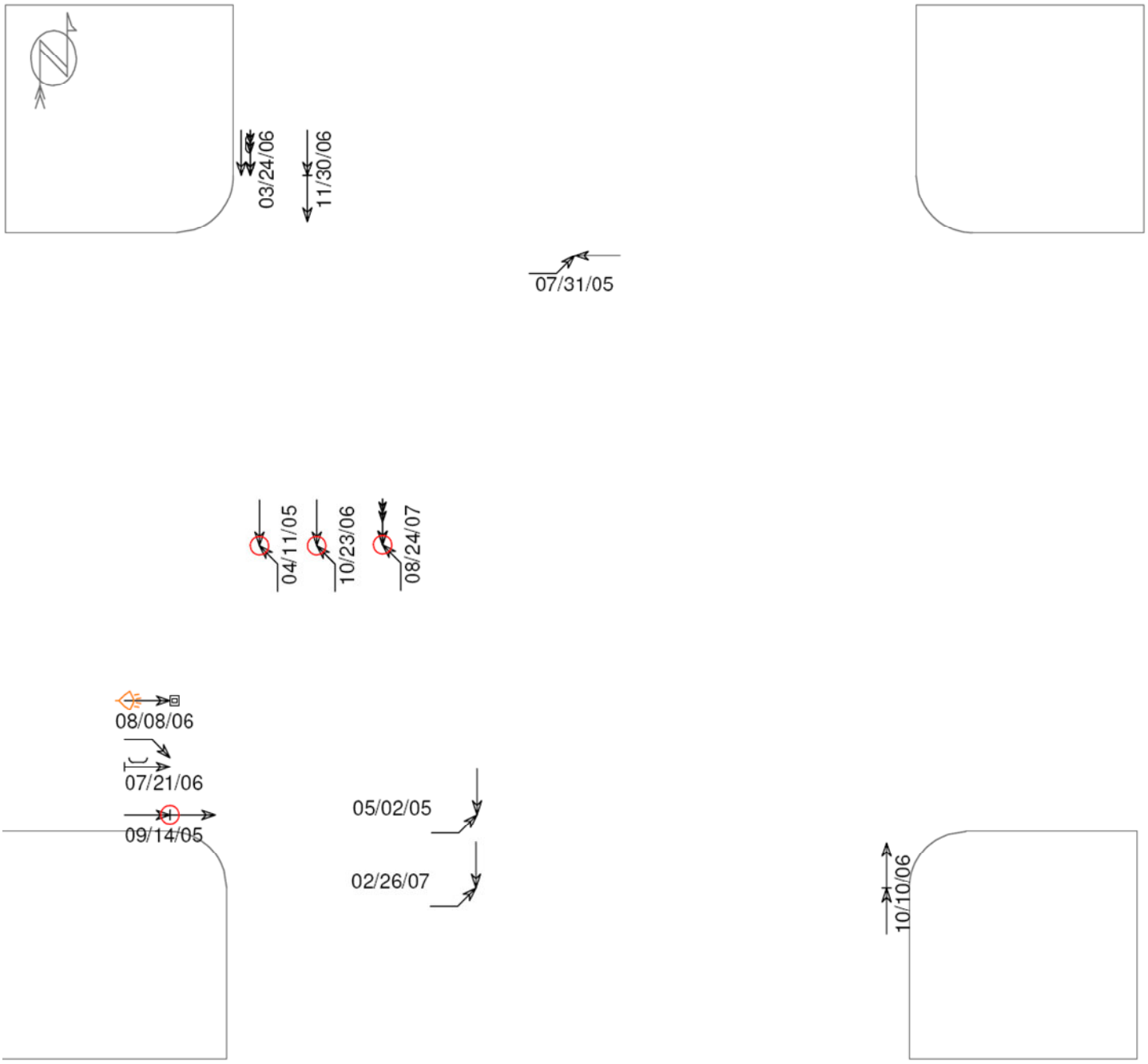
Start	10-Oct-07	Eastbound		Hour Totals		Westbound		Hour Totals		Combined Totals	
Time	Wed	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon
12:00		9	58			6	87				
12:15		6	85			7	89				
12:30		4	82			3	92				
12:45		7	68	26	293	2	84	18	352	44	645
01:00		5	57			2	62				
01:15		3	78			0	72				
01:30		5	66			0	68				
01:45		3	73	16	274	2	77	4	279	20	553
02:00		1	64			0	67				
02:15		1	53			0	84				
02:30		2	69			0	92				
02:45		1	62	5	248	0	111	0	354	5	602
03:00		1	89			0	70				
03:15		0	99			2	85				
03:30		3	122			3	89				
03:45		3	119	7	429	0	116	5	360	12	789
04:00		1	131			2	116				
04:15		1	127			1	133				
04:30		2	118			1	136				
04:45		2	123	6	499	6	107	10	492	16	991
05:00		2	125			10	128				
05:15		4	117			10	138				
05:30		3	108			21	104				
05:45		9	96	18	446	26	101	67	471	85	917
06:00		10	88			40	109				
06:15		27	83			65	122				
06:30		49	93			105	107				
06:45		94	94	180	358	139	116	349	454	529	812
07:00		78	108			131	99				
07:15		86	98			152	82				
07:30		97	76			154	81				
07:45		109	62	370	344	158	49	595	311	965	655
08:00		121	62			154	59				
08:15		104	67			111	50				
08:30		93	75			102	48				
08:45		75	60	393	264	143	41	510	198	903	462
09:00		62	44			110	29				
09:15		66	61			114	33				
09:30		67	46			115	21				
09:45		79	35	274	186	132	20	471	103	745	289
10:00		63	34			88	21				
10:15		47	34			86	24				
10:30		58	45			94	16				
10:45		57	23	225	136	85	22	353	83	578	219
11:00		47	29			73	14				
11:15		51	17			78	12				
11:30		59	13			77	11				
11:45		52	15	209	74	94	8	322	45	531	119
Total		1729	3551			2704	3502			4433	7053
Percent		32.7%	67.3%			43.6%	56.4%			38.6%	61.4%
Grand Total		1729	3551			2704	3502			4433	7053
Percent		32.7%	67.3%			43.6%	56.4%			38.6%	61.4%

ADT Not Calculated

APPENDIX B: CRASH HISTORY

12 Accidents

Fulton CR 72 at Fulton CR 3266
01/01/00 - 12/31/07



(clear filter), (0) accidents with insufficient data for display

Straight	Parked	Pedestrian	Fixed objects:
Stopped	Erratic	Bicycle	General, Pole
Unknown	Out of control	Injury	Signal, Curb
Backing	Right turn	Fatality	Tree, Animal
Overtaking	Left turn	Nighttime	3rd vehicle
Sideswipe	U-turn	DUI	Extra data

APPENDIX C: CAPACITY ANALYSIS PRINTOUTS

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	191	260	525	49	57	112
Peak Hour Factor	0.88	0.88	0.97	0.97	0.88	0.88
Hourly flow rate (vph)	217	295	541	51	65	127
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	592				1296	566
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	592				1296	566
tC, single (s)	4.1				6.5	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.6	3.3
p0 queue free %	78				52	76
cM capacity (veh/h)	989				134	523

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	512	592	192
Volume Left	217	0	65
Volume Right	0	51	127
cSH	989	1700	265
Volume to Capacity	0.22	0.35	0.73
Queue Length 95th (ft)	21	0	127
Control Delay (s)	5.6	0.0	47.7
Lane LOS	A		E
Approach Delay (s)	5.6	0.0	47.7
Approach LOS			E

Intersection Summary			
Average Delay	9.3		
Intersection Capacity Utilization	74.9%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	125	400	271	77	278	295
Peak Hour Factor	0.89	0.89	0.90	0.90	0.92	0.92
Hourly flow rate (vph)	140	449	301	86	302	321
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	387				1074	344
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	387				1074	344
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	88				0	54
cM capacity (veh/h)	1183				216	703

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	590	387	623
Volume Left	140	0	302
Volume Right	0	86	321
cSH	1183	1700	336
Volume to Capacity	0.12	0.23	1.85
Queue Length 95th (ft)	10	0	1036
Control Delay (s)	3.1	0.0	421.3
Lane LOS	A		F
Approach Delay (s)	3.1	0.0	421.3
Approach LOS			F

Intersection Summary			
Average Delay	165.2		
Intersection Capacity Utilization	90.4%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	211	287	580	54	63	124
Peak Hour Factor	0.88	0.88	0.97	0.97	0.88	0.88
Hourly flow rate (vph)	240	326	598	56	72	141
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	654				1431	626
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	654				1431	626
tC, single (s)	4.1				6.5	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.6	3.3
p0 queue free %	74				32	71
cM capacity (veh/h)	938				106	484

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	566	654	212
Volume Left	240	0	72
Volume Right	0	56	141
cSH	938	1700	220
Volume to Capacity	0.26	0.38	0.97
Queue Length 95th (ft)	25	0	212
Control Delay (s)	6.2	0.0	99.0
Lane LOS	A		F
Approach Delay (s)	6.2	0.0	99.0
Approach LOS			F

Intersection Summary			
Average Delay	17.1		
Intersection Capacity Utilization	81.7%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	138	442	299	85	307	326
Peak Hour Factor	0.89	0.89	0.90	0.90	0.92	0.92
Hourly flow rate (vph)	155	497	332	94	334	354
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	427				1186	379
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	427				1186	379
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	86				0	47
cM capacity (veh/h)	1143				182	672

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	652	427	688
Volume Left	155	0	334
Volume Right	0	94	354
cSH	1143	1700	291
Volume to Capacity	0.14	0.25	2.36
Queue Length 95th (ft)	12	0	1359
Control Delay (s)	3.3	0.0	651.1
Lane LOS	A		F
Approach Delay (s)	3.3	0.0	651.1
Approach LOS			F

Intersection Summary			
Average Delay	254.8		
Intersection Capacity Utilization	98.8%	ICU Level of Service	F
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	191	260	525	49	57	112
Peak Hour Factor	0.88	0.88	0.97	0.97	0.88	0.88
Hourly flow rate (vph)	217	295	541	51	65	127
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	592				1296	566
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	592				1296	566
tC, single (s)	4.1				6.5	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.6	3.3
p0 queue free %	78				52	76
cM capacity (veh/h)	989				134	523

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	512	592	65	127
Volume Left	217	0	65	0
Volume Right	0	51	0	127
cSH	989	1700	134	523
Volume to Capacity	0.22	0.35	0.48	0.24
Queue Length 95th (ft)	21	0	56	24
Control Delay (s)	5.6	0.0	54.5	14.1
Lane LOS	A		F	B
Approach Delay (s)	5.6	0.0	27.7	
Approach LOS			D	

Intersection Summary			
Average Delay	6.3		
Intersection Capacity Utilization	68.2%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	125	400	271	77	278	295
Peak Hour Factor	0.89	0.89	0.90	0.90	0.92	0.92
Hourly flow rate (vph)	140	449	301	86	302	321
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	387				1074	344
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	387				1074	344
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	88				0	54
cM capacity (veh/h)	1183				216	703

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	590	387	302	321
Volume Left	140	0	302	0
Volume Right	0	86	0	321
cSH	1183	1700	216	703
Volume to Capacity	0.12	0.23	1.40	0.46
Queue Length 95th (ft)	10	0	432	60
Control Delay (s)	3.1	0.0	246.6	14.3
Lane LOS	A		F	B
Approach Delay (s)	3.1	0.0	127.0	
Approach LOS			F	

Intersection Summary			
Average Delay	50.6		
Intersection Capacity Utilization	72.3%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	191	260	525	49	57	112
Peak Hour Factor	0.88	0.88	0.97	0.97	0.88	0.88
Hourly flow rate (vph)	217	295	541	51	65	127
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	592				1271	541
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	592				1271	541
tC, single (s)	4.1				6.5	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.6	3.3
p0 queue free %	78				53	76
cM capacity (veh/h)	989				139	541

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	SB 2
Volume Total	217	295	541	51	65	127
Volume Left	217	0	0	0	65	0
Volume Right	0	0	0	51	0	127
cSH	989	1700	1700	1700	139	541
Volume to Capacity	0.22	0.17	0.32	0.03	0.47	0.24
Queue Length 95th (ft)	21	0	0	0	53	23
Control Delay (s)	9.7	0.0	0.0	0.0	51.6	13.7
Lane LOS	A				F	B
Approach Delay (s)	4.1		0.0		26.5	
Approach LOS					D	

Intersection Summary			
Average Delay	5.5		
Intersection Capacity Utilization	51.5%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	125	400	271	77	278	295
Peak Hour Factor	0.89	0.89	0.90	0.90	0.92	0.92
Hourly flow rate (vph)	140	449	301	86	302	321
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	387				1031	301
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	387				1031	301
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	88				0	57
cM capacity (veh/h)	1183				229	743

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	SB 2
Volume Total	140	449	301	86	302	321
Volume Left	140	0	0	0	302	0
Volume Right	0	0	0	86	0	321
cSH	1183	1700	1700	1700	229	743
Volume to Capacity	0.12	0.26	0.18	0.05	1.32	0.43
Queue Length 95th (ft)	10	0	0	0	403	55
Control Delay (s)	8.5	0.0	0.0	0.0	211.9	13.5
Lane LOS	A				F	B
Approach Delay (s)	2.0		0.0		109.8	
Approach LOS					F	

Intersection Summary			
Average Delay	43.5		
Intersection Capacity Utilization	46.6%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	211	287	580	54	63	124
Peak Hour Factor	0.88	0.88	0.97	0.97	0.88	0.88
Hourly flow rate (vph)	240	326	598	56	72	141
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	654				1431	626
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	654				1431	626
tC, single (s)	4.1				6.5	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.6	3.3
p0 queue free %	74				32	71
cM capacity (veh/h)	938				106	484

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	566	654	72	141
Volume Left	240	0	72	0
Volume Right	0	56	0	141
cSH	938	1700	106	484
Volume to Capacity	0.26	0.38	0.68	0.29
Queue Length 95th (ft)	25	0	87	30
Control Delay (s)	6.2	0.0	91.5	15.5
Lane LOS	A		F	C
Approach Delay (s)	6.2	0.0	41.1	
Approach LOS			E	

Intersection Summary			
Average Delay	8.5		
Intersection Capacity Utilization	74.1%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	138	442	299	85	307	326
Peak Hour Factor	0.89	0.89	0.90	0.90	0.92	0.92
Hourly flow rate (vph)	155	497	332	94	334	354
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	427				1186	379
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	427				1186	379
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	86				0	47
cM capacity (veh/h)	1143				182	672

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	652	427	334	354
Volume Left	155	0	334	0
Volume Right	0	94	0	354
cSH	1143	1700	182	672
Volume to Capacity	0.14	0.25	1.83	0.53
Queue Length 95th (ft)	12	0	604	78
Control Delay (s)	3.3	0.0	439.9	16.2
Lane LOS	A		F	C
Approach Delay (s)	3.3	0.0	221.7	
Approach LOS			F	

Intersection Summary			
Average Delay	87.6		
Intersection Capacity Utilization	78.8%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	211	287	580	54	63	124
Peak Hour Factor	0.88	0.88	0.97	0.97	0.88	0.88
Hourly flow rate (vph)	240	326	598	56	72	141
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	654				1404	598
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	654				1404	598
tC, single (s)	4.1				6.5	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.6	3.3
p0 queue free %	74				35	72
cM capacity (veh/h)	938				110	502

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	SB 2
Volume Total	240	326	598	56	72	141
Volume Left	240	0	0	0	72	0
Volume Right	0	0	0	56	0	141
cSH	938	1700	1700	1700	110	502
Volume to Capacity	0.26	0.19	0.35	0.03	0.65	0.28
Queue Length 95th (ft)	25	0	0	0	83	29
Control Delay (s)	10.2	0.0	0.0	0.0	84.7	14.9
Lane LOS	B				F	B
Approach Delay (s)	4.3		0.0		38.4	
Approach LOS					E	

Intersection Summary			
Average Delay	7.4		
Intersection Capacity Utilization	55.7%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	138	442	299	85	307	326
Peak Hour Factor	0.89	0.89	0.90	0.90	0.92	0.92
Hourly flow rate (vph)	155	497	332	94	334	354
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	427				1139	332
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	427				1139	332
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	86				0	50
cM capacity (veh/h)	1143				194	714

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	SB 2
Volume Total	155	497	332	94	334	354
Volume Left	155	0	0	0	334	0
Volume Right	0	0	0	94	0	354
cSH	1143	1700	1700	1700	194	714
Volume to Capacity	0.14	0.29	0.20	0.06	1.72	0.50
Queue Length 95th (ft)	12	0	0	0	573	70
Control Delay (s)	8.6	0.0	0.0	0.0	386.6	14.9
Lane LOS	A				F	B
Approach Delay (s)	2.1		0.0		195.2	
Approach LOS					F	

Intersection Summary			
Average Delay	76.8		
Intersection Capacity Utilization	50.4%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	10	10	10	10	9	9
Total Lost time (s)		4.0	4.0		4.0	
Lane Util. Factor		1.00	1.00		1.00	
Frt		1.00	0.99		0.91	
Flt Protected		0.98	1.00		0.98	
Satd. Flow (prot)		1700	1728		1463	
Flt Permitted		0.56	1.00		0.98	
Satd. Flow (perm)		975	1728		1463	
Volume (vph)	191	260	525	49	57	112
Peak-hour factor, PHF	0.88	0.88	0.97	0.97	0.88	0.88
Adj. Flow (vph)	217	295	541	51	65	127
RTOR Reduction (vph)	0	0	4	0	99	0
Lane Group Flow (vph)	0	512	588	0	93	0
Heavy Vehicles (%)	1%	3%	1%	6%	10%	2%
Turn Type	Perm					
Protected Phases		4	8		6	
Permitted Phases	4					
Actuated Green, G (s)		35.7	35.7		9.2	
Effective Green, g (s)		37.7	37.7		11.2	
Actuated g/C Ratio		0.66	0.66		0.20	
Clearance Time (s)		6.0	6.0		6.0	
Vehicle Extension (s)		3.0	3.0		3.0	
Lane Grp Cap (vph)		646	1145		288	
v/s Ratio Prot			0.34		c0.06	
v/s Ratio Perm		c0.53				
v/c Ratio		0.79	0.51		0.32	
Uniform Delay, d1		6.8	4.9		19.6	
Progression Factor		1.00	1.00		1.00	
Incremental Delay, d2		6.6	0.4		0.7	
Delay (s)		13.4	5.3		20.3	
Level of Service		B	A		C	
Approach Delay (s)		13.4	5.3		20.3	
Approach LOS		B	A		C	

Intersection Summary

HCM Average Control Delay	10.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	56.9	Sum of lost time (s)	8.0
Intersection Capacity Utilization	74.9%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	10	10	10	10	9	9
Total Lost time (s)		4.0	4.0		4.0	
Lane Util. Factor		1.00	1.00		1.00	
Frt		1.00	0.97		0.93	
Flt Protected		0.99	1.00		0.98	
Satd. Flow (prot)		1753	1720		1553	
Flt Permitted		0.75	1.00		0.98	
Satd. Flow (perm)		1335	1720		1553	
Volume (vph)	125	400	271	77	278	295
Peak-hour factor, PHF	0.89	0.89	0.90	0.90	0.92	0.92
Adj. Flow (vph)	140	449	301	86	302	321
RTOR Reduction (vph)	0	0	19	0	70	0
Lane Group Flow (vph)	0	589	368	0	553	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type	Perm					
Protected Phases		4	8		6	
Permitted Phases	4					
Actuated Green, G (s)		23.7	23.7		19.0	
Effective Green, g (s)		25.7	25.7		21.0	
Actuated g/C Ratio		0.47	0.47		0.38	
Clearance Time (s)		6.0	6.0		6.0	
Vehicle Extension (s)		3.0	3.0		3.0	
Lane Grp Cap (vph)		627	808		596	
v/s Ratio Prot			0.21		c0.36	
v/s Ratio Perm		c0.44				
v/c Ratio		0.94	0.46		0.93	
Uniform Delay, d1		13.8	9.8		16.1	
Progression Factor		1.00	1.00		1.00	
Incremental Delay, d2		21.9	0.4		20.8	
Delay (s)		35.7	10.2		36.9	
Level of Service		D	B		D	
Approach Delay (s)		35.7	10.2		36.9	
Approach LOS		D	B		D	

Intersection Summary

HCM Average Control Delay	30.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	54.7	Sum of lost time (s)	8.0
Intersection Capacity Utilization	90.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	10	10	10	10	9	9
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1668	1722	1756	1422	1477	1425
Flt Permitted	0.38	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	669	1722	1756	1422	1477	1425
Volume (vph)	191	260	525	49	57	112
Peak-hour factor, PHF	0.88	0.88	0.97	0.97	0.88	0.88
Adj. Flow (vph)	217	295	541	51	65	127
RTOR Reduction (vph)	0	0	0	24	0	95
Lane Group Flow (vph)	217	295	541	27	65	32
Heavy Vehicles (%)	1%	3%	1%	6%	10%	2%
Turn Type	Perm			Perm		Perm
Protected Phases		4	8		6	
Permitted Phases	4			8		6
Actuated Green, G (s)	18.0	18.0	18.0	18.0	7.5	7.5
Effective Green, g (s)	20.0	20.0	20.0	20.0	9.5	9.5
Actuated g/C Ratio	0.53	0.53	0.53	0.53	0.25	0.25
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	357	918	937	758	374	361
v/s Ratio Prot		0.17	0.31		c0.04	
v/s Ratio Perm	c0.32			0.02		0.02
v/c Ratio	0.61	0.32	0.58	0.04	0.17	0.09
Uniform Delay, d1	6.0	4.9	5.9	4.2	10.9	10.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	2.9	0.2	0.9	0.0	0.2	0.1
Delay (s)	9.0	5.1	6.8	4.2	11.2	10.8
Level of Service	A	A	A	A	B	B
Approach Delay (s)		6.8	6.5		10.9	
Approach LOS		A	A		B	

Intersection Summary

HCM Average Control Delay	7.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	37.5	Sum of lost time (s)	8.0
Intersection Capacity Utilization	51.5%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	10	10	10	10	9	9
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1685	1773	1773	1507	1624	1454
Flt Permitted	0.56	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	995	1773	1773	1507	1624	1454
Volume (vph)	125	400	271	77	278	295
Peak-hour factor, PHF	0.89	0.89	0.90	0.90	0.92	0.92
Adj. Flow (vph)	140	449	301	86	302	321
RTOR Reduction (vph)	0	0	0	51	0	201
Lane Group Flow (vph)	140	449	301	35	302	120
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type	Perm			Perm		Perm
Protected Phases		4	8		6	
Permitted Phases	4			8		6
Actuated Green, G (s)	13.4	13.4	13.4	13.4	12.0	12.0
Effective Green, g (s)	15.4	15.4	15.4	15.4	14.0	14.0
Actuated g/C Ratio	0.41	0.41	0.41	0.41	0.37	0.37
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	410	730	730	621	608	544
v/s Ratio Prot		c0.25	0.17		c0.19	
v/s Ratio Perm	0.14			0.02		0.08
v/c Ratio	0.34	0.62	0.41	0.06	0.50	0.22
Uniform Delay, d1	7.5	8.7	7.8	6.6	9.0	8.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.5	1.5	0.4	0.0	0.6	0.2
Delay (s)	8.0	10.2	8.2	6.7	9.6	8.2
Level of Service	A	B	A	A	A	A
Approach Delay (s)		9.7	7.8		8.9	
Approach LOS		A	A		A	

Intersection Summary

HCM Average Control Delay	8.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	37.4	Sum of lost time (s)	8.0
Intersection Capacity Utilization	46.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	10	10	10	10	9	9
Total Lost time (s)		4.0	4.0		4.0	
Lane Util. Factor		1.00	1.00		1.00	
Frt		1.00	0.99		0.91	
Flt Protected		0.98	1.00		0.98	
Satd. Flow (prot)		1700	1728		1463	
Flt Permitted		0.51	1.00		0.98	
Satd. Flow (perm)		890	1728		1463	
Volume (vph)	211	287	580	54	63	124
Peak-hour factor, PHF	0.88	0.88	0.97	0.97	0.88	0.88
Adj. Flow (vph)	240	326	598	56	72	141
RTOR Reduction (vph)	0	0	4	0	81	0
Lane Group Flow (vph)	0	566	650	0	132	0
Heavy Vehicles (%)	1%	3%	1%	6%	10%	2%
Turn Type	Perm					
Protected Phases		4	8		6	
Permitted Phases	4					
Actuated Green, G (s)		53.2	53.2		11.4	
Effective Green, g (s)		55.2	55.2		13.4	
Actuated g/C Ratio		0.72	0.72		0.17	
Clearance Time (s)		6.0	6.0		6.0	
Vehicle Extension (s)		3.0	3.0		3.0	
Lane Grp Cap (vph)		641	1245		256	
v/s Ratio Prot			0.38		c0.09	
v/s Ratio Perm		c0.64				
v/c Ratio		0.88	0.52		0.52	
Uniform Delay, d1		8.2	4.8		28.7	
Progression Factor		1.00	1.00		1.00	
Incremental Delay, d2		13.6	0.4		1.8	
Delay (s)		21.8	5.2		30.4	
Level of Service		C	A		C	
Approach Delay (s)		21.8	5.2		30.4	
Approach LOS		C	A		C	

Intersection Summary

HCM Average Control Delay	15.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	76.6	Sum of lost time (s)	8.0
Intersection Capacity Utilization	81.7%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	10	10	10	10	9	9
Total Lost time (s)		4.0	4.0		4.0	
Lane Util. Factor		1.00	1.00		1.00	
Frt		1.00	0.97		0.93	
Flt Protected		0.99	1.00		0.98	
Satd. Flow (prot)		1753	1721		1554	
Flt Permitted		0.71	1.00		0.98	
Satd. Flow (perm)		1266	1721		1554	
Volume (vph)	138	442	299	85	307	326
Peak-hour factor, PHF	0.89	0.89	0.90	0.90	0.92	0.92
Adj. Flow (vph)	155	497	332	94	334	354
RTOR Reduction (vph)	0	0	18	0	69	0
Lane Group Flow (vph)	0	652	408	0	619	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type	Perm					
Protected Phases		4	8		6	
Permitted Phases	4					
Actuated Green, G (s)		25.0	25.0		18.0	
Effective Green, g (s)		27.0	27.0		20.0	
Actuated g/C Ratio		0.49	0.49		0.36	
Clearance Time (s)		6.0	6.0		6.0	
Vehicle Extension (s)		3.0	3.0		3.0	
Lane Grp Cap (vph)		621	845		565	
v/s Ratio Prot			0.24		c0.40	
v/s Ratio Perm		c0.52				
v/c Ratio		1.05	0.48		1.09	
Uniform Delay, d1		14.0	9.3		17.5	
Progression Factor		1.00	1.00		1.00	
Incremental Delay, d2		49.9	0.4		66.4	
Delay (s)		63.9	9.8		83.9	
Level of Service		E	A		F	
Approach Delay (s)		63.9	9.8		83.9	
Approach LOS		E	A		F	

Intersection Summary

HCM Average Control Delay	58.6	HCM Level of Service	E
HCM Volume to Capacity ratio	1.07		
Actuated Cycle Length (s)	55.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	98.8%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	10	10	10	10	9	9
Total Lost time (s)	4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	1.00	1.00		1.00	
Frt	1.00	1.00	0.99		0.91	
Flt Protected	0.95	1.00	1.00		0.98	
Satd. Flow (prot)	1668	1722	1728		1463	
Flt Permitted	0.32	1.00	1.00		0.98	
Satd. Flow (perm)	557	1722	1728		1463	
Volume (vph)	211	287	580	54	63	124
Peak-hour factor, PHF	0.88	0.88	0.97	0.97	0.88	0.88
Adj. Flow (vph)	240	326	598	56	72	141
RTOR Reduction (vph)	0	0	5	0	109	0
Lane Group Flow (vph)	240	326	649	0	104	0
Heavy Vehicles (%)	1%	3%	1%	6%	10%	2%
Turn Type	Perm					
Protected Phases		4	8		6	
Permitted Phases	4					
Actuated Green, G (s)	26.1	26.1	26.1		8.7	
Effective Green, g (s)	28.1	28.1	28.1		10.7	
Actuated g/C Ratio	0.60	0.60	0.60		0.23	
Clearance Time (s)	6.0	6.0	6.0		6.0	
Vehicle Extension (s)	3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	334	1034	1038		334	
v/s Ratio Prot		0.19	0.38		c0.07	
v/s Ratio Perm	c0.43					
v/c Ratio	0.72	0.32	0.63		0.31	
Uniform Delay, d1	6.6	4.6	6.0		15.0	
Progression Factor	1.00	1.00	1.00		1.00	
Incremental Delay, d2	7.2	0.2	1.2		0.5	
Delay (s)	13.8	4.8	7.2		15.5	
Level of Service	B	A	A		B	
Approach Delay (s)		8.6	7.2		15.5	
Approach LOS		A	A		B	

Intersection Summary

HCM Average Control Delay	9.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	46.8	Sum of lost time (s)	8.0
Intersection Capacity Utilization	66.6%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	10	10	10	10	9	9
Total Lost time (s)	4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	1.00	1.00		1.00	
Frt	1.00	1.00	0.97		0.93	
Flt Protected	0.95	1.00	1.00		0.98	
Satd. Flow (prot)	1685	1773	1721		1554	
Flt Permitted	0.36	1.00	1.00		0.98	
Satd. Flow (perm)	632	1773	1721		1554	
Volume (vph)	138	442	299	85	307	326
Peak-hour factor, PHF	0.89	0.89	0.90	0.90	0.92	0.92
Adj. Flow (vph)	155	497	332	94	334	354
RTOR Reduction (vph)	0	0	20	0	79	0
Lane Group Flow (vph)	155	497	406	0	609	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type	Perm					
Protected Phases		4	8		6	
Permitted Phases	4					
Actuated Green, G (s)	14.8	14.8	14.8		19.5	
Effective Green, g (s)	16.8	16.8	16.8		21.5	
Actuated g/C Ratio	0.36	0.36	0.36		0.46	
Clearance Time (s)	6.0	6.0	6.0		6.0	
Vehicle Extension (s)	3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	229	643	624		722	
v/s Ratio Prot		c0.28	0.24		c0.39	
v/s Ratio Perm	0.25					
v/c Ratio	0.68	0.77	0.65		0.84	
Uniform Delay, d1	12.5	13.1	12.3		10.9	
Progression Factor	1.00	1.00	1.00		1.00	
Incremental Delay, d2	7.7	5.8	2.4		8.9	
Delay (s)	20.2	18.8	14.7		19.8	
Level of Service	C	B	B		B	
Approach Delay (s)		19.1	14.7		19.8	
Approach LOS		B	B		B	

Intersection Summary

HCM Average Control Delay	18.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	46.3	Sum of lost time (s)	8.0
Intersection Capacity Utilization	75.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	10	10	10	10	9	9
Total Lost time (s)		4.0	4.0		4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00
Frt		1.00	0.99		1.00	0.85
Flt Protected		0.98	1.00		0.95	1.00
Satd. Flow (prot)		1700	1728		1477	1425
Flt Permitted		0.53	1.00		0.95	1.00
Satd. Flow (perm)		918	1728		1477	1425
Volume (vph)	211	287	580	54	63	124
Peak-hour factor, PHF	0.88	0.88	0.97	0.97	0.88	0.88
Adj. Flow (vph)	240	326	598	56	72	141
RTOR Reduction (vph)	0	0	3	0	0	119
Lane Group Flow (vph)	0	566	651	0	72	22
Heavy Vehicles (%)	1%	3%	1%	6%	10%	2%
Turn Type	Perm					Perm
Protected Phases		4	8		6	
Permitted Phases	4					6
Actuated Green, G (s)		52.6	52.6		9.3	9.3
Effective Green, g (s)		54.6	54.6		11.3	11.3
Actuated g/C Ratio		0.74	0.74		0.15	0.15
Clearance Time (s)		6.0	6.0		6.0	6.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		678	1277		226	218
v/s Ratio Prot			0.38		c0.05	
v/s Ratio Perm		c0.62				0.02
v/c Ratio		0.83	0.51		0.32	0.10
Uniform Delay, d1		6.6	4.0		27.9	26.9
Progression Factor		1.00	1.00		1.00	1.00
Incremental Delay, d2		8.7	0.3		0.8	0.2
Delay (s)		15.3	4.4		28.7	27.1
Level of Service		B	A		C	C
Approach Delay (s)		15.3	4.4		27.7	
Approach LOS		B	A		C	

Intersection Summary

HCM Average Control Delay	12.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	73.9	Sum of lost time (s)	8.0
Intersection Capacity Utilization	74.1%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	10	10	10	10	9	9
Total Lost time (s)		4.0	4.0		4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00
Frt		1.00	0.97		1.00	0.85
Flt Protected		0.99	1.00		0.95	1.00
Satd. Flow (prot)		1753	1721		1624	1454
Flt Permitted		0.78	1.00		0.95	1.00
Satd. Flow (perm)		1382	1721		1624	1454
Volume (vph)	138	442	299	85	307	326
Peak-hour factor, PHF	0.89	0.89	0.90	0.90	0.92	0.92
Adj. Flow (vph)	155	497	332	94	334	354
RTOR Reduction (vph)	0	0	18	0	0	249
Lane Group Flow (vph)	0	652	408	0	334	105
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type	Perm					Perm
Protected Phases		4	8		6	
Permitted Phases	4					6
Actuated Green, G (s)		27.1	27.1		13.7	13.7
Effective Green, g (s)		29.1	29.1		15.7	15.7
Actuated g/C Ratio		0.55	0.55		0.30	0.30
Clearance Time (s)		6.0	6.0		6.0	6.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		762	949		483	432
v/s Ratio Prot			0.24		c0.21	
v/s Ratio Perm		c0.47				0.07
v/c Ratio		0.86	0.43		0.69	0.24
Uniform Delay, d1		10.1	7.0		16.4	14.1
Progression Factor		1.00	1.00		1.00	1.00
Incremental Delay, d2		9.3	0.3		4.2	0.3
Delay (s)		19.4	7.3		20.7	14.3
Level of Service		B	A		C	B
Approach Delay (s)		19.4	7.3		17.4	
Approach LOS		B	A		B	

Intersection Summary

HCM Average Control Delay	15.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	52.8	Sum of lost time (s)	8.0
Intersection Capacity Utilization	78.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	10	10	10	10	9	9
Total Lost time (s)		4.0	4.0	4.0	4.0	
Lane Util. Factor		1.00	1.00	1.00	1.00	
Frt		1.00	1.00	0.85	0.91	
Flt Protected		0.98	1.00	1.00	0.98	
Satd. Flow (prot)		1700	1756	1422	1463	
Flt Permitted		0.54	1.00	1.00	0.98	
Satd. Flow (perm)		940	1756	1422	1463	
Volume (vph)	211	287	580	54	63	124
Peak-hour factor, PHF	0.88	0.88	0.97	0.97	0.88	0.88
Adj. Flow (vph)	240	326	598	56	72	141
RTOR Reduction (vph)	0	0	0	17	79	0
Lane Group Flow (vph)	0	566	598	39	134	0
Heavy Vehicles (%)	1%	3%	1%	6%	10%	2%
Turn Type	Perm			Perm		
Protected Phases		4	8		6	
Permitted Phases	4			8		
Actuated Green, G (s)		45.8	45.8	45.8	11.1	
Effective Green, g (s)		47.8	47.8	47.8	13.1	
Actuated g/C Ratio		0.69	0.69	0.69	0.19	
Clearance Time (s)		6.0	6.0	6.0	6.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)		652	1218	987	278	
v/s Ratio Prot			0.34		c0.09	
v/s Ratio Perm		c0.60		0.03		
v/c Ratio		0.87	0.49	0.04	0.48	
Uniform Delay, d1		8.1	4.9	3.3	24.9	
Progression Factor		1.00	1.00	1.00	1.00	
Incremental Delay, d2		11.8	0.3	0.0	1.3	
Delay (s)		19.9	5.2	3.3	26.2	
Level of Service		B	A	A	C	
Approach Delay (s)		19.9	5.1		26.2	
Approach LOS		B	A		C	

Intersection Summary

HCM Average Control Delay	14.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	68.9	Sum of lost time (s)	8.0
Intersection Capacity Utilization	78.4%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	10	10	10	10	9	9
Total Lost time (s)		4.0	4.0	4.0	4.0	
Lane Util. Factor		1.00	1.00	1.00	1.00	
Frt		1.00	1.00	0.85	0.93	
Flt Protected		0.99	1.00	1.00	0.98	
Satd. Flow (prot)		1753	1773	1507	1554	
Flt Permitted		0.77	1.00	1.00	0.98	
Satd. Flow (perm)		1368	1773	1507	1554	
Volume (vph)	138	442	299	85	307	326
Peak-hour factor, PHF	0.89	0.89	0.90	0.90	0.92	0.92
Adj. Flow (vph)	155	497	332	94	334	354
RTOR Reduction (vph)	0	0	0	49	59	0
Lane Group Flow (vph)	0	652	332	45	629	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type	Perm			Perm		
Protected Phases		4	8		6	
Permitted Phases	4			8		
Actuated Green, G (s)		29.0	29.0	29.0	24.0	
Effective Green, g (s)		31.0	31.0	31.0	26.0	
Actuated g/C Ratio		0.48	0.48	0.48	0.40	
Clearance Time (s)		6.0	6.0	6.0	6.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)		652	846	719	622	
v/s Ratio Prot			0.19		c0.41	
v/s Ratio Perm		c0.48		0.03		
v/c Ratio		1.00	0.39	0.06	1.01	
Uniform Delay, d1		17.0	10.9	9.2	19.5	
Progression Factor		1.00	1.00	1.00	1.00	
Incremental Delay, d2		35.2	0.3	0.0	39.0	
Delay (s)		52.2	11.2	9.2	58.5	
Level of Service		D	B	A	E	
Approach Delay (s)		52.2	10.8		58.5	
Approach LOS		D	B		E	

Intersection Summary

HCM Average Control Delay	44.7	HCM Level of Service	D
HCM Volume to Capacity ratio	1.01		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	93.6%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	10	10	10	10	9	9
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1668	1722	1756	1422	1477	1425
Flt Permitted	0.35	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	613	1722	1756	1422	1477	1425
Volume (vph)	211	287	580	54	63	124
Peak-hour factor, PHF	0.88	0.88	0.97	0.97	0.88	0.88
Adj. Flow (vph)	240	326	598	56	72	141
RTOR Reduction (vph)	0	0	0	24	0	108
Lane Group Flow (vph)	240	326	598	32	72	33
Heavy Vehicles (%)	1%	3%	1%	6%	10%	2%
Turn Type	Perm			Perm		Perm
Protected Phases		4	8		6	
Permitted Phases	4			8		6
Actuated Green, G (s)	22.1	22.1	22.1	22.1	7.9	7.9
Effective Green, g (s)	24.1	24.1	24.1	24.1	9.9	9.9
Actuated g/C Ratio	0.57	0.57	0.57	0.57	0.24	0.24
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	352	988	1008	816	348	336
v/s Ratio Prot		0.19	0.34		c0.05	
v/s Ratio Perm	c0.39			0.02		0.02
v/c Ratio	0.68	0.33	0.59	0.04	0.21	0.10
Uniform Delay, d1	6.3	4.7	5.8	3.9	12.9	12.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	5.4	0.2	0.9	0.0	0.3	0.1
Delay (s)	11.6	4.9	6.7	3.9	13.2	12.7
Level of Service	B	A	A	A	B	B
Approach Delay (s)		7.8	6.5		12.9	
Approach LOS		A	A		B	

Intersection Summary

HCM Average Control Delay	7.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	42.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	55.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	10	10	10	10	9	9
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1685	1773	1773	1507	1624	1454
Flt Permitted	0.52	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	927	1773	1773	1507	1624	1454
Volume (vph)	138	442	299	85	307	326
Peak-hour factor, PHF	0.89	0.89	0.90	0.90	0.92	0.92
Adj. Flow (vph)	155	497	332	94	334	354
RTOR Reduction (vph)	0	0	0	55	0	221
Lane Group Flow (vph)	155	497	332	39	334	133
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type	Perm			Perm		Perm
Protected Phases		4	8		6	
Permitted Phases	4			8		6
Actuated Green, G (s)	14.2	14.2	14.2	14.2	12.5	12.5
Effective Green, g (s)	16.2	16.2	16.2	16.2	14.5	14.5
Actuated g/C Ratio	0.42	0.42	0.42	0.42	0.37	0.37
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	388	742	742	631	608	545
v/s Ratio Prot		c0.28	0.19		c0.21	
v/s Ratio Perm	0.17			0.03		0.09
v/c Ratio	0.40	0.67	0.45	0.06	0.55	0.24
Uniform Delay, d1	7.9	9.1	8.0	6.7	9.5	8.3
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.7	2.3	0.4	0.0	1.0	0.2
Delay (s)	8.5	11.4	8.5	6.8	10.5	8.6
Level of Service	A	B	A	A	B	A
Approach Delay (s)		10.7	8.1		9.5	
Approach LOS		B	A		A	

Intersection Summary

HCM Average Control Delay	9.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	38.7	Sum of lost time (s)	8.0
Intersection Capacity Utilization	50.4%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

1.Bell Rd & Boles Rd

Opening Year 2011 Volume:

	NB			SB			EB			WB	
				Bell Rd			Boles Rd			Bell Rd	
	L	T	R	L	T	R	L	T	R	L	T	R
AM				57		112	191	260			525	49
PM				278		295	125	400			271	77

Circulating Volumes

	$V_{NB, circ}$	$V_{SB, circ}$	$V_{EB, circ}$	$V_{WB, circ}$
AM		525	57	191
PM		271	278	125

For Single Lane Approaches:

Entering Flow

	$V_{NB, Ent Flow}$	$V_{SB, Ent Flow}$	$V_{EB, Ent Flow}$	$V_{WB, Ent Flow}$
AM	0	169	451	574
PM	0	573	525	348

Approach Capacity

	c_{NB}	c_{SB}	c_{EB}	c_{WB}
AM		668	1067	934
PM		862	856	997

V/c ratio

	V/c_{NB}	V/c_{SB}	V/c_{EB}	V/c_{WB}	ALL
AM		0.25	0.42	0.61	0.44
PM		0.66	0.61	0.35	0.53

Control Delay

	d_{NB}	d_{SB}	d_{EB}	d_{WB}	AVG
AM		7.2	5.8	9.8	7.9
PM		12.2	10.7	5.6	10.1

95% Queue Length in Vehicles

	Q_{NB}	Q_{SB}	Q_{EB}	Q_{WB}
AM		1	3	5
PM		6	5	2

Level of Service

	NB	SB	EB	WB	ALL
AM		A	A	A	A
PM		B	B	A	B

1.Bell Rd & Boles Rd

Design Year 2031 Volume:

	NB			SB			EB			WB	
				Bell Rd			Boles Rd			Bell Rd	
	L	T	R	L	T	R	L	T	R	L	T	R
AM				63		124	211	287			580	54
PM				307		326	138	442			299	85

Circulating Volumes

	$V_{NB, circ}$	$V_{SB, circ}$	$V_{EB, circ}$	$V_{WB, circ}$
AM		580	63	211
PM		299	307	138

For Single Lane Approaches:

Entering Flow

	$V_{NB, Ent Flow}$	$V_{SB, Ent Flow}$	$V_{EB, Ent Flow}$	$V_{WB, Ent Flow}$
AM	0	187	498	634
PM	0	633	580	384

Approach Capacity

	c_{NB}	c_{SB}	c_{EB}	c_{WB}
AM		633	1061	915
PM		838	831	984

V/c ratio

	V/c_{NB}	V/c_{SB}	V/c_{EB}	V/c_{WB}	ALL
AM		0.3	0.47	0.69	0.51
PM		0.76	0.7	0.39	0.6

Control Delay

	d_{NB}	d_{SB}	d_{EB}	d_{WB}	AVG
AM		8.1	6.4	12.6	9.6
PM		17.5	14.3	6.0	13.6

95% Queue Length in Vehicles

	Q_{NB}	Q_{SB}	Q_{EB}	Q_{WB}
AM		2	3	7
PM		9	7	2

Level of Service

	NB	SB	EB	WB	ALL
AM		A	A	B	A
PM		C	B	A	B

Benefit Cost Analysis Work Sheet
CONGESTION Projects

PROJECT NUMBER: CSHPP-0007-00(311)
PI NUMBER: 0007311
COUNTY: Fulton

Intersection Improvement of Bell Road at Boles Road

Congestion Benefit = Tb + CMb + Fb

Person Time Savings Benefit (Tb)

*Db (hrs)	0.047
ADT	14,074.00
Tb ($s)	$22,738,306.25

Commercial or Truck Time Savings Benefit (CMb)

Db (hrs)	0.047
% Truck Traffic	0.022
ADT	14,074.00
CMb	$2,643,100.72

Fuel Savings Benefit (Fb)

ADT	14,074.00
Fb ($s)	$7,923,955.21

Total Congestion Benefit	**$33,305,362.18**
Total Project Cost	**$1,326,940.00**
B/C Ratio	**25.10**