

## QUEUEING STUDY & ACCESS EVALUATION MEMORANDUM

Date: May 24, 2018

To: Tom Odell  
Charlotte-Mecklenburg Schools  
3301 Stafford Drive  
Charlotte, NC 28208

From: Randy E. Goddard, P.E.  
Managing Principal  
Design Resource Group, PA (C-2165)

Subject: **Elizabeth Lane (K-5) Elementary School (157-021)**



### Background:

Per the request of Town of Matthews Planning and Development, a queueing study and traffic evaluation is required by Charlotte-Mecklenburg Schools (CMS) to ensure compliance with conditions of approval of application #2017-662 (Elizabeth Lane Mobile Classroom Sunset Revision) with Matthews.



The queueing study/traffic evaluation will include observation of existing traffic patterns and queues during both the AM and PM school peak periods and the calculation of minimum stacking per the Municipal School Transportation Assistance (MSTA) calculator using current 2017-2018 enrollment data.

### Location and School Information:

Elizabeth Lane Elementary School is located at 121 Elizabeth Lane (south of Pineville Matthews Road [NC 51]) in the Town of Matthews, NC. Per CMS personnel, the following is the latest information regarding the school:

- School begins at 7:45 AM and dismisses at 2:45 PM
- Approximately 1,088 students
- Approximately 9 buses during both the morning arrival period and 14 buses in the afternoon dismissal period
- Approximately 53 faculty/staff

The existing campus has two access locations on Elizabeth Lane on the west side of the school each going to a separate parking lot. Lot A is the southern most lot and is mainly used by buses (unloading and loading of students on the buses). Lot B is the northern most lot on Elizabeth Lane and is used for staff parking and is the primary drop-off/pickup area for students arriving in cars.



**Trip Generation:**

Based on an elementary school with an enrollment of 1,088 students (13 buses, and 53 staff/faculty), the school is expected to potentially generate 875 trips in the AM peak hour. The PM dismissal peak hour for the school does not typically coincide with the normal traffic PM peak “rush” hour and is, therefore, not considered to be a significant factor. It should be noted that there were significantly fewer trips witnessed during the campus field visit than what the Municipal School Transportation Assistance (MSTA) trip generation calculates.

Table 1: Trip Generation

School Type	Number of Students	Daily Trips	AM Arrival Peak			PM Dismissal Peak*		
			Enter	Exit	Total	Enter	Exit	Total
Elementary School	1,088	1,310	464	411	875	191	191	382

Reference: MSTA School Traffic Calculator, NCDOT 2015

\* School PM Peak Occurs Prior to Typical Peak Hour, for Informational Purposes Only

**Existing Morning Arrival Plan for Elizabeth Lane Elementary School (7:45 AM):**

Elizabeth Lane Elementary staff have recently implemented a new traffic pattern for the morning drop off period (see Figure 1 for current AM traffic patterns) which typically operates in three waves.

**Wave 1 (Students Arriving before 7:15 AM)**

Students arriving before 7:15 AM are required to travel to Lot A to insure vehicles do not stack into Lot B and block any arriving staff members. This also helps to eliminate vehicles queueing onto Elizabeth lane and blocking any through traffic heading to Pineville-Matthews Road (NC 51). A member of staff directs traffic at Lot B’s entrance to allow staff to enter and restrict student traffic before 7:15 AM.

**Wave 2 (Students Arriving After 7:15 AM)**

At 7:13 AM, school staff release the vehicles waiting in Lot A to progress to Lot B for student drop-off. The staff member directing traffic at Lot B restricts left turn movements into the site until all the queued vehicles in Lot A have cleared.

Once the vehicles in Lot A have cleared, the buses begin to unload students in Lot A and traffic from both directions (right and left turns) are allowed into the Lot B. All students must enter for drop-off at Lot B while the buses are unloading in Lot A. It should be noted that the staff member in charge of directing traffic at Lot B’s access returns to the school to assist with the drop-off process after Lot A has cleared (i.e. traffic is no longer directed by a staff member).



### Wave 3 (Students Arriving After Buses Have Unloaded)

After the buses have unloaded all students, Lot A also opens for student drop-off (both lots open to vehicle traffic drop-off at this time).

It should be noted, there is a crossing guard at the crosswalk on Elizabeth Lane at Lot A/Brightwood Lane intersection that directs buses and assists any students walking to school and using the crosswalk, but there are not staff or officers directing vehicle traffic at either of the lot accesses.

### **Existing Afternoon Dismissal Pattern for Elizabeth Lane Elementary School (2:45 PM):**

During the afternoon dismissal period, Lot A (bus lot) is closed to all student pick-up traffic to allow for safe and timely movement and loading of buses. The current operation has parents stacking on-site in Lot B (see Figure 2 for current PM traffic pattern). Once the dismissal queue in Lot B reaches Elizabeth Lane the dismissal traffic begins to queue along Elizabeth lane, with vehicles performing U-turns on Elizabeth Lane in order enter the vehicle queue.

Student dismissal begins around 2:40 PM for “car riders” and moves efficiently due to a student call out system employed by staff. Vehicles have student identifier tags with staff announcing arrival for each student. Per staff comments, the dismissal period is typically completed within ten to fifteen minutes once pick-up begins.

The same crossing guard also provides her assistance to students and buses in the afternoon dismissal period as well, but there are not staff or officers directing vehicle traffic at either of the lot accesses.

### **Existing Maximum Vehicle Queues**

Field observations were performed during the morning arrival and afternoon dismissal peaks for the school (documenting approximately every five minutes during arrival/dismissal peaks) to determine the maximum vehicle queue lengths for pertinent traffic movements for Elizabeth Lane Elementary. These movements included:

- Northbound left and right turn movements on Elizabeth Lane at Pineville-Matthews Road (NC 51)
- Southbound left turn movements on Elizabeth Lane at Elizabeth Lane Elementary School’s Lot A and Lot B accesses
- Eastbound right turn movements on Pineville-Matthews Road (NC 51) at Elizabeth lane
- Westbound left turn movements on Pineville-Matthews Road (NC 51) at Elizabeth Lane

The maximum and average queues observed are as follows (see Figures 3 & 4):



Morning Arrival Observations for Elizabeth Lane Elementary School (6:45 – 7:50 AM):



**Elizabeth Lane facing south  
at Pineville-Matthews Road**



**Pineville-Matthews Road facing  
west at Elizabeth Lane**

- Northbound left and right turn movements Elizabeth Lane at Pineville-Matthews Road (NC 51):
  - The maximum queue witnessed during the morning arrival period was 50 vehicles (1,250 feet – a combination of left, through and right turn movements) and occurred on multiple occasions. The average northbound queue for this period was approximately 34 vehicles (850 feet).
  - The combined through-right lane did not typically experience a queue as the vehicles queueing in the northbound left turn lane spilled into the through-right lane and did not allow passage for vehicles to make these movements.
- Southbound left turn movements on Elizabeth Lane at Lot A's access
  - The maximum queue witnessed during the morning arrival period was 9 vehicles (225 feet) and occurred on multiple occasions. The average southbound queue for this period was approximately 4 vehicles (100 feet).
- Southbound left turn movements on Elizabeth Lane at Lot B's access
  - The maximum queue witnessed during the morning arrival period was 29 vehicles (725 feet – queue extended to eastbound Pineville-Matthews Road (NC 51) and occurred on multiple occasions. The average southbound queue for this period was approximately 11 vehicles (275 feet).
- Eastbound right turn movements on Pineville-Matthews Road (NC 51) at Elizabeth Lane
  - The maximum queue witnessed during the morning arrival period was 15 vehicles (375 feet – within the queue caused by the southbound left turn movement queue to Lot B on Elizabeth Lane) and occurred on multiple occasions. The maximum queue on NC 51 was a direct result of the southbound queue from Elizabeth Lane. The average operation of the traffic signal saw no queue as a result of the Elizabeth Lane Elementary traffic.



- Westbound left turn movements on Pineville-Matthews Road (NC 51) at Elizabeth Lane
  - The maximum queue witnessed during the morning arrival period was 9 vehicles (225 feet) and occurred on couple of occasions. The average westbound left turn lane queue for this period was approximately 3 vehicles (75 feet).

Afternoon Dismissal Observations for Elizabeth Lane Elementary School (2:00 – 3:00 PM):



**Elizabeth Lane facing south  
at Lot B's Access**



**Elizabeth Lane facing north  
at Lot B's Access**

- Northbound left and right turn movements Elizabeth Lane at Pineville-Matthews Road (NC 51):
  - The maximum queue witnessed during the afternoon dismissal period was 55 vehicles (1,400 feet) and occurred on one occasion. The average northbound queue for this period was approximately 29 vehicles (725 feet).
  - The combined through-right lane did not typically experience a queue as the vehicles queueing in the northbound left turn lane spilled into the through-right lane and did not allow passage for vehicles to make these movements.
- Southbound left turn movements on Elizabeth Lane at Lot A's access
  - The maximum queue witnessed during the afternoon dismissal period was 4 buses (150 feet – only buses entering the bus lot) and occurred on multiple occasions. The average southbound queue for this period was approximately 2 buses (75 feet).
- Southbound left turn movements on Elizabeth Lane at Lot B's access
  - The maximum queue witnessed during the afternoon dismissal period was 6 vehicles (150 feet) and occurred on a couple of occasions. The average southbound queue for this period was approximately 4 vehicles (100 feet).
- Eastbound right turn movements on Pineville-Matthews Road (NC 51) at Elizabeth Lane
  - No queue was witnessed as a direct result of the Elizabeth Lane Elementary School for the eastbound right turn movements.
- Westbound left turn movements on Pineville-Matthews Road (NC 51) at Elizabeth Lane
  - The maximum and average queue witnessed during the afternoon dismissal period was 3 vehicles (75 feet) and occurred on multiple occasions.



### **Elizabeth Lane Elementary Campus Comments/ Recommendations:**

We provide the following recommendations related to future circulation/access:

- The MSTA School Traffic Calculator, from the Traffic Engineering and Safety Systems Branch, Division of Highways, NCDOT 2017 is a useful worksheet for calculating the recommended minimum on-site stacking (queue) length for vehicles dropping-off and picking-up students during the morning arrival and afternoon dismissal times. This worksheet derives/calculates information from variables such as whether the school is a private or public school, the number of students, the number of faculty, and the number of buses. Calculations for the school buildings are as follows (a copy of the MSTA School Traffic Calculator is attached to this document).
  - Elizabeth Lane Elementary (1,088 elementary school students) the estimated number of queued vehicles at any one time during the PM peak dismissal time is approximately 72 vehicles (1,797 feet). With all vehicular access via Elizabeth Lane, there is approximately 650 feet of on-site single stacking under the currently required afternoon dismissal traffic pattern. Single stacking of vehicles is recommended due to safety concerns.
- The morning arrival period traffic management plan recently implemented at the elementary school is sufficient in our opinion, especially considering the school peak queue on Elizabeth Lane typically begins and clears in a 30-minute period (7:15 - 7:45 AM). Therefore, our only recommendation for the morning arrival period is the following:
  - An off-duty officer directing traffic at each of the lot access locations, for the minimum 30-minute period as noted above, which will help with the overall circulation and flow of vehicles entering and exiting the school.
- In order to better meet the stacking requirements set forth by the MSTA calculator in the afternoon dismissal period, which typically begins and clears in a 30-minute period (2:25 – 2:55 PM), we suggest the following (see Figure 5):
  - Implement a traffic management plan similar to the current morning arrival plan, so once the queue in Lot B reaches Elizabeth Lane parents enter Lot A (bus lot) to begin stacking as they currently do in the morning peak. Once dismissal begins, the vehicles queued in Lot A can begin moving to Lot B for student pick-up. This will allow Elizabeth Lane to operate better with less school related traffic. This change will provide 1,850 feet of on-site stacking (slightly higher than the 1,797 feet recommended by MSTA).
  - An off-duty officer directing traffic at each of the lot access locations, for the minimum 30-minute period as noted above, which will help with the overall circulation and flow of vehicles entering and exiting the school.
  - Although, the proposed afternoon traffic plan mixes bus and vehicle traffic (not typically recommended), it could be a reasonable solution if all vehicles in the queue are allowed to clear Lot A before bus loading begins (typically a 10 to 15 minute process); therefore, eliminating any conflicts between students and vehicle traffic.

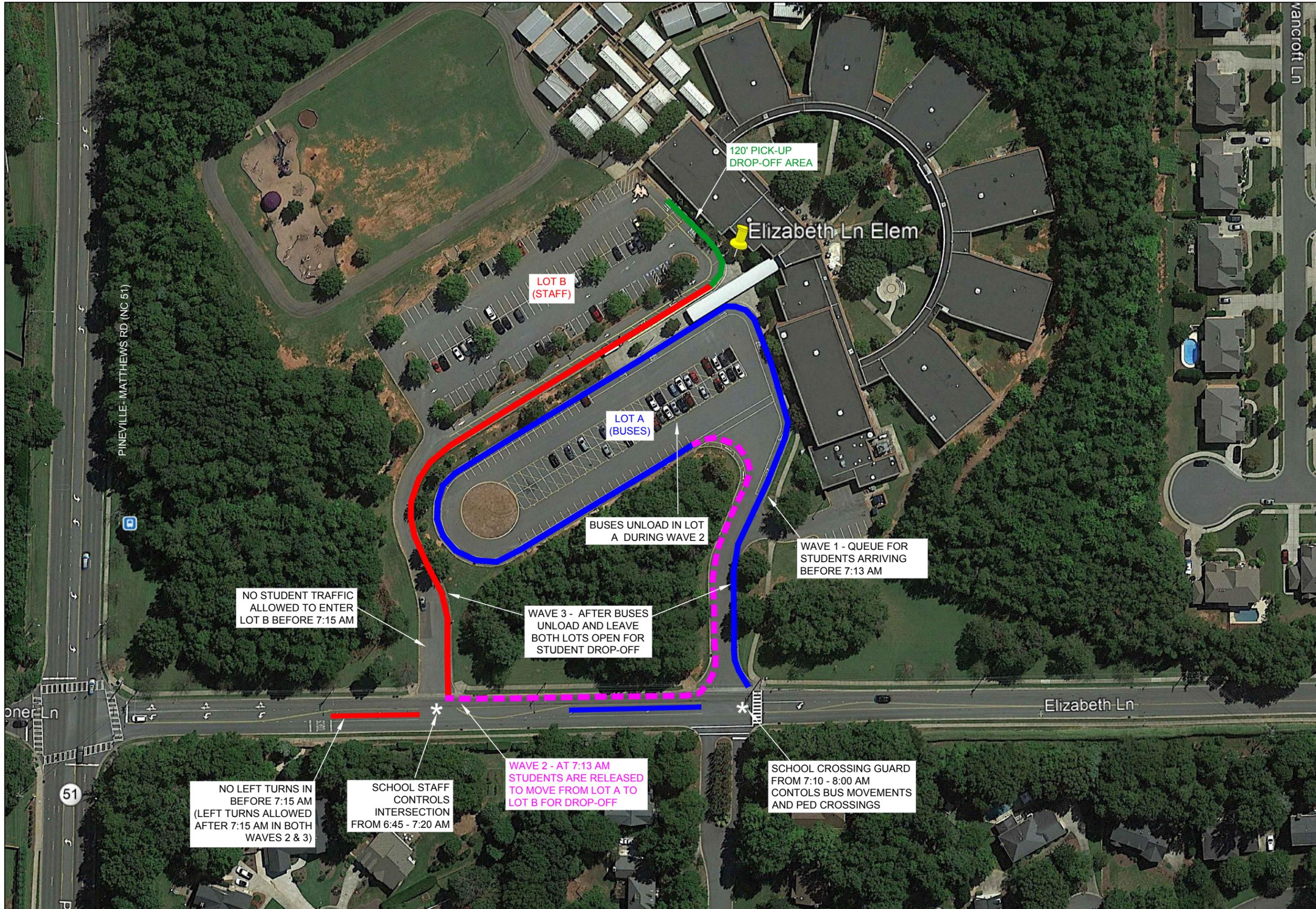


**In our professional opinion and based on our morning and afternoon school observations, the suggested changes to the morning and afternoon traffic management plans could prove beneficial and will allow for better circulation and flow in and around Elizabeth Lane Elementary School and will also provide the minimum recommended MSTA on-site stacking. Although current patterns see queueing along Elizabeth Lane and Pineville-Matthews Road (NC 51), all school related traffic typically disperses in no more than a 30-minute window which we feel could be further reduced by implementing these recommendations.**

Should you have any questions concerning our evaluation and recommendations, please call.

Attachments: Figure 1 – Existing Morning Arrival Operation Plan  
Figure 2 – Existing Afternoon Dismissal Operation Plan  
Figure 3 – Morning Arrival Period Maximum & Average Queue Lengths  
Figure 4 – Afternoon Dismissal Period Maximum & Average Queue Lengths  
Figure 5 – Suggested Afternoon Dismissal Operation Plan  
MSTA Calculator

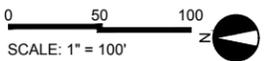
cc: Susan Habina-Woolard P.E.                      Town of Matthews  
File



**CMS - ELIZABETH LANE ELEM.  
QUEUEING STUDY TTM**

MATTHEWS, NC  
CHARLOTTE-MECKLINBURG SCHOOLS  
3301 STAFFORD DRIVE  
CHARLOTTE, NC 28208

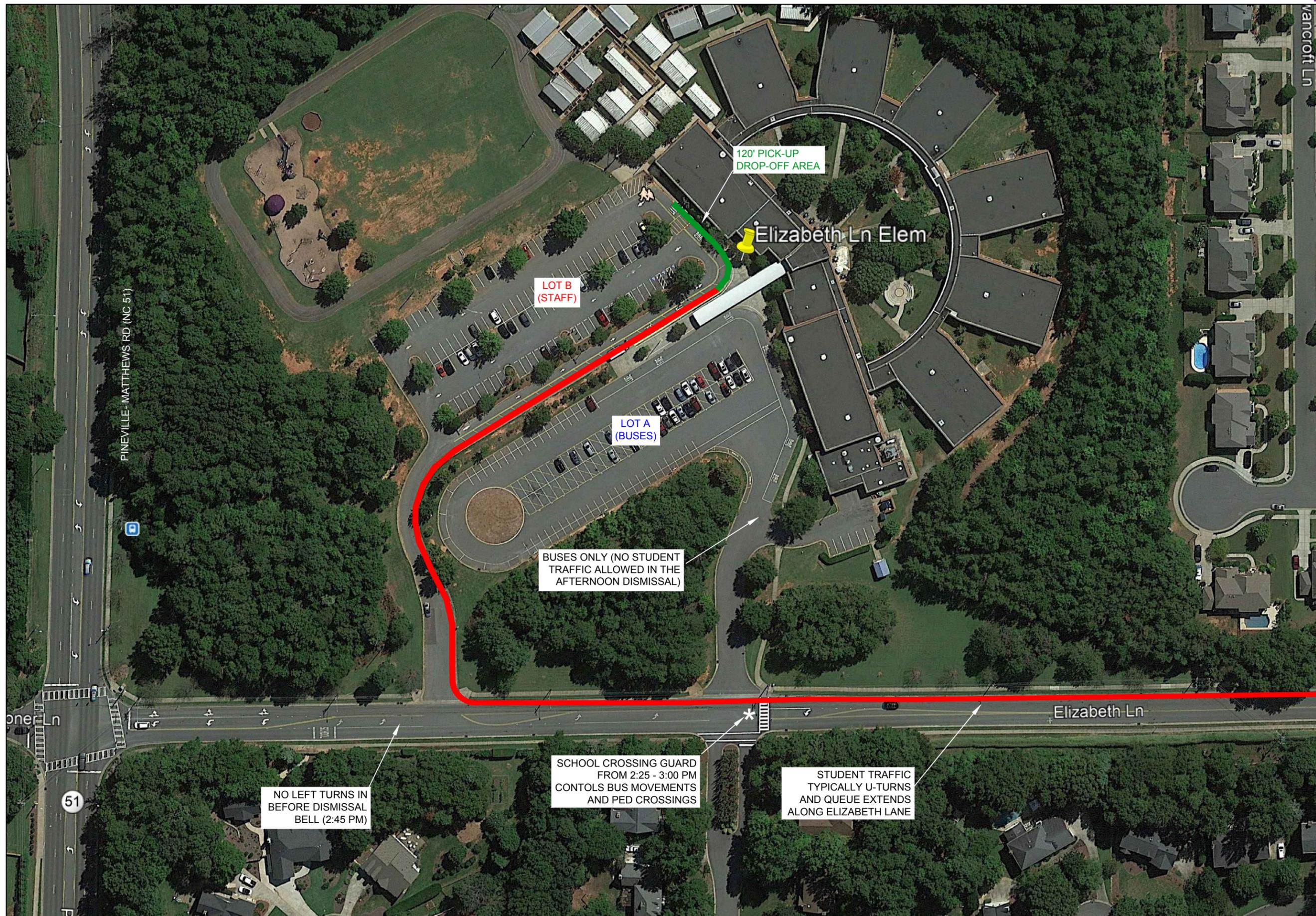
**EXISTING MORNING  
ARRIVAL  
OPERATION PLAN**



PROJECT #: 157-021  
DRAWN BY: MWW  
CHECKED BY: REG

MAY 2018  
REVISIONS:

**Figure 1**



120' PICK-UP  
DROP-OFF AREA

Elizabeth Ln Elem

LOT B  
(STAFF)

LOT A  
(BUSES)

BUSES ONLY (NO STUDENT  
TRAFFIC ALLOWED IN THE  
AFTERNOON DISMISSAL)

SCHOOL CROSSING GUARD  
FROM 2:25 - 3:00 PM  
CONTROLS BUS MOVEMENTS  
AND PED CROSSINGS

STUDENT TRAFFIC  
TYPICALLY U-TURNS  
AND QUEUE EXTENDS  
ALONG ELIZABETH LANE

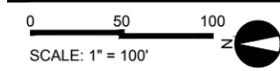
NO LEFT TURNS IN  
BEFORE DISMISSAL  
BELL (2:45 PM)

**CMS - ELIZABETH LANE ELEM.  
QUEUEING STUDY TTM**

MATTHEWS, NC

**CHARLOTTE-MECKLINBURG SCHOOLS**  
3301 STAFFORD DRIVE  
CHARLOTTE, NC 28208

**EXISTING  
AFTERNOON  
DISMISSAL  
OPERATION PLAN**

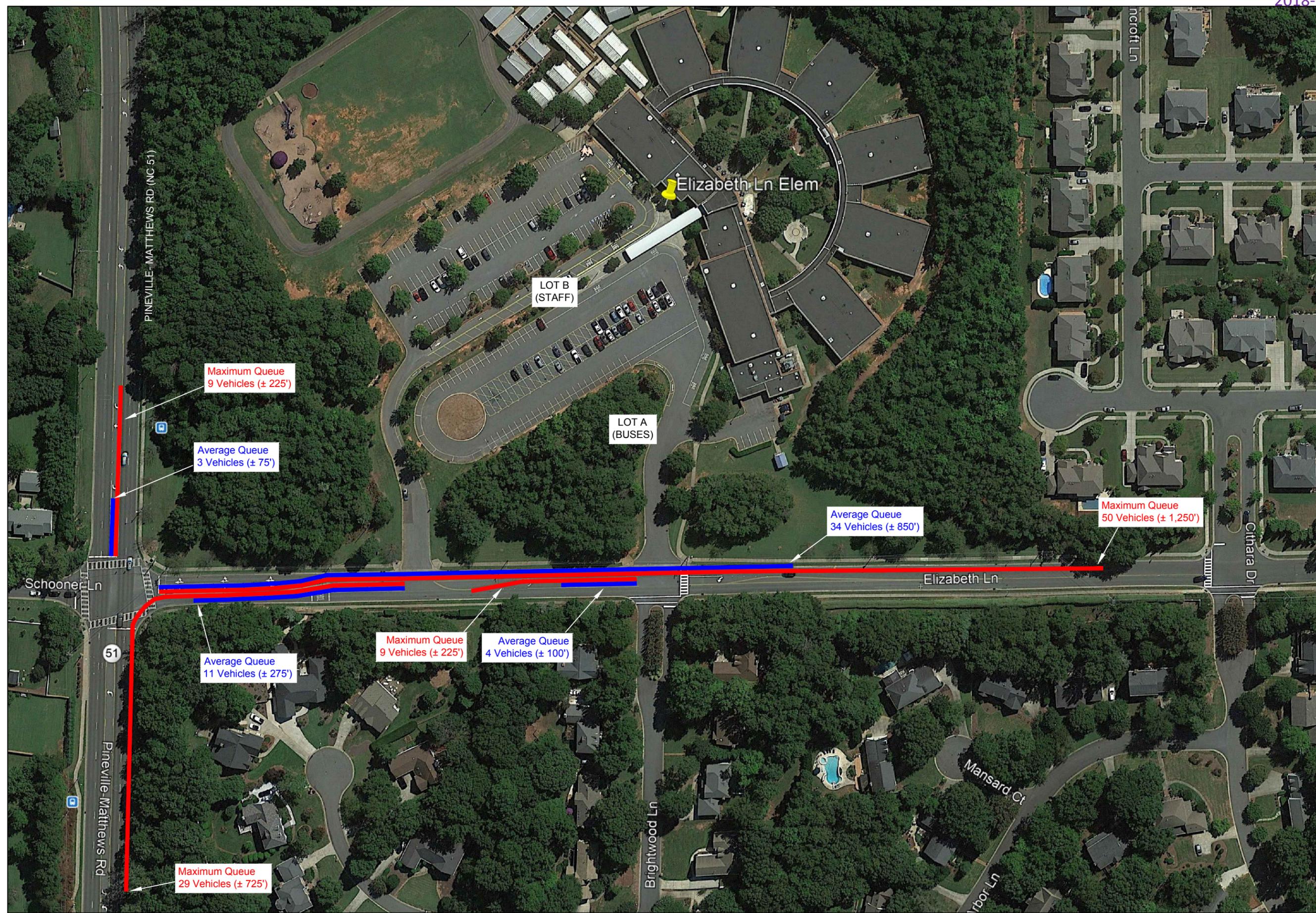


PROJECT #: 157-021  
DRAWN BY: MWW  
CHECKED BY: REG

MAY 2018

REVISIONS:

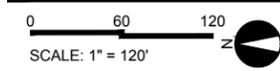
Figure 2



CMS - ELIZABETH LANE ELEM.  
QUEUEING STUDY TTM

MATTHEWS, NC  
CHARLOTTE-MECKLINBURG SCHOOLS  
3301 STAFFORD DRIVE  
CHARLOTTE, NC 28208

MORNING ARRIVAL  
PERIOD MAX &  
AVERAGE QUEUE  
LENGTHS

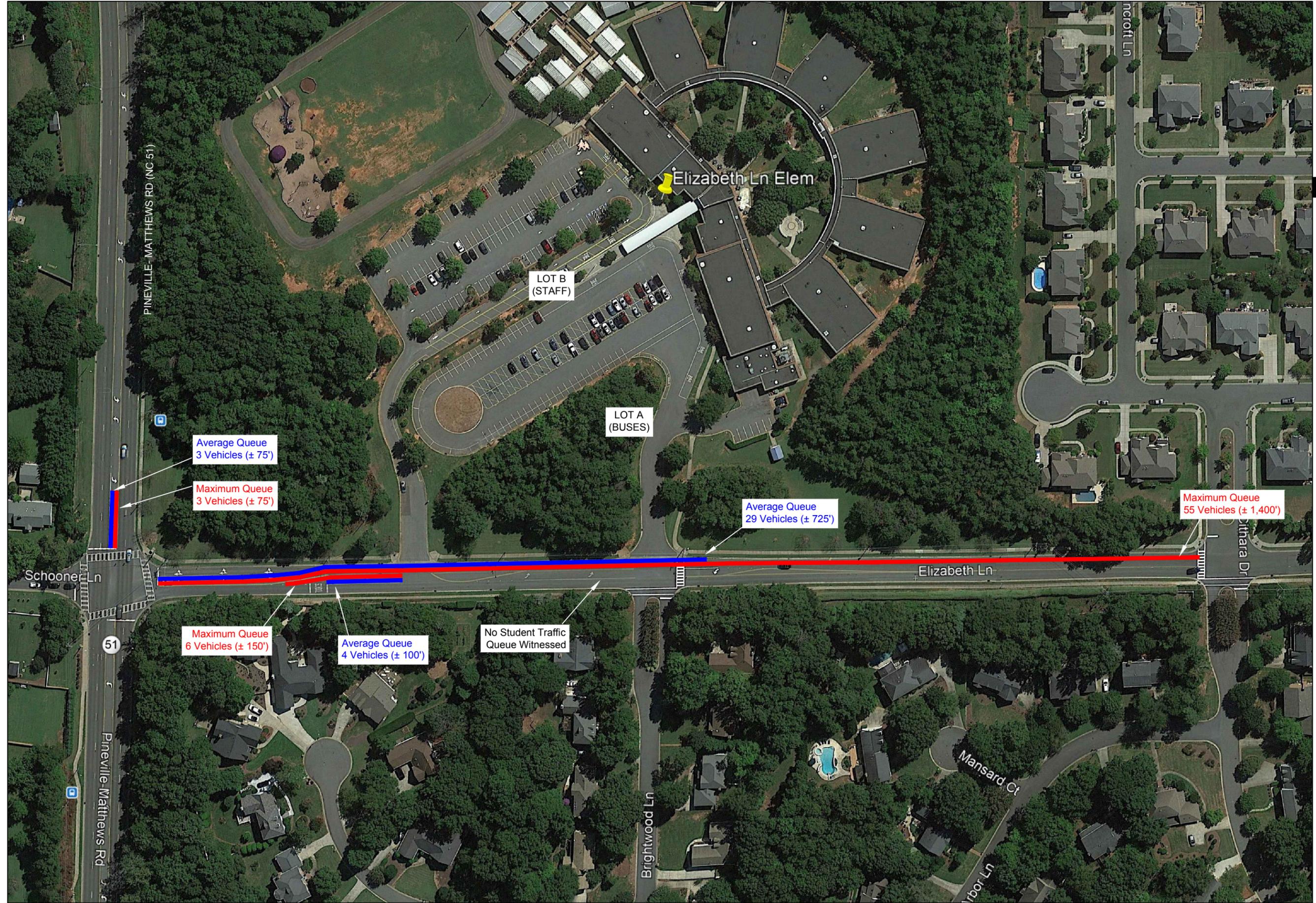


PROJECT #: 157-021  
DRAWN BY: MWW  
CHECKED BY: REG

MAY 2018

REVISIONS:

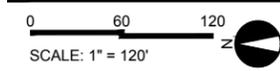
Figure 3



CMS - ELIZABETH LANE ELEM.  
QUEUEING STUDY TTM

MATTHEWS, NC  
CHARLOTTE-MECKLINBURG SCHOOLS  
3301 STAFFORD DRIVE  
CHARLOTTE, NC 28208

AFTERNOON  
DISMISSAL PERIOD  
MAX & AVERAGE  
QUEUE LENGTHS



PROJECT #: 157-021  
DRAWN BY: MWW  
CHECKED BY: REG

MAY 2018

REVISIONS:

Figure 4

**LOT A = ±1,210' OF STACKING LENGTH**  
**LOT B = ± 640' OF STACKING LENGTH**  
**TOTAL = ±1,850' OF STACKING LENGTH**



QUEUE BEGINS WITH FIRST ARRIVING PARENTS

120' PICK-UP DROP-OFF AREA

Elizabeth Ln Elem

LOT B (STAFF)

DISMISSAL FOR STUDENTS RIDING BUSES SHIFTED UNTIL AFTER LOT A HAS CLEARED ALL VEHICLE TRAFFIC ~2:55 PM

LOT A (BUSES)

±640' OF STACKING LENGTH

BEGINNING OF QUEUE IN LOT A SIMILAR TO AM OPERATION PLAN

ONCE QUEUE REACHES ELIZABETH LANE STACKING BEGINS IN LOT A

±1,210' OF STACKING LENGTH

OFF-DUTY OFFICER CONTROLS INTERSECTION FROM 2:25 - 2:55 PM

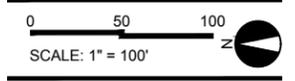
QUEUE RELEASED ONCE DISMISSAL OF STUDENT BEGINS

OFF-DUTY OFFICER CONTROLS INTERSECTION FROM 2:25 - 3:55 PM

**CMS - ELIZABETH LANE ELEM. QUEUING STUDY TTM**

MATTHEWS, NC  
CHARLOTTE-MECKLINBURG SCHOOLS  
3301 STAFFORD DRIVE  
CHARLOTTE, NC 28208

**SUGGESTED AFTERNOON DISMISSAL OPERATION PLAN**



PROJECT #: 157-021  
DRAWN BY: MWW  
CHECKED BY: REG

MAY 2018  
REVISIONS:

Figure 5

## MSTA School Traffic Calculations

AM and PM Peak Traffic Estimates  
(These numbers do not reflect peak hour traffic volumes)

School Name: Elizabeth Ln. Elementary

Type: **Typical Public with buses**

Version: 102816

AM Cars / Student	PM Cars / Student	Avg. Car Length	PM At one Time
36.56%	16.31%	22.19	45.50%
34.58%	14.10%	22.70	51.90%
9.20%	4.30%	24.42	55.71%

MSTA School Queue Input					Calculations					
Type School	Student Population	Number of Buses	Staff Members	Student Drivers	PM Total Vehicles	PM Peak Vehicles	Average Queue Length	Total AM Trips	Total PM Trips	High Demand Length
Elementary	1088	13	53		178	81	1797	875	382	1797
Middle		15	128							
High										
							1797	875	382	1797

### Elementary School Data

AM Trips Generated					PM Trips Generated				
Direction	Parents	Buses	Staff	Trips	Parents	Buses	Staff	Trips	
IN	398	13	53	464	178	13		191	
OUT	398	13		411	178	13		191	
				AM Elementary Trips	875				
					PM Elementary Trips				382

AM Trips Generated					PM Trips Generated			
Direction	Parents	Buses	Staff	Trips	Parents	Buses	Staff	Trips
IN								
OUT								
				AM Middle Trips	PM Middle Trips			

AM Trips Generated					PM Trips Generated				
Direction	Parents	Buses	Staff	Trips	Parents	Buses	Staff	Trips	
IN									
OUT									
				AM High Trips	PM High Trips				
				All AM TRIPS	All PM TRIPS				
				In	In				
				Out	Out				
				Total	Total				
				464	191				
				411	191				
				875	382				

ADT
1310
1310

**NOTES**

- Average Queue Length does not include an alternative traffic pattern required for high traffic demand days which is usually 30% additional length.
- Average Queue Length does not include the Student Loading Zone.
- Peak traffic volumes at schools normally occur within a 30-minute time period. (justifying a PHF of 0.5)