Oxmoor Road Corridor Study

April 2014

Prepared by:

SKIPPER CONSULTING INC.

Prepared for:

The City of Homewood

On Behalf of:

RPCGB
REGIONAL PLANNING COMMISSION OF GREATER BIRMINGHAM

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INTRODUCTION

The purpose of this report is to present a summary of the findings of a traffic operational study along Oxmoor Road in Homewood, Alabama. The study involves 12 intersections along the corridor and will summarize comprehensive operational evaluations of the intersections including existing conditions analysis, operational/geometric deficiencies and intersection crash data analysis. Additionally, this report will document an alternatives analysis in which potential transportation system modifications are presented and analyzed.

Sources of information used in this report include: the Institute of Transportation Engineers; the Transportation Research Board; Federal Highway Administration; the City of Homewood; Jefferson County; Regional Planning Commission of Greater Birmingham; and field reconnaissance efforts and other information collected by Skipper Consulting, Inc.

Project Study Area

The study area for this project will be along Oxmoor Road in Homewood, Alabama. The focus of the study will be along Oxmoor Road from Edgeview Avenue to 19th Street South. The following intersections are considered study intersections:

- Oxmoor Road at Edgeview Avenue/Havenwood Court
- Oxmoor Road at Virginia Drive/Peerless Avenue
- Oxmoor Road at St. Charles Street
- Oxmoor Road at Broadway
- Oxmoor Road at Evergreen Avenue
- Oxmoor Road at W. Hawthorn/Clermont Drive
- Oxmoor Road at E. Hawthorne/Seminole Drive
- Oxmoor Road at E. Glenwood Drive/Bridge Lane
- Oxmoor Road at E. Edgewood Drive/Central Avenue
- Oxmoor Road at Ridge Road
- Oxmoor Road at 18th Street South/Roxbury Road
- Oxmoor Road at 19th Street South/Firefighter Lane

Currently Oxmoor Road is a two-lane minor arterial roadway with a posted speed limit of 25 miles per hour. **Figure 1** illustrates the typical roadway section within the study area. **Figure 2** is a project study area vicinity map.

Figure 1 - Typical Study Roadway Segment – Oxmoor Road

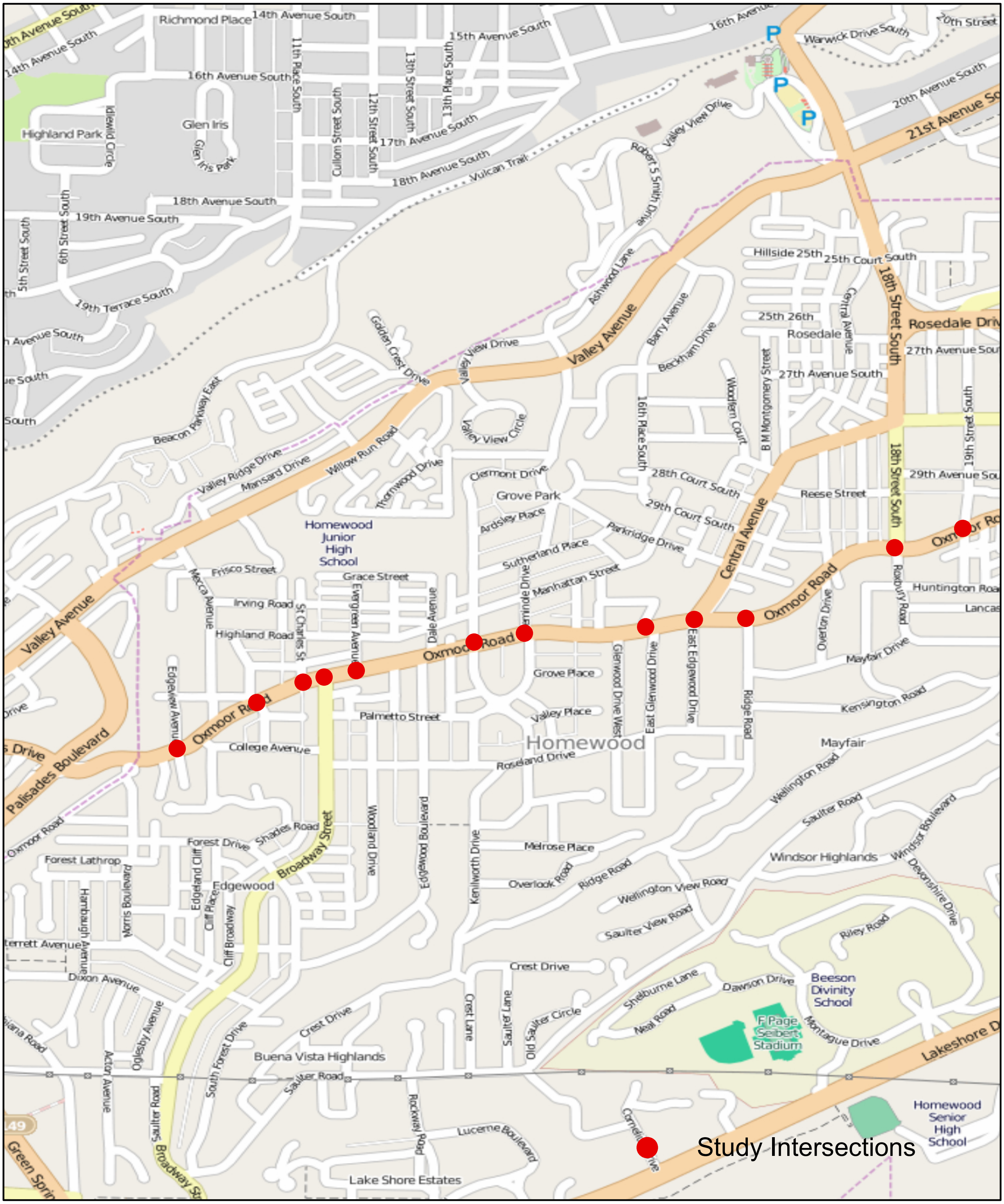

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Figure 2
Study Area Map
Homewood Traffic Study
Homewood, Alabama

Feb. 2014 Not to Scale

EXISTING TRAFFIC CONDITIONS

Existing Traffic Count Data

In order to evaluate existing traffic conditions along the Oxmoor Road corridor turning movement traffic counts were conducted for the morning, midday and afternoon peak hours at the study intersections. Additionally, daily traffic counts were conducted along Oxmoor Road in two locations. All traffic counts were taken at study locations on a typical weekday while the area schools were in session, which should represent the typical weekday traffic conditions along the study area. Existing traffic count volumes are included as **Figures 3**. Detailed traffic count data is also included as **Appendix A**.

Existing Study Area Peak Hour Capacity Analyses

In order to evaluate existing traffic conditions within the study area, capacity analysis calculations were completed for current morning, midday and afternoon peak periods using the existing traffic count volumes and existing traffic signal timings. Peak hour intersection capacity analyses were completed utilizing methods as outlined in the *Highway Capacity Manual, 2000 Edition.* According to methods of analysis, intersection capacity is expressed as levels of service, ranging from "A" (best) to "F" (worst). In general, a level of service (LOS) "C" is considered desirable, while a level of service "D" is considered acceptable during peak periods of traffic flow. The results of the existing capacity analysis are presented in **Table 1**. Detailed prints of intersection capacity analyses are included as **Appendix B**.

Table 1
Study Intersection Capacity Analysis – Existing Conditions

Intersection (Traffic Control)	Approach	Level of Service (Delay) Existing		
		AM Peak	Midday	PM Peak
Oxmoor Road At Havenwood Court/Edgeview Ave.	EB Oxmoor Road	D (36)	C (28)	C (31)
	WB Oxmoor Road	C (28)	C (35)	C (31)
	NB Havenwood Court	B (15)	B (12)	B (13)
	SB Edgeview Avenue	B (15)	B (12)	B (13)
	Overall Intersection LOS	***C (32)***	***C (31)***	***C (31)***
Oxmoor Road At Virginia Drive/Peerless Avenue	EB Oxmoor Road	A (0)	A (2)	A (0)
	WB Oxmoor Road	A (2)	A (2)	A (2)
	NB Virginia Drive	E (60)	D (49)	D (51)
	SB Peerless Avenue	D (55)	D (50)	D (51)
	Overall Intersection LOS	***A (5)***	***A (3)***	***A (3)***
Oxmoor Road At Virginia Broadway/St. Charles Street	EB Oxmoor Road	A (3)	A (2)	A (5)
	WB Oxmoor Road	A (2)	A (2)	A (2)
	NB Virginia Broadway	D (55)	D (49)	D (48)
	SB St. Charles Street	E (60)	D (40)	D (50)
	Overall Intersection LOS	***A (6)***	***A (4)***	***A (6)***

Intersection (Traffic Control)	Approach	Level of Service (Delay) Existing		
		AM Peak	Midday	PM Peak
Oxmoor Road At Broadway Street	EB Oxmoor Road	C (3)	B (14)	B (16)
	WB Oxmoor Road	A (3)	A (1)	A (3)
	NB Broadway Street	D (41)	C (30)	D (36)
	Overall Intersection LOS	***C (22)***	***B (12)***	***B (14)***
Oxmoor Road At Evergreen Avenue	EB Oxmoor Road	A (4)	A (5)	A (5)
	WB Oxmoor Road	C (22)	B (14)	B (17)
	SB Evergreen Avenue	D (44)	C (37)	D (32)
	Overall Intersection LOS	***B (14)***	***B (10)***	***B (14)***
Oxmoor Road At Hawthorne Road/Clermont Drive	EB Oxmoor Road	A (1)	A (2)	A (2)
	WB Oxmoor Road	A (2)	A (2)	A (3)
	NB Hawthorne Road	D (54)	D (52)	D (50)
	SB Clermont Drive	D (53)	D (53)	D (52)
	Overall Intersection LOS	***A (7)***	***A (4)***	***A (6)***
Oxmoor Road At E. Hawthorne Road/Seminole Drive	EB Oxmoor Road	A (3)	A (2)	A (3)
	WB Oxmoor Road	A (3)	A (3)	A (5)
	NB E. Hawthorne Road	D (43)	D (44)	D (44)
	SB Seminole Drive	D (49)	D (45)	D (47)
	Overall Intersection LOS	***A (8)***	***A (5)***	***A (7)***
Oxmoor Road At Glenwood Drive/Bridge Lane	EB Oxmoor Road	A (7)	A (5)	A (7)
	WB Oxmoor Road	A (4)	A (4)	A (7)
	NB Glenwood Drive	D (54)	D (47)	D (46)
	SB Bridge Lane	E (56)	D (48)	D (49)
	Overall Intersection LOS	***A (10)***	***A (6)***	***A (9)***
Oxmoor Road At Edgewood Drive/Central Avenue	EB Oxmoor Road	D (35)	C (32)	C (23)
	WB Oxmoor Road	C (28)	C (34)	C (31)
	NB Edgewood Drive	D (48)	C (27)	D (37)
	SB Central Avenue	E (60)	D (44)	D (45)
	Overall Intersection LOS	***D (40)***	***D (36)***	***C (34)***
Oxmoor Road At Ridge Road	EB Oxmoor Road	A (9)	A (9)	B (11)
	WB Oxmoor Road	A (8)	A (10)	B (11)
	NB Ridge Road	C (31)	C (31)	C (32)
	Overall Intersection LOS	***B (12)***	***B (11)***	***B (13)***
Oxmoor Road At Roxbury Road/18th Street	EB	C (25)	C (28)	C (27)
	WB	C (26)	C (31)	C (33)
	NB Roxbury Road	C (27)	C (27)	C (31)
	SB 18th Street	C (24)	C (28)	C (30)
	Overall Intersection LOS	***C (26)***	***C (28)***	***C (30)***
Oxmoor Road At Firefighter Lane/19th Street	EB Oxmoor Road	A (7)	A (8)	A (8)
	WB Oxmoor Road	B (11)	B (12)	B (13)
	NB Firefighter Lane	C (30)	C (26)	C (26)
	SB 19th Street	C (24)	C (25)	C (27)
	Overall Intersection LOS	***B (11)***	***B (13)***	***B (13)***

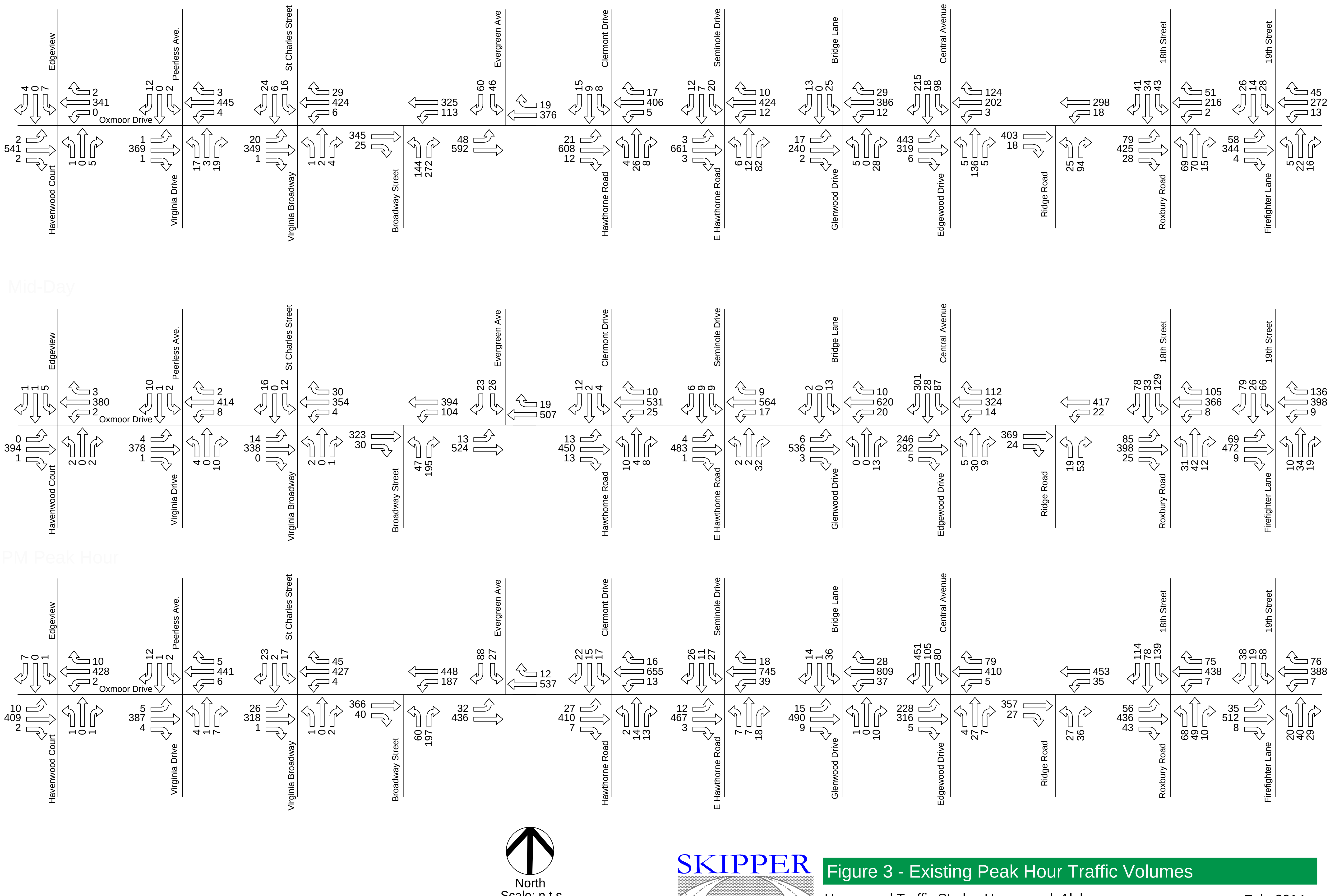

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Figure 3 - Existing Peak Hour Traffic Volumes

Homewood Traffic Study - Homewood, Alabama

Feb. 2014

Oxmoor Road Existing Conditions Conclusions

Upon review of the existing traffic count data, existing conditions capacity analyses, and the field observation notes, the following can be stated about existing traffic conditions within the study area of Oxmoor Road:

- The area of Oxmoor Road between Broadway and Central Avenue carries the most vehicles along the corridor and is subject the most congestions during the peak periods.
- Oxmoor Road signal system is currently not coordinated and is running outdated timings and phasing plans. This contributes significantly to congestion and undue delay at the study intersections.
- Unnecessary delay is caused due to vehicles waiting at signals with no opposing traffic on the side street due to faulty detection and poor timing/programming.
- Speeds along Oxmoor Road were observed to be reasonable during the peak hours.
- Vehicular queues do accumulate on the side streets, but are usually served.
- Traffic congestion is present on Oxmoor Road during the peak periods analyzed.
- Traffic congestion appears to be at its heaviest within the study area in the locations where traffic signals and side street intersections are closely spaced.

Based upon existing conditions it can be concluded that study area traffic congestion is likely a product of a combination of the following: spacing between side street locations and traffic signals, and vehicular lost time due to traffic signals.

The following is a further explanation of the contributing factors for traffic congestion along the study area:

Vehicular queues/congestion from areas external to the study area – Both the morning and afternoon commuter peaks saw traffic congestion build outside of the study area. Traffic queues were observed to build along Oxmoor Road. This buildup of traffic also caused traffic to queue along the westbound approach of Oxmoor Road within the study area.

Accident Study

Data Collection

Intersection crash data was collected for each study intersection in the corridor. These reports were reviewed and the data was categorized by intersection, accident type, roadway conditions, weather, time of day, property damage, injuries and fatalities. This data was then analyzed to determine if any patterns existed that could potentially be corrected with traffic control or geometric modifications. **Appendix B** shows a summary table of the accidents along the corridor. **Figure 4** summarizes the accidents by intersection.

From the data it was determined there were a total of 50 crashes along the corridor in a one year period with zero fatalities and 11 injuries. The intersection with the highest number of crashes was Broadway with 14 crashes. 12 of these crashes involved a vehicle making parking maneuvers and all the crashes resulted in property damage only with no injuries. 18th Street South had the highest number of injuries at 4. All 4 injuries occurred in a single accident which was the conclusion of a police chase which began in downtown Birmingham.

After analysis of the crash data it was determined that only pattern that can be concluded from the data involves the high number of crashes at Broadway due to improper backing from parking spaces. This is a common pattern seen in downtown areas with on street angle parking and little or no buffer space between the parking and travel lane. As vehicles are backing from the spaces they can back into oncoming traffic that is not visible due to adjacent vehicles blocking the line of sight. The best prevention for this is to increase the buffer zone, or space between the back of the parking and the travel lane. At the Broadway intersection this is not easily achieved alternative due to the current narrow roadway envelope.

Parking Maneuvers near Broadway

Figure 6
Intersection Crash Summary
Homewood Traffic Study
Feb. 2014

Alternative Analysis

Based on the existing conditions along the corridor potential improvements can be made to alleviate congestions, increase capacity, decrease delays during the peak hours and increase safety to motorists and pedestrians.

Signal Removal

Each signalized study intersection was evaluated to determine if the use of a signal could possibly be causing more harm to the corridor than benefit it is providing. Candidates for removal were evaluated using the 2009 MUTCD signal warrant requirements. Other considerations included pedestrian use, proximity to adjacent signals, and nearby school traffic. Based on this evaluation the following four signals are recommended for removal:

- Oxmoor Road at Edgeview Avenue/Havenwood Court
- Oxmoor Road at E. Hawthorne/Seminole Drive
- Oxmoor Road at St. Charles Street

Each of the above intersections did not meet the minimum requirements to warrant a signal. These intersections would benefit operationally from removing the signal due to the decrease in delay to vehicles on Oxmoor Road. Additionally, the side street traffic volumes are low enough at these intersections that the delay would be impacted minimally and even decreased at for some approaches.

Estimated Cost: $7,000 per intersection (Contractor price. Includes removal of signal heads, cabinet and controller and 4 poles)

Broadway/Evergreen Signals

The intersections of Broadway and Evergreen Drive are currently controlled by a single signal controller. While this configuration insures that intersections will operate in conjunction with each other, it also limits the operation and results in less than ideal sequences that result in much of the congestion experienced in this section of the corridor.

It is recommended that the signal cabinet be modified to operate as two separate controllers. This will allow for better phasing configurations and a more efficient operation at both intersections.

Estimated Cost: $5,000

Signal System Upgrades

The current signal system along Oxmoor Road is not coordinated resulting in unnecessary stops to through vehicles. There are multiple approaches to intersections that have failed detection loops. It is recommended these be replaced so the signals can operate optimally. Additionally, it is recommended that each intersection be upgraded to include a GPS time clock so the controllers can be synced by time of day and the operation can be coordinated. With the installation of the time clocks, new timings can be programmed allowing for a more efficient flow of vehicles through the corridor.

Estimated Equipment Cost: Under $50,000

Traffic Signal Preemption

In an effort to improve the response time of emergency vehicles it is recommended that the traffic signals along Oxmoor Road be upgraded with traffic signal preemption. Using a transmitter on emergency vehicles, sensors on the traffic signal would detect the approaching vehicle and cycle the signal to a green phase for the approaching direction. The preemption can reduce delays to emergency vehicles by clearing queues at intersections and avoiding vehicles entering from the side-streets.

Estimated cost: $4,000 per intersection, $2,000 per vehicle.

Alternatives Improvements

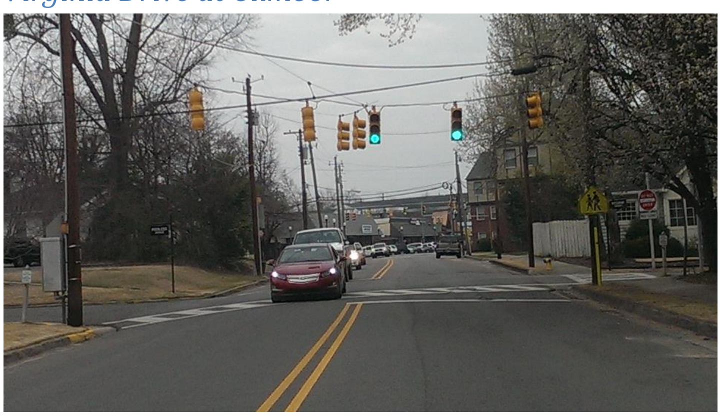
Upon completion of the recommended improvements to the corridor, it is anticipated that congestion during the peak hours will decrease dramatically. Based on analysis, it is estimated that the average vehicle delay in the corridor will be decreased by 56%. With the decrease in congestion and delay, the capacity of the roadway will increase allowing for more vehicles to use the roadway. As a result, it is also anticipated that traffic from parallel roadway will be rerouted to Oxmoor Road, especially from Roseland, Mayfair and Manhattan. Additionally, the average speeds along Oxmoor Road would be expected to increase, however they would remain on average less than 30 miles per hour during the peak times.

Intersection Improvements

Edgeview at Oxmoor

It is recommended that the existing signal be removed and the side streets be converted to a stop condition. This signal serves two dead end side streets and operates very inefficiently. As seen in the above picture, it often serves the side streets when no vehicle are present causing undue delay to the Oxmoor Road. Removing the signal does create a sight distance issue for vehicles turning left from southbound Edgeview Lane onto Oxmoor Road. It is recommended that vegetation along the north side of Oxmoor be trimmed to increase the sight distance and the installation of an intersection ahead sign be placed on westbound Oxmoor Road approaching the intersection. Further warning systems could be put in place if deemed necessary such as a warning flasher or even a vehicle approaching warning light such as the one used on Broadway at Redfern Street. Estimated Cost for signal removal: $7,000

Virginia Drive at Oxmoor



While traffic volumes do not justify the signal at Virginia Drive it is recommended that the signal be retained and upgraded to improve the safety of the intersection for pedestrians and children walking to school. Full pedestrian features should be installed including pedestrian heads with countdown timers and pushbuttons. Estimated Cost: $5,000

Oxmoor Road at St. Charles Street

The signal at Oxmoor Road and St. Charles Street should be considered for removal. It currently does not meet the minimum requirements for signalization and is spaced very closely to the signal at Broadway. With the existing crosswalk at this intersection, it is recommended that with the signal removal proper signage be installed. Additionally, a curb extension should be considered on the northern end of the crosswalk to shorten the crossing distance and increase pedestrian visibility. See Figure 7 below from the FHWA Best Practices Design Guide for an example of a curb extension.

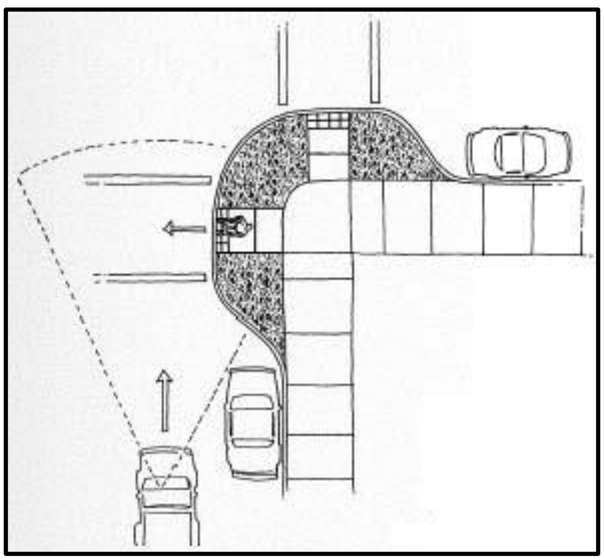


Figure 7 – Crosswalk Curb Extension

Estimated Costs:
Signal Removal: $7,000
Curb Extension: $3,000

Oxmoor Road at Broadway

The intersection of Broadway at Oxmoor road should be upgraded to run independently of the Evergreen signal. (it is currently operated in conjunction with Evergreen Avenue from a single controller). The Westbound left turn currently lacks detection, this should be installed to help the intersection work more efficiently. Since this intersection is an area of heavy pedestrian activity, especially in the evenings and on the weekends, the addition of a pedestrian only phase is recommended for those periods to protect pedestrians from turning vehicles.

Estimated Cost for upgrades: $3,000

Oxmoor Road at Evergreen Avenue

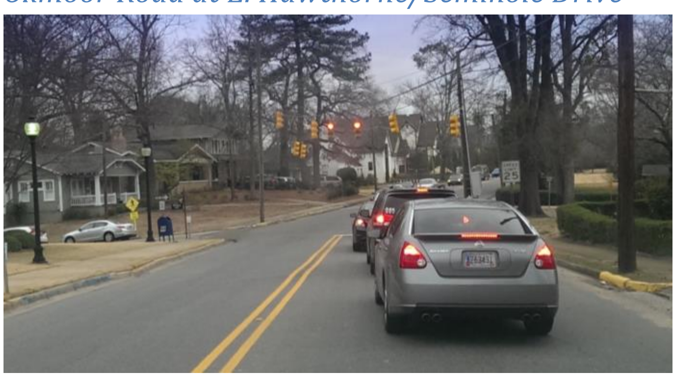
The signal at Evergreen Avenue with Oxmoor should be modified so Broadway and Evergreen can operate independently.

Oxmoor Road at W. Hawthorn/Clermont Drive

At the intersection of Oxmoor and W. Hawthorn/Clermont it is recommended that the signal remain and pedestrian features be added to the north and south sides of the intersection for pedestrians crossing east or westbound. As part of this work it is recommended that the southeast corner of the intersection be modified to provide a proper pedestrian ramp and sidewalk in addition to relocating the utility poles out or the sidewalk. Due to the wall and grade issues on the south side of Broadway, it is recommended that the sidewalk be widened into the existing travel lane. This would provide room for ramps at the intersection as well as an unobstructed sidewalk.

Traffic signal improvements: $3,500
Sidewalk from W. Hawthorn to W. Glenwood: $15,000

Oxmoor Road at E. Hawthorne/Seminole Drive



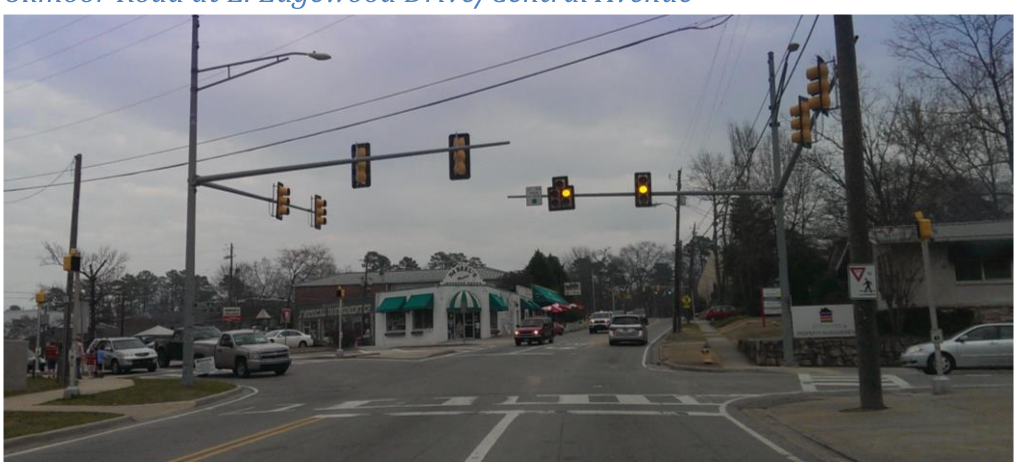
The signal at the intersection of Oxmoor and E. Hawthorn/Seminole is recommended for removal since it does not meet the minimum warrant criteria. This intersection experiences significant delays for Oxmoor Road as a result of the signal. With the removal of the signal the pedestrian crossing should be upgraded with a crosswalk, ramps and proper signage. Furthermore, additional lighting should be consider at the intersection. Estimated cost for signal removal and crosswalk: $8,000

Oxmoor Road at E. Glenwood Drive/Bridge Lane

At the intersection of Oxmoor with E. Glenwood/Bridge the signal should remain. The detection on the side streets should be upgraded with delay timers to account for right turning vehicles. The pedestrian crossing on the south side of the intersection should be restriped for greater visibility. Due to the construction of the new community center, the detection loops for the southbound approach have been removed and should be replaced with the new pavement. Additionally, the signal controller at this intersection should be swapped out with one of the controllers from the signal removals since it is a different model than the controllers on the majority of the corridor. This will aid in implementation of the coordinated signal system in the corridor.

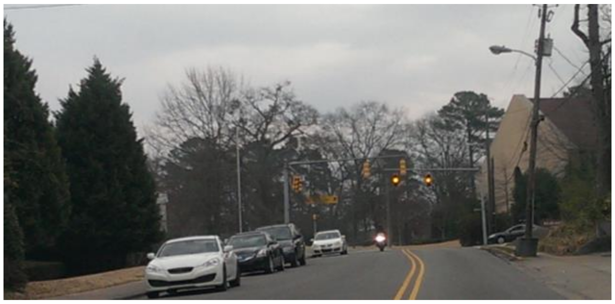
Estimated costs for new loops, crosswalk and controller swap: $5,000

Oxmoor Road at E. Edgewood Drive/Central Avenue



The intersection of Oxmoor at Central Avenue serves as one of the main intersections along the Oxmoor corridor. This signal should remain along with the pedestrian features which are important due to the adjacent park. The existing crosswalks should be restriped to improve visibility.

Oxmoor Road at Ridge Road



The signal at Oxmoor and Ridge Road should remain with improvements to the side street detection to add a time delay to prevent right turning vehicles from triggering the light after they turn. Additionally, the controller at this intersection should be swapped out with one of the controllers obtained from the signal removals since it is a different model than the controllers on the majority of the corridor.

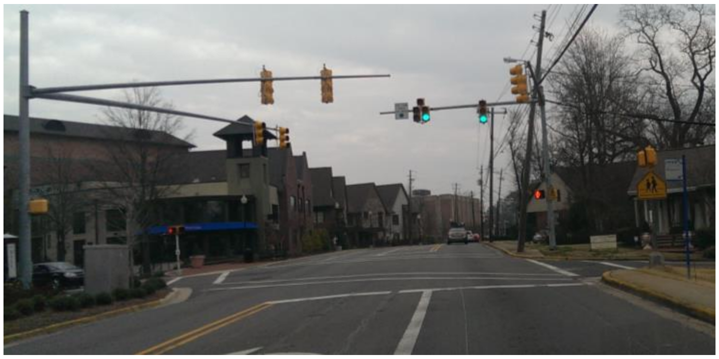
Estimated cost for detection updates and controller swap: $1,000

Oxmoor Road at 18th Street South/Roxbury Road

The signal at Oxmoor and 18th Street/Roxbury Road should remain. It is recommended that the signal be upgraded to have full pedestrian features for all the crosswalks. Additionally, protected permissive signal heads should be installed for the east and westbound approached to allow left turning vehicles to turn without a protected arrow.

Estimated Cost for pedestrian and signal upgrades: $6,000

Oxmoor Road at 19th Street South/Firefighter Lane



The intersection of Oxmoor at 19th Street/Firefighter Lane should continue to be signalized. Pedestrian upgrades should be considered for the south side of the intersection including ramps and the relocation of the utility poles which nearly block the entire sidewalk.
Estimated costs for sidewalk improvements: TBD

CONCLUSIONS

Based on the analyses documented in this report, the following conclusions can be stated:

1. the following can be stated about existing traffic conditions within the study area of Oxmoor Road:
   - The area of Oxmoor Road between Broadway and Central Avenue carries the most vehicles along the corridor and is subject the most congestions during the peak periods.
   - Oxmoor Road signal system is currently not coordinated and is running outdated timings and phasing plans. This contributes significantly to congestion and undue delay at the study intersections.
   - Unnecessary delay is caused due to vehicles waiting at signals with no opposing traffic on the side street due to faulty detection and poor timing/programming.
   - Speeds along Oxmoor Road were observed to be reasonable during the peak hours.
   - Vehicular queues do accumulate on the side streets, but are usually served.
   - Traffic congestion appears to be at its heaviest within the study area in the locations where traffic signals and side street intersections are closely spaced.
2. Analysis of the crash data determined there were a total of 50 crashes along the corridor in a one year period with zero fatalities and 11 injuries.
3. The only pattern from the crash data involves the high number of crashes at Broadway due to improper backing from parking spaces.
4. Recommended improvements along the Oxmoor Road corridor include:
   - Removal of signals at 4 intersections:
     - Oxmoor Road at Edgeview Avenue/Havenwood Court
     - Oxmoor Road at St. Charles Street
     - Oxmoor Road at E. Hawthorne/Seminole Drive
   - Modification of the Broadway and Evergreen intersections to be operated by separate controllers improving the phasing of the intersections
   - Upgrade the signals to include emergency vehicle preemption
   - Upgrade the signal system by replacing failed detectors and adding GPS time clocks to allow for time based coordination through the corridor.
5. Upon completion of the above recommended improvements to the corridor, it is estimated that the average vehicle delay in the corridor will be decreased by 56%. Additionally, it is anticipated that traffic currently using Roseland, Mayfair and Manhattan will reroute to use Oxmoor due to the increased capacity.

Technical Memorandum

TO: **Jim Wyatt, CBO**
Department Head/Building Official
City of Homewood

From: **Clark Bailey, P.E.**
Skipper Consulting, Inc.

Date: **March 27, 2015**

Subject: **Roseland Traffic Calming Study**

At the request of the Public Safety Committee of the City of Homewood, an evaluation of vehicle speeds and potential traffic calming measures was conducted along Roseland Drive in Homewood, Alabama. Roseland Drive is a local roadway located within a neighborhood with single family homes fronting each side. The posted speed limit along Roseland Drive is 25 mph, and it runs in an east/west direction. Roseland Drive is a fairly straight roadway with only minor changes in the horizontal geometry. Additionally, it is approximately 36 feet wide for most of its length. Both of these factors can promote higher speeds along a roadway.


Roseland Drive between East and West Glenwood

Speed Study

Based on conversations with the committee, many of the residents along Roseland have been concerned with vehicles speeding through the neighborhood. In addition to vehicular traffic, Roseland Drive has a large number of pedestrians and bicycles, many of which are children. In an effort to better understand the behavior of vehicles, a speed study was conducted along the roadway to measure both volumes and speed throughout a 24 hour period on February 12, 2015 at two locations. The first was located just east of Linwood Drive, and the second location was to the west of Edgewood Drive. The table below summarizes the data collected. Detailed speed study data is attached at the end of this document.

Location	85% speed	ADT
East of Linwood	30.4 mph	2,158 veh/day
West of E. Edgewood Drive	28.6 mph	2,129 veh/day

This 85th percentile speeds presented in the table above are on the upper threshold of an acceptable range for the speed limit posted on the roadway. Further analysis of the detailed speed data shows that nearly 99% of the vehicles are traveling under 35 mph. The risk of serious injury or death increases significantly for vehicle pedestrian collisions above 35 mph.

Traffic Calming Measures

Based on the speed data, additional measures along Roseland Drive to promote reduced speeds and less cut-through traffic would not be discouraged. Current traffic calming measures on Roseland drive include the use of speed humps and the use of 4-way stops at four intersection locations (at West Glenwood, at Linwood, at Edgewood Blvd and at Woodland Drive). The speed humps are proven effective tools for reducing speeds along low speed roadways. However, the use of stop signs at intersections for the sole purpose of reducing speeds is strongly discouraged. Numerous studies have shown that un-warranted stop signs have negative effects on both vehicle speeds and the safety of the roadway. In many instances, due to the inconvenience of an unwarranted stop, midblock speeds will increase due to drivers attempting to make up lost time due to a stop. Furthermore, unwarranted stops result in drivers becoming careless in fully coming to a complete stop. This can result in an unsafe condition for pedestrians and bicycles who may have a false sense of safety from the existence of a stop sign. For more information on the use of stop signs to reduce speeds, please see the report attached to the end of this document.

Alternative intersection treatments to intersections where a four-way stop is not warranted include the use of yield signs, traffic circle/roundabout, or conversion to a two-way stop condition. For Roseland Drive, it is recommended that stop sign warrants be conducted to verify the need for their installation. In the event that the current stop signs are not warranted, it is recommended that they be removed and alternative measures be implemented instead.

In an effort to reduce speeds along Roseland Drive further, multiple tools can be used to discourage speeding. There are many effective tools to accomplish this. Unfortunately, however, there is no general solution to the problem of speeding traffic. There will always be drivers that speed through residential areas. It is important for residents in a neighborhood to be aware of this issue.

Public Awareness

Often times, the majority of speeding traffic comes from residents living within the neighborhood. By simply raising awareness in the neighborhood drivers may adjust their driving and reduce their speeds.

Enforcement
While it is not possible to enforce speeds all the times, periodic and random enforcement for speeding violations, will not only discourage drivers who receive a citation but pass-by vehicles as well.

Lane Narrowing
The majority of Roseland Drive has a width of approximately 36 feet. This is the typical width of a three lane roadway; however, Roseland Drive is only used as two lanes. While it would be cost prohibitive to adjust the curb lines to narrow the entire roadway, selecting key locations to physically narrow the roadway through curb extensions or medians can have positive effects on reducing vehicle speeds. Another option involves the use of strategic striping to give the roadway a narrower feel along its entire length. In this case, a centerline would be placed along the length of the roadway and edge lines would be installed on either side offset 10 feet from center. The remaining 8 feet outside the centerline would serve as shared space for parking and bicycles.

Physical Measures
Roseland currently has 2 sets of speed humps installed between Linwood Drive and West Glenwood Drive. These are proven effective tools at reducing speeds along a roadway. Additional installations along the roadway would aid in reducing speeds. Alternatives to speed humps include speed tables, which can be less jarring to traverse for vehicles. Whenever physical features are installed in a roadway, consideration must be made for school buses and fire trucks. These devices are more of an impediment to large vehicles and can reduce response time for emergency vehicles if placed on a major response route.

Intersection Control
In the event that the current stop signs are not warranted and alternative intersection control measures are desired, the use of traffic circles at key intersections can be effective at calming traffic. By placing a small raised circle in the center of the intersection, vehicles from all approaches are required to make a horizontal change in travel to continue. Oftentimes, these traffic circles can include landscaping in the islands to increase aesthetics. The use of traffic circles is recommended for the intersections of Linwood Drive, Edgewood Blvd, and Woodland Drive. In lieu of the 4-way stop at West Glenwood, it is recommended that a physical traffic calming measure be installed between East and West Glenwood drive. This would entail either a speed hump, speed table, or a curb extension to physically narrow the lanes.

Additional traffic calming information is provided at the end of this report.

Roseland Drive at Kenilworth Drive
In addition to an evaluation of traffic calming methods along Roseland Drive, an evaluation of the configuration of the intersection of Roseland and Kenilworth was requested. Currently Kenilworth Drive intersects Roseland Drive at a skewed angle. This angle results in a very large intersection and large sweeping turning radii. As a result, pedestrians crossing the intersection are exposed to traffic for a longer time, and many vehicles turn on and off Kenilworth Drive at higher than normal speeds.

Current configuration of Roseland at Kenilworth

In an effort to create a safer intersection, it is recommended that the intersection be modified so that Kenilworth intersects Roseland Drive as close to a right angle as possible. This would be accomplished with the used of raised concrete islands. The use of raised concrete is important in order to shorten the distance pedestrians must cross Roseland Drive. A proposed intersection concept is presented on the following page.

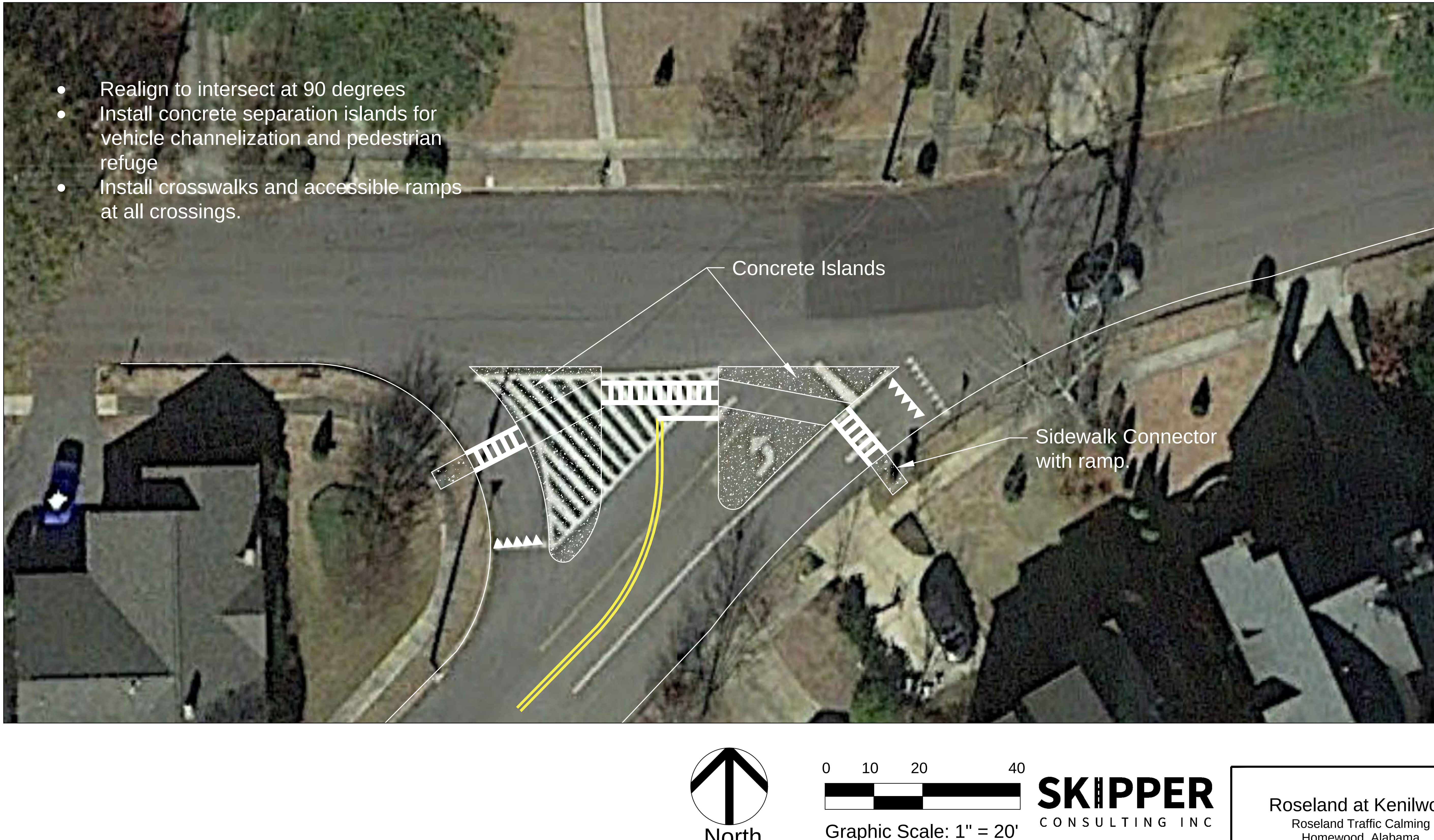
Conclusions

Based upon the analysis in this document, the following conclusions can be stated:

1. Roseland Drive is a local roadway located within a neighborhood with single family homes fronting each side. The posted speed limit along Roseland Drive is 25mph.
2. A speed study was conducted at two locations along Roseland Drive revealing 85th percentile speeds to be 30.4 mph and 28.6 mph respectively.
3. Recommendations made with this document are as follows:
    a. Stop sign warrants should be conducted to verify the need for the use of Stop Signs along Roseland Drive. In the event that the current stop signs are not warranted, it is recommended that they be removed and alternative measures be implemented instead.
    b. In lieu of stop signs, it is recommended that traffic circles be installed at the intersections of Linwood Drive, Edgewood Blvd, and Woodland Drive. In lieu of the 4-way stop at West Glenwood, it is recommended that a physical traffic calming measure be installed between East and West Glenwood drive.
    c. The intersection of Roseland Drive and Kenilworth Drive should be reconfigured as shown to provide for a safer intersection.

Roseland Traffic Calming

Homewood, Alabama



SKIPPER CONSULTING INC

Roseland at Kenilworth
Roseland Traffic Calming
Homewood, Alabama
03.27.2015 1292.004

TRAFFIC DATA, LLC
1409 Turnham Lane, Birmingham, AL 35216
205-824-0125

Location:: ROSELAND DR east of LINWOOD DR W
City, State: : HOMEWOOD, AL
Speed Limit: : 25 mph

Date: 2/12/2015 Thursday

24 Hour Volume

Begin	WB		EB		Combined	
11:00 AM	12	51	14	47	26	98
11:15 AM	13		15		28	
11:30 AM	10		10		20	
11:45 AM	16		8		24	
12:00 PM	11	67	24	69	35	136
12:15 PM	21		18		39	
12:30 PM	15		12		27	
12:45 PM	20		15		35	
1:00 PM	15	48	25	72	40	120
1:15 PM	15		16		31	
1:30 PM	7		19		26	
1:45 PM	11		12		23	
2:00 PM	15	94	14	51	29	145
2:15 PM	20		14		34	
2:30 PM	21		14		35	
2:45 PM	38		9		47	
3:00 PM	26	98	52	152	78	250
3:15 PM	34		48		82	
3:30 PM	28		25		53	
3:45 PM	10		27		37	
4:00 PM	21	89	17	65	38	154
4:15 PM	15		17		32	
4:30 PM	27		13		40	
4:45 PM	26		18		44	
5:00 PM	55	185	25	88	80	273
5:15 PM	50		26		76	
5:30 PM	50		23		73	
5:45 PM	30		14		44	
6:00 PM	22	73	19	63	41	136
6:15 PM	17		19		36	
6:30 PM	21		15		36	
6:45 PM	13		10		23	
7:00 PM	5	38	13	50	18	88
7:15 PM	16		11		27	
7:30 PM	12		14		26	
7:45 PM	5		12		17	
8:00 PM	7	27	11	23	18	50
8:15 PM	6		8		14	
8:30 PM	7		3		10	
8:45 PM	7		1		8	
9:00 PM	4	15	3	12	7	27
9:15 PM	5		5		10	
9:30 PM	3		1		4	
9:45 PM	3		3		6	
10:00 PM	3	8	1	8	4	16
10:15 PM	3		4		7	
10:30 PM	2		3		5	
10:45 PM	0		0		0	

Begin	WB		EB		Combined	
11:00 PM	2	4	1	3	3	7
11:15 PM	1		0		1	
11:30 PM	0		1		1	
11:45 PM	1		1		2	
2/13/2015 12:00 AM	0	0	0	3	0	3
12:15 AM	0		2		2	
12:30 AM	0		1		1	
12:45 AM	0		0		0	
1:00 AM	0	1	0	0	0	1
1:15 AM	1		0		1	
1:30 AM	0		0		0	
1:45 AM	0		0		0	
2:00 AM	0	0	0	2	0	2
2:15 AM	0		1		1	
2:30 AM	0		0		0	
2:45 AM	0		1		1	
3:00 AM	0	0	0	0	0	0
3:15 AM	0		0		0	
3:30 AM	0		0		0	
3:45 AM	0		0		0	
4:00 AM	0	1	0	1	0	2
4:15 AM	0		0		0	
4:30 AM	1		0		1	
4:45 AM	0		1		1	
5:00 AM	0	3	1	7	1	10
5:15 AM	0		2		2	
5:30 AM	1		2		3	
5:45 AM	2		2		4	
6:00 AM	2	19	3	31	5	50
6:15 AM	7		3		10	
6:30 AM	5		9		14	
6:45 AM	5		16		21	
7:00 AM	8	111	14	179	22	290
7:15 AM	20		24		44	
7:30 AM	45		41		86	
7:45 AM	38		100		138	
8:00 AM	9	39	29	74	38	113
8:15 AM	7		15		22	
8:30 AM	13		16		29	
8:45 AM	10		14		24	
9:00 AM	14	39	16	60	30	99
9:15 AM	10		22		32	
9:30 AM	10		11		21	
9:45 AM	5		11		16	
10:00 AM	8	34	10	54	18	88
10:15 AM	9		12		21	
10:30 AM	6		13		19	
10:45 AM	11		19		30	

	WB	EB	Combined
24 Hour Volume	1044 (48.4%)	1114 (51.6%)	2158

12:00 AM - 12:00 PM

	WB	EB	Combined
Count	298	458	756
	39.4 %	60.6 %	
Peak Hour	7:15 AM	7:15 AM	7:15 AM
Volume	112	194	306
Factor	0.62	0.48	0.55

12:00 PM - 12:00 AM

	WB	EB	Combined
Count	746	656	1402
	53.2 %	46.8 %	
Peak Hour	5:00 PM	3:00 PM	4:45 PM
Volume	185	152	273
Factor	0.84	0.73	0.85

TRAFFIC DATA, LLC
1409 Turnham Lane, Birmingham, AL 35216
205-824-0125

Location:: ROSELAND DR east of LINWOOD DR W
City, State: : HOMEWOOD, AL
Speed Limit:: 25 mph

Date: 2/12/2015
Thursday

24 Hour Speed
Combined Channels

mph	Total	0 - < 15	15 - < 20	20 - < 25	25 - < 30	30 - < 35	35 - < 40	40 - < 45	45 - < 50	50 - < 55	55 - < 60	60 - < 65	65 - < 70	70 - < 200
11:00 AM	98	1	3	23	37	28	6	0	0	0	0	0	0	0
12:00 PM	136	4	7	41	52	29	3	0	0	0	0	0	0	0
1:00 PM	120	0	13	28	42	31	5	0	0	0	0	0	0	0
2:00 PM	145	2	12	46	63	19	3	1	0	0	0	0	0	0
3:00 PM	250	11	21	89	96	31	2	0	0	0	0	0	0	0
4:00 PM	154	7	17	43	62	23	2	0	0	0	0	0	0	0
5:00 PM	273	2	24	95	119	32	1	0	0	0	0	0	0	0
6:00 PM	136	1	6	49	64	14	1	0	0	0	0	0	0	0
7:00 PM	88	3	14	34	28	9	0	0	0	0	0	1	0	0
8:00 PM	50	0	6	18	20	6	0	0	0	0	0	0	0	0
9:00 PM	27	0	7	8	10	2	0	0	0	0	0	0	0	0
10:00 PM	16	0	1	6	4	5	0	0	0	0	0	0	0	0
11:00 PM	7	0	1	2	1	3	0	0	0	0	0	0	0	0
2/13/2015														
12:00 AM	3	0	1	0	1	1	0	0	0	0	0	0	0	0
1:00 AM	1	0	0	0	1	0	0	0	0	0	0	0	0	0
2:00 AM	2	0	0	1	1	0	0	0	0	0	0	0	0	0
3:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:00 AM	2	0	2	0	0	0	0	0	0	0	0	0	0	0
5:00 AM	10	1	1	2	5	1	0	0	0	0	0	0	0	0
6:00 AM	50	0	3	18	24	5	0	0	0	0	0	0	0	0
7:00 AM	290	4	34	134	102	12	2	0	0	0	0	0	0	0
8:00 AM	113	1	13	31	47	20	1	0	0	0	0	0	0	2
9:00 AM	99	1	13	37	34	13	1	0	0	0	0	0	0	0
10:00 AM	88	0	13	20	39	15	1	0	0	0	0	0	0	0
Total	2158	38	212	725	852	299	28	1	0	0	0	1	0	2
%		1.8	9.8	33.6	39.5	13.9	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.1

Percentile Speeds (mph)

10 %	15 %	50 %	85 %	90 %
19.6	20.7	25.7	30.4	31.7

10 mph Pace Speed 20.4 - 30.4
Number in Pace 1613 (74.7 %)

Average 25.5 mph
Minimum 5.3 mph
Maximum 99.3 mph

Speeds Exceeded

	15 mph	25 mph	35 mph
	98.2 %	54.8 %	1.5 %
Count	2120	1183	32

TRAFFIC DATA, LLC
1409 Turnham Lane, Birmingham, AL 35216
205-824-0125

Location:: ROSELAND DR west of E EDGEWOOD DR
City, State:: HOMEWOOD, AL
Speed Limit:: 25 mph

Date: 2/12/2015 Thursday

24 Hour Volume

Begin	EB		WB		Combined	
11:00 AM	16	57	14	58	30	115
11:15 AM	15		11		26	
11:30 AM	15		16		31	
11:45 AM	11		17		28	
12:00 PM	23	76	18	76	41	152
12:15 PM	23		19		42	
12:30 PM	13		22		35	
12:45 PM	17		17		34	
1:00 PM	24	74	15	56	39	130
1:15 PM	18		20		38	
1:30 PM	17		7		24	
1:45 PM	15		14		29	
2:00 PM	15	50	10	76	25	126
2:15 PM	10		16		26	
2:30 PM	17		23		40	
2:45 PM	8		27		35	
3:00 PM	29	88	21	87	50	175
3:15 PM	31		32		63	
3:30 PM	17		18		35	
3:45 PM	11		16		27	
4:00 PM	10	66	29	115	39	181
4:15 PM	17		25		42	
4:30 PM	23		31		54	
4:45 PM	16		30		46	
5:00 PM	16	82	66	226	82	308
5:15 PM	16		68		84	
5:30 PM	27		52		79	
5:45 PM	23		40		63	
6:00 PM	7	49	23	96	30	145
6:15 PM	15		29		44	
6:30 PM	13		28		41	
6:45 PM	14		16		30	
7:00 PM	9	34	9	43	18	77
7:15 PM	4		13		17	
7:30 PM	12		13		25	
7:45 PM	9		8		17	
8:00 PM	7	18	7	34	14	52
8:15 PM	4		11		15	
8:30 PM	6		7		13	
8:45 PM	1		9		10	
9:00 PM	4	14	6	14	10	28
9:15 PM	4		4		8	
9:30 PM	2		1		3	
9:45 PM	4		3		7	
10:00 PM	2	9	2	5	4	14
10:15 PM	3		0		3	
10:30 PM	4		1		5	
10:45 PM	0		2		2	

	Begin	EB		WB		Combined	
	11:00 PM	1	1	2	4	3	5
	11:15 PM	0		0		0	
	11:30 PM	0		1		1	
	11:45 PM	0		1		1	
2/13/2015	12:00 AM	0	2	0	0	0	2
	12:15 AM	2		0		2	
	12:30 AM	0		0		0	
	12:45 AM	0		0		0	
	1:00 AM	0	1	0	1	0	2
	1:15 AM	0		0		0	
	1:30 AM	0		1		1	
	1:45 AM	1		0		1	
	2:00 AM	0	1	1	4	1	5
	2:15 AM	0		3		3	
	2:30 AM	0		0		0	
	2:45 AM	1		0		1	
	3:00 AM	0	0	1	2	1	2
	3:15 AM	0		0		0	
	3:30 AM	0		0		0	
	3:45 AM	0		1		1	
	4:00 AM	1	3	0	1	1	4
	4:15 AM	0		0		0	
	4:30 AM	1		1		2	
	4:45 AM	1		0		1	
	5:00 AM	2	12	0	5	2	17
	5:15 AM	3		1		4	
	5:30 AM	1		1		2	
	5:45 AM	6		3		9	
	6:00 AM	5	34	1	16	6	50
	6:15 AM	4		6		10	
	6:30 AM	11		3		14	
	6:45 AM	14		6		20	
	7:00 AM	10	153	2	47	12	200
	7:15 AM	29		12		41	
	7:30 AM	40		17		57	
	7:45 AM	74		16		90	
	8:00 AM	36	95	9	45	45	140
	8:15 AM	22		9		31	
	8:30 AM	17		14		31	
	8:45 AM	20		13		33	
	9:00 AM	14	64	10	39	24	103
	9:15 AM	23		17		40	
	9:30 AM	14		10		24	
	9:45 AM	13		2		15	
	10:00 AM	14	59	5	37	19	96
	10:15 AM	15		12		27	
	10:30 AM	20		10		30	
	10:45 AM	10		10		20	

	EB	WB	Combined
24 Hour Volume	1042 (48.9%)	1087 (51.1%)	2129

12:00 AM - 12:00 PM

	EB	WB	Combined
Count	481	255	736
	65.4 %	34.6 %	
Peak Hour	7:15 AM	11:00 AM	7:15 AM
Volume	179	58	233
Factor	0.60	0.85	0.65

12:00 PM - 12:00 AM

EB	WB	Combined
561	832	1393
40.3 %	59.7 %	
3:00 PM	5:00 PM	5:00 PM
88	226	308
0.71	0.83	0.92

TRAFFIC DATA, LLC
1409 Turnham Lane, Birmingham, AL 35216
205-824-0125

Location:: ROSELAND DR west of E EDGEWOOD DR
City, State:: HOMEWOOD, AL
Speed Limit:: 25 mph

Date: 2/12/2015
Thursday

24 Hour Speed
Combined Channels

mph	Total	0 - < 15	15 - < 20	20 - < 25	25 - < 30	30 - < 35	35 - < 40	40 - < 45	45 - < 50	50 - < 55	55 - < 60	60 - < 65	65 - < 70	70 - < 200
11:00 AM	115	4	7	40	51	12	1	0	0	0	0	0	0	0
12:00 PM	152	1	9	56	63	21	2	0	0	0	0	0	0	0
1:00 PM	130	0	6	54	49	19	2	0	0	0	0	0	0	0
2:00 PM	126	10	20	54	34	8	0	0	0	0	0	0	0	0
3:00 PM	175	9	24	74	60	6	2	0	0	0	0	0	0	0
4:00 PM	181	3	15	90	58	15	0	0	0	0	0	0	0	0
5:00 PM	308	9	46	159	83	11	0	0	0	0	0	0	0	0
6:00 PM	145	6	17	64	52	5	0	0	0	0	1	0	0	0
7:00 PM	77	3	7	33	30	4	0	0	0	0	0	0	0	0
8:00 PM	52	2	4	27	18	1	0	0	0	0	0	0	0	0
9:00 PM	28	1	2	9	12	4	0	0	0	0	0	0	0	0
10:00 PM	14	0	1	5	7	1	0	0	0	0	0	0	0	0
11:00 PM	5	0	0	3	2	0	0	0	0	0	0	0	0	0
2/13/2015														
12:00 AM	2	0	0	1	0	0	1	0	0	0	0	0	0	0
1:00 AM	2	0	0	1	1	0	0	0	0	0	0	0	0	0
2:00 AM	5	0	0	2	2	0	1	0	0	0	0	0	0	0
3:00 AM	2	0	0	1	1	0	0	0	0	0	0	0	0	0
4:00 AM	4	0	1	3	0	0	0	0	0	0	0	0	0	0
5:00 AM	17	3	2	5	6	1	0	0	0	0	0	0	0	0
6:00 AM	50	1	7	21	17	4	0	0	0	0	0	0	0	0
7:00 AM	200	4	35	96	60	5	0	0	0	0	0	0	0	0
8:00 AM	140	3	15	71	41	10	0	0	0	0	0	0	0	0
9:00 AM	103	3	7	34	44	13	1	1	0	0	0	0	0	0
10:00 AM	96	0	8	31	43	13	1	0	0	0	0	0	0	0
Total	2129	62	233	934	734	153	11	1	0	0	1	0	0	0
%		2.9	10.9	43.9	34.5	7.2	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Percentile Speeds (mph)	10 %	15 %	50 %	85 %	90 %
	18.9	20.1	24.4	28.6	29.2

10 mph Pace Speed 19.9 - 29.9
Number in Pace 1684 (79.1 %)

Average 24.2 mph
Minimum 6.0 mph
Maximum 55.2 mph

Speeds Exceeded	15 mph	25 mph	35 mph
	97.1 %	42.3 %	0.6 %
Count	2067	900	13

Multi-way Stops - The Research Shows the MUTCD is Correct!

W. Martin Bretherton Jr., P.E.(M)

Abstract

This paper reviewed over 70 technical papers covering all-way stops (or multi-way stops) and their success and failure as traffic control devices in residential areas. This study is the most comprehensive found on multi-way stop signs

The study looked at how multi-way stop signs have been used as traffic calming measures to control speed. There have been 23 hypotheses studied using multi-way stop as speed control. The research found an additional 9 hypotheses studied showing the effect multi way stops have on other traffic engineering problems.

The research found that, overwhelmingly, multi-way stop signs do NOT control speed except under very limited conditions. The research shows that the concerns about unwarranted stop signs are well founded.

Introduction

Many elected officials, citizens and some traffic engineering professionals feel that multi-way stop signs should be used as traffic calming devices. Many times unwarranted stop signs are installed to control traffic. The Manual on Uniform Traffic Control Devices (MUTCD)(16) describes warrants for installing multi-way stop signs. However, it does not describe many of the problems caused by the installation of unwarranted stop signs. These problems include concerns like liability issues, traffic noise, automobile pollution, traffic enforcement and driver behavior.

This paper is a result of searching over 70 technical papers about multi-way stop signs. The study concentrated on their use as traffic calming devices and their relative effectiveness in controlling speeds in residential neighborhoods. The references found 23 hypotheses on their relative effectiveness as traffic calming devices. One study analyzed the economic cost of installing a multi-way stop at an intersection. The reference search also found 9 hypotheses about traffic operations on residential streets.

The literature search found 85 papers on the subject of multi-way stops. There are probably many more references available on this very popular subject.There was a problem finding 14 papers found in literature searches. The 14 papers are listed in the appendix for information only. Most of the papers were old sources of information.

Multi-Way Stop Signs as Speed Control Devices

A summary of the articles found the following information about the effectiveness of multi-way stop signs and other solutions to controlling speeds in residential neighborhoods.

1. Multi-way stops do not control speeds. Twenty-two papers were cited for these findings. (Reference 1, 2, 7, 8, 10, 12, 13, 14, 15, 16, 17, 19, 20, 39, 45, 46, 51, 55, 62, 63, 64, 66 and 70).

2. Stop compliance is poor at unwarranted multi-way stop signs. Unwarranted stop signs means they do not meet the warrants of the MUTCD. This is based on the drivers feeling that the signs have no traffic control purpose. There is little reason to yield the right-of - way because there are usually no vehicles on the minor street. Nineteen references found this to be their finding. (Reference 7, 8, 10, 12, 13, 14, 15, 17, 19, 20, 39, 45, 46, *51*, *55*, 61, 62, 63 and 64).

3. Before-After studies show multi-way stop signs do not reduce speeds on residential streets. Nineteen references found this to be their finding. (Reference 19 (1 study), 55 (5 studies), 60 (8 studies) and 64(5 studies)).

4. Unwarranted multi-way stops <u>increased</u> speed some distance from intersections. The studies hypothesizing that motorists are making up the time they lost at the "unnecessary" stop sign. Fifteen references found this to be their finding. (Reference 1, 2, 7, 8, 10, 13, 14, 17, 19, 20,39, 45,46, 51, 55, 70 and 71).

5. Multi-way stop signs have high operating costs based on vehicle operating costs, vehicular travel times, fuel consumption and increased vehicle emissions. Fifteen references found this to be their finding. (Reference 3, 4, 7, 8, 10, 14, 15, 17, 45, 55 ,61, 62, 63, 67 and 68).

6. Safety of pedestrians is decreased at unwarranted multi-way stops, especially small children. It seems that pedestrians expect vehicles to stop at the stop signs but many vehicles have gotten in the habit of running the "unnecessary" stop sign. Thirteen references found this to be their finding. (References 7, 8, 10, 13, 14, 15, 17, 19, 20, 45, 51, 55 and 63).

7. Citizens feel "safer" in communities "positively controlled" by stop signs. Positively controlled is meant to infer that the streets are controlled by unwarranted stop signs.

Homeowners on the residential collector feel safer on a 'calmed' street. Seven references found this to be their finding. (Reference 6, 14, 18, 20, 51, 58 and 66).

Hypothesis twelve (below) lists five references that dispute the results of these studies.

8. Speeding problems on residential streets are associated with" through" traffic. Frequently homeowners feel the problem is created by 'outsiders'. Many times the problem is the person complaining or their neighbor. Five references found this to be their finding. (References 2, 15, 45, 51 and 55).

9. Unwarranted multi-way stops may present potential liability problems for undocumented exceptions to accepted warrants. Local jurisdictions feel they may be incurring higher liability exposure by 'violating' the MUTCD. Many times the unwarranted stop signs are installed without a warrant study or some documentation. Cited by six references. (Reference 7, 9, 19, 46, 62 and 65).

10. Stop signs increase noise in the vicinity of an intersection. The noise is created by the vehicle braking noise at the intersection and the cars accelerating up to speed. The noise is created by the engine exhaust, brake, tire and aerodynamic noises. Cited by five references. (Reference 14, 17, 20, 45, 55).

11. Cost of installing multi-way stops are low but enforcement costs are prohibitive. many communities do not have the resources to effectively enforce compliance with the stop signs. Five references found this to be their finding. (Reference 1, 10, 45, 51, 55).

12. Stop signs do not significantly change safety of intersection. Stop signs are installed with the hope they will make the intersection and neighborhood safer. Cited by five references. (Reference 55, 60, 61, 62, 63).

    Hypothesis seven (above) lists seven references that dispute the results of these studies.

13. Unwarranted multi-way stops have been successfully removed with public support and result in improved compliance at justified stop signs. Cited by three references. (Reference 8, 10, 12).

14. Unwarranted multi-way stops reduce accidents in cities with intersection sight distance problems and at intersections with parked cars that restrict sight distance. The stop signs are unwarranted based on volume and may not quite meet the accident threshold. Cited by three references. (Reference 6, 18, 68).

15. Citizens feel stop signs should be installed at locations based on traffic engineering studies. Some homeowners realize the importance of installing 'needed' stop signs. Cited by two references. (References 56, 57).

16. Multi-way stops can reduce cut-through traffic volume if many intersections along the road are controlled by stop signs. If enough stop signs are installed on a residential or collector street motorists may go another way because of the inconvenience of having to start and stop at so many intersections. This includes the many drivers that will not stop but slowly 'cruise' through the stop signs. This driving behavior has been nicknamed the 'California cruise'. Cited by two references. (Reference 14, 61).

17. Placement of unwarranted stop signs in violation of Georgia State Law 32-6-50 (a) (b) (c). This study was conducted using Georgia law. Georgia law requires local governments to install all traffic controls devices in accordance with the MUTCD. This is probably similar to traffic signing laws in other states. Cited by two references. (Reference 19, 62).

18. Special police enforcement of multi-way stop signs has limited effectiveness. This has been called the 'hallo' effect. Drivers will obey the 'unreasonable' laws as long as a policemen is visible. Cited by two references. (Reference 39, 46).

19. District judge orders removal of stop signs not installed in compliance with city ordinance. Judges have ordered the removal of 'unnecessary' stop signs. The problem begins when the traffic engineer and/or elected officials are asked to consider their intersection a 'special case'. This creates a precedent and results in a proliferation of 'special case' all-way stop signs. Cited by two references. (Reference 59, 62).

20. Some jurisdictions have created warrants for multi-way stops that are easier to meet than MUTCD. The jurisdiction feel that the MUTCD warrants are too difficult to meet in residential areas. The reduced warrants are usually created to please elected officials. Cited by two references. (Reference 61 and 70).

21. Citizens perceive stop signs are effective as speed control devices because traffic "slows" at stop sign. If everybody obeyed the traffic laws, stop signs would reduce speeds on residential streets. Cited by one reference. (Reference 55).

22. Removal of multi-way stop signs does not change speeds but they are slightly lower without the stop signs. This study findings support the drivers behavior referenced in item #4, speed increases when unwarranted stop signs are installed. Speed decreases when the stop signs were removed! Cited by one reference. (Reference 64).

23. Multi-way stops degrade air quality and increase CO, HC, and Nox. All the starting and stopping at the intersection is bad for air quality. Cited by one reference. (Reference 68).

Other Speed Control Issues

24. There area many ways to "calm" traffic. Cited by twenty-two references. (Reference 1, 14, 20, 32, 33, 34, 35, 36, 37, 38, 40,41,42, 44, 45, 46, 47, 48, 50, 51, 53 and 66).

They include:

(a) Traffic Chokers	(f) Sidewalks and Other Pedestrian Solutions
(b) Traffic Diverters	(g) Neighborhood Street Design
(c) Speed Humps	(h) On-Street Parking
(d) Roundabouts	(i) One Way Streets
(e) Neighborhood Speed Watch	(j) Street Narrowing

25. Other possible solutions to residential speed. Most speeding is by residents - Neighborhood Speed Watch Programs may work. This program works by using the principle of 'peer' pressure. Cited by seven references. (Reference 2, 30, 31, 36, 42, 48 and 53).

26. Reduced speed limits are not effective at slowing traffic. Motorists do not drive by the number on the signs, they travel a safe speed based on the geometrics of the roadway. Cited by five references. (Reference 1, 20, 39, 46 and 69).

27. Local streets should be designed to discourage excessive speeds. The most effective way to slow down traffic on residential streets is to design them for slow speeds. Cited by two references. (Reference 43, 52).

28. Speeding on residential streets is a seasonal problem. This is a myth. The problem of speeding is not seasonal, it's just that homeowners only see the problem in 'pleasant' weather. That's the time they spend in there front yard or walking the neighborhood. Cited by one reference. (Reference 2).

29. Speed variance and accident frequency are directly related. The safest speed for a road is the speed that most of the drivers feel safest driving. This speed creates the lowest variance and the safest road. Cited by one reference. (Reference 47).

30. The accident involvement rate is lowest at the 85th percentile speed. The 85th percentile speed is the speed that most drivers feel comfortable driving. The lowest variance is usually from the 85th percentile speed and the 10 mph less. Cited by one reference. (Reference 47).

31. Psycho-perceptive transverse pavement markings are not effective at reducing the 85th percentile speed but do reduce the highest speed percentile by 5 MPH. Cited by one reference. (Reference 47).

32. The safest residential streets would be short (0.20 miles) non-continuous streets that are 26 to 30 feet from curb to curb width. The short streets make it difficult of drivers to get up to speed. Cited by one reference. (Reference 52).

Economics of Multi-Way Stop Signs

Studies have found that installing unwarranted stop signs increases operating costs for the traveling public. The operating costs involve vehicle operating costs, costs for increased delay and travel time, cost to enforce signs, and costs for fines and increases in insurance premiums.

The total costs are as follows (Reference 55):

Operating Costs (1990) ($.04291/Stop)	$ 111,737/year
Delay & Travel Costs (1990) ($.03401/Stop)	$ 88,556 /year
Enforcement Costs (1990)	$ 837/year
Cost of Fines (19 per year)	$ 1,045/year
Cost of 2 stop signs (1990)	$ 280
Costs of increased insurance (1990)	$ 7,606/year
Total (1990)	**$210,061/year/intersection**

The cost to install two stops signs is $280. The cost to the traveling public is $210,061 (1990) per year in operating costs. This cost is based on about 8,000 vehicles entering the intersection per day.

Another study (62) found that the average annual road user cost increased by $2,402.92 (1988 cost) per intersection when converting from two to four way stop signs for low volume intersections.

Summary of Stop Signs as Speed Control Devices

Researchers found that multi-way stop signs do not control speed. In analyzing the 23 hypotheses for multi-way stop signs, five were favorable and 18 were unfavorable toward installing unwarranted all-way stop signs. The Chicago study (6) was the only research paper that showed factual support for "unwarranted" multi-way stop signs. They were found to be effective at reducing accidents at intersections that have sight distance problems and on-street parking.

It is interesting to note that residential speeding problems and multi-way stop sign requests date back to 1930 (63). The profession still has not "solved" this perception problem.

Summary of Economic Analysis

Benefits to control speeds by installing multi-way stop signs are perceived rather than actual and the costs for the driving public are far greater than any benefits derived from the installation of the multi-way stop signs.

W. Martin Bretherton Jr., P.E.
Chief Engineer, Traffic Studies Section
Gwinnett County Department of Transportation
75 Langley Drive
Lawrenceville, Georgia 30045
770-822-7412
brethema@co.gwinnett.ga.us

Appendix A

References used in Research of Multi-Way Stop Signs

1. Gerald L. Ullman, "Neighborhood Speed Control - U.S. Practices", ITE Compendium of Technical Papers, 1996, pages 111- 115.

2. Richard F. Beaubein, "Controlling Speeds on Residential Streets", ITE Journal, April 1989,
pages 37-39.

3. "4 Way Stop Signs Cut Accident Rate 58% at Rural Intersections", ITE Journal, November 1984, pages 23-24.

4. Michael Kyte & Joseph Marek, "Collecting Traffic Data at All-Way Stop Controlled Intersections", ITE Journal, April 1989, pages 33-36.

5. Chan, Flynn & Stocker, "Volume Delay Relationship at Four Way Stop Controlled Intersections: A Response Surface Model", ITE Journal, March 1989, pages 27-34.

6. La Plante and Kripidlowkdki, "Stop Sign Warrants: Time for Change", ITE Journal, October 1992, pages 25-29.

7. Patricia B. Noyes, "Responding to Citizen Requests for Multi Way Stops", ITE Journal, January 1994, pages 43-48.

8. Chadda and Carter, "Multi-Way Stop Signs - Have We Gone Too Far?", ITE Journal, May 1983, pages 19-21.

9. Gary Moore,"Gwinnett County Legal Opinions on Unwarranted Multi-Way Stops", March 6,1990.

10. Chadda and Carter, " The Changing Role of Multi-Way Stop Control", ITE Compendium of Technical Papers, 1983, pages 4-31 to 4-34.

11. Lovell and Haver, "The Safety Effect of Conversion to All-Way Stop Control", Transportation Research Record 1068, pages 103-107.

12. "Indiana Suggests Ways to Halt Stop Sign Misuse", Transafety Reporter, February 1989, page 7.

13. "Why Don't They Put in More Stop Signs?", Traffic Information Program Series, ITE, 1978.

14. "State of the Art: Residential Traffic Management", US DOT, FHWA/RD-80/092, December 1980, pages 63-65, 22-23.

15. Dick Williams, "A New Direction for Traffic Dispute", Atlanta Journal, January 14, 1988, Section E, page 1.

16. "Warrants for Multi-Way Stop Signs" (2B-6), Manual on Uniform Traffic Control Devices, US DOT , FHWA, pages 2B-3 to 2B-4.

17. "Stop and Yield Sign Control", Traffic Control Devices Handbook, US DOT, FHWA, 1983, pages 2-14 to 2-16.

18. La Pante & Kropidlowdki, "Stop Sign Warrants ", Presented at ITE Conference, San Diego, CA, September 18, 1989.

19. Walt Rekuc, "Traffic Engineering Study of Multi-Way Stop Signs", City of Roswell, February 15, 1988.

20. Homburger, etal, Residential Street Design and Traffic Control, ITE, Washington, DC, 1989.

21. Speed Zone Guidelines, ITE, Washington, DC, 1993.

22. A Policy on Geometric Design of Highways and Streets, AASHTO, Washington, DC, 1994.

23. A.J. Ballard, "Efforts to Control Speeds on Residential Collector Streets", ITE Compendium of Technical Papers, 1990, pages 445-448.

24. C.E. Walter, "Suburban Residential Traffic Calming", ITE Compendium of Technical Papers, 1994, pages 445-448.

25. K.L. Gonzalez, " Neighborhood Traffic Control: Bellevue's Approach", ITE Journal, Vol. 43, No.5, May 1993, pages 43-45.

26. Brian Kanely & B.E. Ferris, "Traffic Diverter's for Residential Traffic Control - The Gainesville Experience", ITE Compendium of Technical Papers, 1985, pages 72-76.

27. Marshall Elizer, "Guidelines for the Design and Application of Speed Humps", ITE Compendium of Technical Papers, 1993, pages 11-15.

28. T. Mazella & D. Godfrey, "Building and Testing a Customer Responsive Neighborhood Traffic Control Program", ITE Compendium of Technical Papers, 1995, pages 75-79.

29. W.M. Bretherton and J.E. Womble, "Neighborhood Traffic Management Program", ITE Compendium of Technical Papers, 1992, pages 398-401.

30. J.E. Womble, "Neighborhood Speed Watch: Another Weapon in the Residential Speed Control Arsenal", ITE Journal, Vol. 60, No. 2, February 1990, pages 1- 17.

31. Michael Wallwork, "Traffic Calming", The Genesis Group, unpublished.

32. Doug Lemov, "Calming Traffic", Governing, August 1996, pages 25-27.

33. Michael Wallwork, "Traffic Calming", The Traffic Safety Toolbox, ITE, Washington, DC, 1993, pages 234-245.

34. Ransford S. McCourt, Neighborhood Traffic Management Survey, ITE District 6, Technical Chair, unpublished, June 3, 1996.

35. Halbert, etal, "Implementation of Residential Traffic Control Program in the City of San Diego", District 6 Meeting, July 1993.

36. Anton Dahlerbrush, "Speed Humps & Implementation and Impact on Residential Traffic Control", City of Beverly Hills, California, District 6 Meeting, July 1993.

37. Firoz Vohra, "Modesto Speed Hump Experience", District 6, ITE Meeting, July 1993.

38. Patricia Noyes, "Evaluation of Traditional Speed Reduction in Residential Area", District 6 ITE Meeting, July 1993.

39. Cynthia L. Hoyle, Traffic Calming, American Planning Association, Report No 456, July 1995.

40. Sam Yager, Use of Roundabouts, ITE Technical Council Committee, 5B- 17, Washington, DC, February 1992.

41. Guidelines for Residential Subdivision Street Design, ITE, Washington, DC, 1993.

42. Residential Streets, 2nd Edition, ASCE, NAHB & ULI, 1990.

43. Traffic Calming, Citizens Advocating Responsible Transportation, Australia, 1989.

44. Traffic Calming in Practice, Department of Transport, etal, London, November 1994.

45. Todd Long, "The Use of Traffic Control Measures in the Prevention of Through Traffic Movement on Residential Streets", unpublished, Masters Thesis, Georgia Tech, September 1990.

46. Patricia Noyes, "Evaluation of Traditional Speed Reduction Efforts in Residential Areas", ITE Compendium of Technical Papers, District 6 Meeting, 1993, pages 61-66.

47. G.E. Frangos, "Howard County's Speed Control in Residential Areas Utilizing Psycho-perceptive Traffic Controls", ITE Compendium of Technical Papers, 1985, pages 87-92.

48. Halbert, etal, "Implementation of Residential Traffic Control Program in the City of San Diego", ITE Compendium of Technical Papers, District 6, 1993, pages 23-60.

49. Radwan & Sinha, "Gap Acceptance and Delay at Stop Controlled Intersections on Multi-Lane Divided Highways", ITE Journal, March 1980, page 38.

50. Borstel, "Traffic Circles : Seattle's Experience", ITE Compendium of Technical Papers, 1985, page 77.

51. D. Meier, "The Policy Adopted in Arlington County, VA, for Solving Real and Perceived Speeding Problems on Residential Streets", ITE Compendium of Technical Papers, 1985, page 97.

52. Jeff Clark, "High Speeds and Volumes on Residential Streets: An Analysis of Physical Characteristics as Causes in Sacramento, California", ITE Compendium of Technical Papers, 1985, page 93.

53. Wiersig & Van Winkle, "Neighborhood Traffic Management in the Dallas/Fort Worth Area", ITE Compendium of Technical Papers, 1985, page 82.

54. Improving Residential Street Environments, FHWA RD-81-031, 1981.

55. Carl R. Dawson, Jr., "Effectiveness of Stop Signs When Installed to Control Speeds Along Residential Streets", Proceedings from Southern District ITE Meeting, Richmond, Virginia, April 17, 1993.

56. Arthur R. Theil, "Let Baton Rouge's Traffic Engineers Decide Whether Signs Are Needed", State Times, LA, August 30, 1983.

57. Gary James, "Merits Being Totally Ignored in This Instance", Morning Advocate, Baton Rouge, LA, July 30,1983.

58. James Thomason, "Traffic Signs Allow Crossing", Morning Advocate, Baton Rouge, LA, July 30, 1983.

59. "City-Parish Must Move Stop Signs", Morning Advocate, Baton Rouge, LA, 1983.

60. Synthesis of Safety Research Related to Traffic Control and Roadway Elements, Vol. 2, FHWA Washington, D. C., 19982.

61. B.H. Cottrell, Jr.,"Using All-Way Stop Control for Residential Traffic Management", Report No. FHWA VTRC 96-R17, Virginia Transportation Research Council, Charlottesville, Virginia, January, 1996.

62. Eck & Diega, "Field Evaluation at Multi-Way Versus Four-Way Stop Sign Control at Low Volume Intersections in Residential Areas", Transportation Research Record 1160, Washington, DC, 1988, pages 7-13.

63. Hanson, "Are There Too Many Four-Way Stops?", Traffic Engineering, November 1957, pages 20-22, 42.

64. Beaubien, "Stop Signs for Speed Control", ITE Journal, November 1976, pages 26-28.

65. Antwerp and Miller, "Control of Traffic in Residential Neighborhoods : Some Considerations for Implementation", Transportation 10, 1981, pages 35-49.

66. Lipinski, "Neighborhood Traffic Controls", Transportation Engineering Journal, May 1979, pages 213-221.

67. Richardson,"A Delay Model for Multi-Way Stop Sign Intersections", Transportation Research Record 1112, Washington, DC, 1987, pages 107-114.

68. Briglin, "An Evaluation of Four-Way Stop Sign Control", ITE Journal, August 1982, pages 16-19.

69. Ullman and Dudek, "Effects of Reduced Speed Limits in Rapidly Developing Urban Fringe Areas", Transportation Research Record 1114, 1989, pages 45-53.

70. Robert Rees, "All-Way STOP Signs Installation Criteria", Westernite, Jan-Feb 1999, Vol 53, No. 1, pg 1-4.

71. Wes Siporski, "Stop Sign Compliance", posting on Traffic Engineering Council List Serve, Jan 15, 1999.

Appendix B

Additional References for Multi-Way Stop Signs

Not included in Analysis - Reports not available

1. Improving Traffic Signal Operations, ITE Report IR-081, August 1995.

2. Kunde, " Unwarranted Stop Signs in Cities", ITE Technical Notes, July 1982, page 12.

3. "In search of Effective Speed Control", ITE Technical Notes, December 1980, pages 12-16.

4. "Stop Signs Do Not Control Speed", ITE Technical Notes, July 1978, pages 6-7.

5. "An Evaluation of Unwarranted Stop Signs", ITE San Francisco Bay Area, February 1979.

6. "Cost of Unnecessary Stops", Auto Club of Missouri, Midwest Motorists, 1974.

7. Nitzel, Schatter & Mink, "Residential Traffic Control Policies and Measures", ITE Compendium of Technical Papers, 1988.

8. Weike and Keim, "Residential Traffic Controls", ITE Compendium of Technical Papers, Washington DC, August 1976.

9. Landom and Buller, "The Effects on Road Noise in Residential Areas", Watford, United Kingdom, October 1977.

10. Wells and Joyner, "Neighborhood Automobile Restraints", Transportation Research Record 813, 1981.

11. Byrd and Stafford, "Analysis of Delay and User Costs of Unwarranted Four Way Stop Sign Controlled Intersections", TRR 956, Washington, DC, 1984, pages 30-32.

12. Marconi, "Speed Control Measures in Residential Areas", Traffic Engineering, Vol. 47, No. 3, March 1977, pages 28-30.

13. Mounce, "Driver's Compliance with Stop Sign Control at Low Volume Intersections", TRR 808, TRB, Washington, DC, 1981, pages 30-37.

14. Orlob, "Traffic Diversion for Better Neighborhoods", Traffic Engineering, ITE, Vol. 45, No. 7, July 1975, pages 22-25.

TRAFFIC CALMING

Traffic Calming involves the use of mainly physical measures to change the behavior of drivers in the interest of public safety and livability. Typically, it is used to reduce speeds and cut-through volumes on low volume roadways, namely neighborhood streets. Traffic Calming methods include altering street alignment or installing barriers or obstacles to slow speeding vehicles. The following is a list of the methods available.

Speed Hump

Description: a raised hump across the width of the roadway. Not to be confused with a speed bump, the speed hump offers a gentle profile allowing vehicles to traverse at speeds of 15-25 mph. It is recommended that they be placed between 300 and 500 feet apart.

Estimated Cost: $2,000 - $10,000

Effectiveness: Average 22% reduction in speeds

Advantages: Proven concept that reduces speeds.

Disadvantages: Increase to emergency response times. Increases noise as vehicles traverse over them.

Speed Lumps

Description: a modification to the speed hump that splits it into multiple lumps in the roadway. It allows the large wheel base of a fire engine to straddle the lumps. Speed lumps cam be purchased as premanufactured pieces that are anchored to the pavement.

Estimated Cost: $2,000 - $10,000

Effectiveness: Same as Speed Hump

Advantages: Proven concept that reduces speeds. Does not inhibit large emergency response vehicles. Allows for drainage and bicycles to pass.

Disadvantages: Increases noise as vehicles traverse over them.

Speed Tables

Description: A speed table is basically a speed hump with a flat top in the middle. The flat top allows for a more gentle changes in the vertical direction. As a result, speed tables can be traversed at slightly higher speeds than speed humps (25-30 mph).

Estimated Cost: $3,000 - $15,000

Effectiveness: Average 18% reduction in speeds

Advantages: Proven concept that reduces speeds. Can be traversed at slightly higher speeds than speed humps. Can be integrated as an elevated crosswalk, as well.

Disadvantages: Increase to emergency response times. Increases noise as vehicles traverse over them. More expensive to construct than speed humps and lumps.

Traffic Circle

Description: Consists of a small raised island installed in the center of intersecting roadways. The traffic circle should be designed to be large enough to slow through traffic but still small enough to allow for large emergency vehicles to use. All vehicles that use the intersection travel in a counter-clockwise direction.

Estimated Cost: $5,000 - $15,000

Effectiveness: Average 11% reduction in speeds.

Advantages: Proven concept that reduces speeds. It does not require vehicles to go over anything and is therefore quieter.

Disadvantages: Can only be placed in intersections. Can slow emergency response times. Can be costly to design and construct.

Narrowing

Description: Consists of a small raised island installed in the center of the roadway or extending the curbs from the outside. The features, which can be landscaped, reduce the overall width of the roadway. They can be combined with textured pavement along the length to enhance the effect.

Estimated Cost: $5,000 - $15,000

Effectiveness: Average 7% reduction in speeds.

Advantages: Can reduce cut-through volumes. Can add aesthetic value.

Disadvantages: Speed reduction is somewhat limited due to the lack of horizontal or vertical deflection.