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February 26, 2020

Ms. Brianna Medema
Aurora Public Works/Traffic Division
15151 East Alameda Parkway
Aurora, CO 80012

Dear Brianna:

This letter provides information related to the proposed USAA ATM kiosk located at 512 South Chambers Road in Aurora. The site location and site plan are provided in Appendix A. It is proposed in the west parking lot of the Aurora City Center Marketplace. Specifically, this letter addresses the trip generation, queuing analysis, and turning template analysis. The scope was discussed with Aurora Traffic Division staff on February 11, 2020.

As shown on the site plan, this ATM is a single sided kiosk with vehicles approaching (driver side) in the southbound direction. It is proposed in an area that currently has 12-90 degree parking spaces. According to the site plan, the queue distance is approximately 70 feet, which provides for a queue of three vehicles [~22 feet per vehicle (front bumper to front bumper)]. This includes the vehicle that is at the ATM.

TRIP GENERATION

Trip generation information was requested from the client (Security Vault Works, Inc.). That information was provided for the busiest days: 50-75 visits per day, morning peak hour average of 10 visits, and afternoon peak hour average of 15 visits. Each visit involves two trip ends (1 inbound/ 1 outbound). This trip generation results in: 150 daily trip ends, 20 morning peak hour trip ends, and 30 afternoon peak hour trip ends. The trip generation was also calculated utilizing Trip Generation, 10th Edition, ITE as a reference [Drive-in Bank, Code 912]. The number of drive-through lanes was selected as the trip generation variable. It is noted that ATM lanes are not specifically distinguished in this reference document. An ATM lane is likely to be less busy than a conventional teller-served drive-through lane. Also, the data contained in the cited reference often covers a period of 20 or more years. With the growing use of on-line banking, it is likely that the information (trip generation rates) contained in the cited reference is high. That said no adjustments were made in calculating the trip generation. Table 1 shows the calculated daily and peak hour trip generation for a single drive-through lane. The calculated trip generation is: 124 daily trip ends, 18 morning peak hour trip ends, and 27 afternoon peak hour trip ends. In all cases the client provided information was higher than the calculated trip generation from the cited reference. Therefore, use of the client provided information was deemed to be appropriate.

TABLE 1 Trip Generation								
Code	Use	Size	AWDTE		AM Peak Hour		PM Peak Hour	
			Rate	Trip Ends	Rate	Trip Ends	Rate	Trip Ends
912	Drive-in Bank	1 Drive-in lane	124.75	124	17.55	18	27.15	27

QUEUE ANALYSIS

Since the parking lot circulation aisle is also a fire lane, it is essential that the queue not block this aisle. To verify this, it must be demonstrated that the queued vehicles will not spill into the parking lot circulation aisle.

The queuing analysis utilized the highest trip generation which occurred in the afternoon. The one hour volume of 15 visits (30 trip ends) was used. In an email, it was stated that for banks, the drive-through queue as eight vehicles [based upon an ITE paper ***Drive-Through Queue Generation***, Mike Spack]. The information did not distinguish between ATM and teller lanes, but acknowledged that it could be different. The information in this paper was based upon observations. Since an eight vehicle queue is not possible at the subject site, the following presents an analysis that the available three vehicle queue at the subject site will meet/exceed the demand. It also determines the length of the expected queue. The following queue analysis utilized procedures contained in Chapter 8 -- Drive-In Facilities contained in **Transportation and Land Development**, Vergil G. Stover/Frank J. Koepke, ITE, This book and the procedures were part of a continuing education course at Northwestern University. The procedure for the queuing analysis is based upon the demand (trip generation) and length of the service duration (transaction time). The queue analysis (number of stored vehicles) utilized the equations contained in Appendix B.

As stated earlier, the available queue length is three vehicles. The peak hour (afternoon) volume is 15 visits. According to information provided by the client, the average transaction is 65 seconds (1.08 minutes). In the case of this ATM, there is one drive-through lane. Appendix B contains a calculation sheet of the various elements pertaining to the queue for the proposed USAA ATM. A one (1) percent probability of back-up into the aisle (fire lane) is judged to be acceptable. At this probability, the queue (storage) is 1.5 vehicles (say 2 vehicles). It is concluded that the ATM queue will not exceed the available storage length. This is not surprising given the frequency of visits (15/hour) and the average duration of the transaction (65 seconds).

TURNING TEMPLATE ANALYSIS

The parking lot drive aisle is approximately 25 feet wide. This provides two-way circulation in the drive aisle. This is the standard for 90-degree parking lots. In the previously referenced email, Aurora staff requested a turning template analysis to determine whether a vehicle travelling northbound could execute a turn into the vehicle queue in a single movement (no backing). The design vehicle is a passenger car.

The detailed analysis was conducted by the project civil engineer. The turning template analysis is provided in Appendix C. It demonstrates that a northbound vehicle could not enter the vehicle queue in a single maneuver. Conversely, a vehicle exiting the ATM could not execute a turn to the northbound direction. Therefore, it is concluded that vehicles entering the ATM queue will approach in the southbound direction and vehicles exiting the ATM will proceed the southbound direction. Appropriate signage (NO LEFT TURN) should be place in the 'striped out' area just to the north of the ATM queue area.

This letter provides trip generation information with regard to the proposed USAA ATM at the Aurora City Center Marketplace. It also documents the vehicle queue and turning template analyses. Do not hesitate to contact me if there are questions or if additional information is required.

Sincerely,



Matthew J. Delich, P.E., PTOE

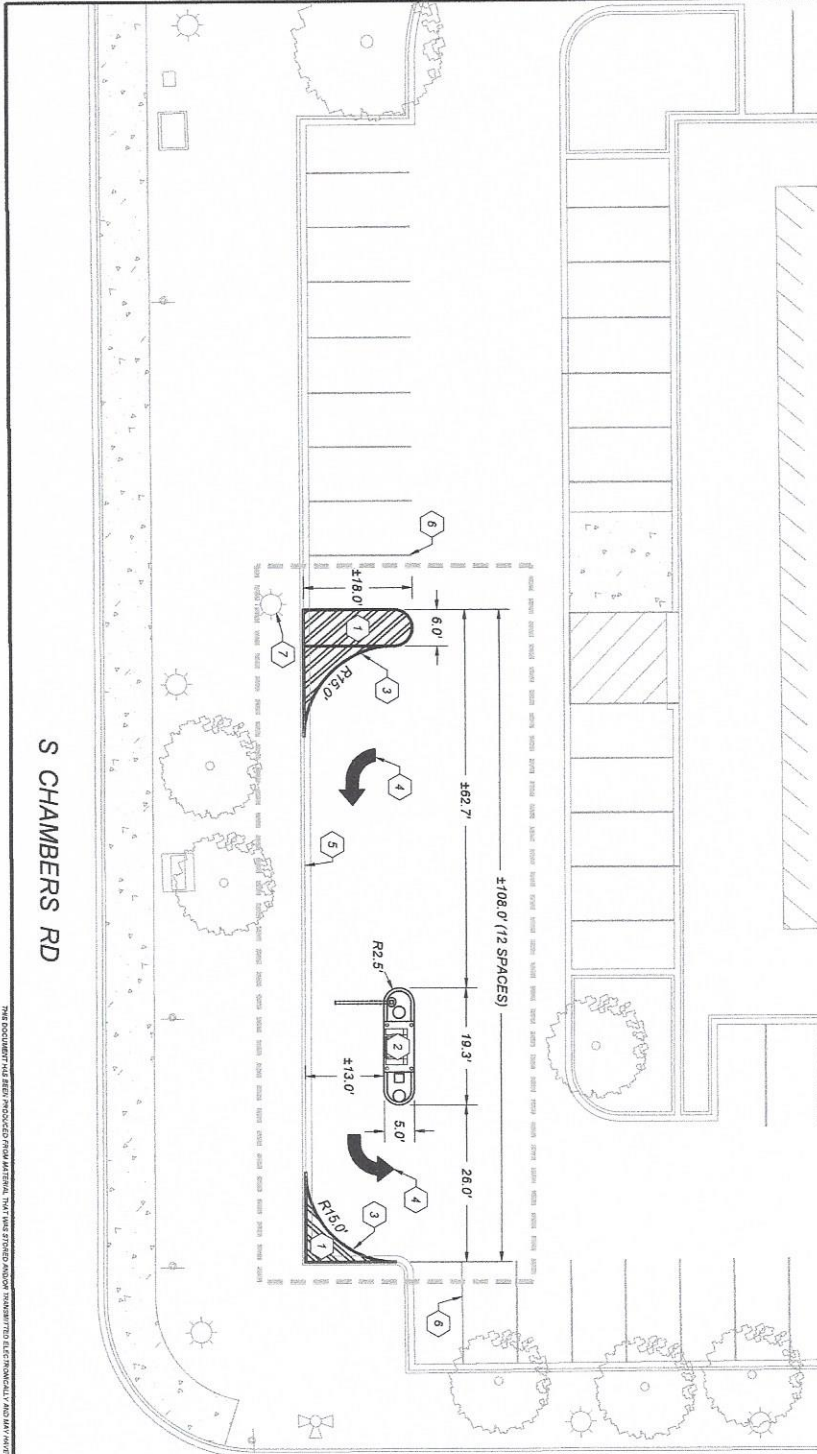
File: 2013LT01



APPENDIX A



- GENERAL NOTES:**
1. ALL CURBS SHALL BE 6" UNLESS OTHERWISE NOTED (REF. CIVIL DETAIL).
 2. ALL DIMENSIONS MUST BE VERIFIED ON THE JOB AND THE ENGINEER MUST BE NOTIFIED OF ANY DISCREPANCIES BEFORE PROCEEDING WITH THE WORK.
 3. THE CONTRACTOR SHALL IMMEDIATELY NOTIFY THE ENGINEER ANY QUESTIONS THAT MAY ARISE CONCERNING THE INTENT, PLACEMENT, OR LIMITS OF CONSTRUCTION NECESSARY FOR CONSTRUCTION OF THIS PROJECT.
 4. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ESTABLISHING ALL UTILITY LOCATIONS PER THE CONSTRUCTION DRAWINGS (E.G. NO CONSTRUCTION STRIKING WILL BE PROVIDED WITH THIS CONTRACT).
 5. NECESSARY PERMITS BEFORE BEGINNING WORK SHALL BE OBTAINED BY THE CONTRACTOR. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ACQUIRING ALL NECESSARY PERMITS.
 6. ALL EXISTING AND PROPOSED DIMENSIONS SHOWN ARE FROM FACE OF CURB TO FACE OF CURB.
 7. REFERENCE STRUCTURAL AND ELECTRICAL PLANS FOR ADDITIONAL DIMENSION CONTROL.
 8. THE CONTRACTOR SHALL BE RESPONSIBLE FOR RESTORING TO ITS ORIGINAL OR BETTER CONDITION ANY DAMAGE DONE TO EXISTING UTILITIES, FENCES, PAVEMENT, CURBS, DRIVEWAYS, OR SIDEWALKS INTENDED TO REMAIN SAUCUT AT EDGES OF ASPHALT CALLED TO BE REMOVED. NO AGED OR IRREGULAR CUTS WILL BE ACCEPTED.
 9. REFER TO PROJECT SPECIFICATIONS FOR ADDITIONAL SPECIFICATIONS AND CONTRACT INFORMATION.
 10. TO BE GRANDED TO ASSURE DAMAGE TO EXISTING PAVEMENT AND ADJACENT EXISTING PARKING LOT CONCRETE PAVEMENT WITHIN ISLAND SHALL MATCH TOP OF EXISTING CURB AND AVOID ANY FLOODING ON ISLAND.
 11. AVOID ANY FLOODING ON ISLAND.
 12. ATM FOUNDATION TO BE LEVEL TO ALLOW PROPER ATM INSTALLATION.



S CHAMBERS RD

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LEGEND

- EXISTING PAVEMENT
- EXISTING CONCRETE CURB
- EXISTING GUTTER
- PROPOSED STRIPING
- APPROXIMATE LIMITS OF CONSTRUCTION
- EXISTING TREE

KEYED NOTES:

1. PROPOSED PAVEMENT STRIPING
2. (REF. SHEET C10 FOR DETAILS)
3. PROPOSED 4" WHITE PAVEMENT STRIPE
4. (REF. SHEET C10 FOR DETAILS)
5. EXISTING STRIPING
6. EXISTING LIGHT POLE

0 10' 20' 30'

1" = 20'

Issue #	Date	Description
1		

SITE PLAN

PERMIT SET
 JOB NO. 288-13-12
 DATE: AUGUST 2019

C08

USAA

AURORA CITY CENTER MARKETPLACE
 AURORA, COLORADO 80017

APPENDIX B

TABLE 8-10
Queueing System Equations

Equation Number	Variable	Equation
(8-1)	Coefficient of utilization	$\rho = \frac{q}{NQ}$
(8-2)	Probability of no customers in the system	$P(0) = \left[\sum_{n=0}^{N-1} \frac{\left(\frac{q}{Q}\right)^n}{n!} + \frac{\left(\frac{q}{Q}\right)^N}{N!(1-\rho)} \right]^{-1}$
(8-3)	Mean number in the queue	$E(m) = \left[\frac{\rho \left(\frac{q}{Q}\right)^N}{N!(1-\rho)^2} \right] P(0)$
(8-4)	Mean number in the system	$E(n) = E(m) + \frac{q}{Q}$
(8-5)	Mean wait time in queue (hours)	$E(w) = \frac{E(m)}{q}$
(8-6)	Mean time in the system (hours)	$E(t) = E(w) + \frac{1}{Q}$ $= E(w) + \text{Avg } (t)$
(8-7)	Proportion of customers who wait	$P[E(w) > 0] = \left[\frac{\left(\frac{q}{Q}\right)^N}{N!(1-\rho)} \right] P(0)$
(8-8)	Probability of a queue exceeding a length M	$P(x > M) = (\rho^{N+1})P[E(w) > 0]$
(8-9a)	Queue storage required	$M = \left[\frac{\ln P(x > M) - \ln E(w) > 0}{\ln \rho} \right] - 1$
(8-9b)*	Queue storage required	$M = \left[\frac{\ln P(x > M) - \ln Q_M}{\ln \rho} \right] - 1$

n = number of customers in the drive-in system

M = number of customers in the queue waiting to be served (number of customers in the system minus the number being served)

$P(n)$ = steady-state probability that exactly n customers are in the queueing system

$P(0)$ = probability that zero vehicles are in the queueing system

N = number of parallel service positions

q = mean average arrival rate of vehicles into the system (vehicles/hour)

Q = mean average service rate per service position (vehicles/hour/position)

$\text{Avg } (t) = \frac{60}{Q} =$ mean service time expressed in minutes per vehicle

$\rho = \frac{q}{NQ} =$ coefficient of utilization

$E(m)$ = expected (average) number of customers in the system

$E(n)$ = expected (average) number of customers waiting in the queue

$E(t)$ = expected (average) waiting time in system (includes service time)

$E(w)$ = expected (average) waiting time in queue (excludes service time)

TRANSPORTATION AND LAND DEVELOPMENT. V. STOVER

F. KOEPKE, ITE

QUEUE ANALYSIS

n - NUMBER OF TRANSACTIONS - 15

q - ARRIVAL RATE (VEHICLES/HOUR) - 15

N - NUMBER OF SERVICE POSITIONS (LANES) - 1

t - SERVICE TIME - 65 SECONDS - 1.08 MINUTES

Q - SERVICE RATE (VEHICLES/HOUR/POSITION) - $\frac{60 \text{ MIN}}{1.08} = 55.6$

$$\rho = \frac{q}{NQ} = \frac{15}{(1)55.6} = 0.2698$$

$$P(0) = 0.7302$$

$n=0$

$$E(m) = 0.0997$$

$$\bar{E}(n) = 0.0269$$

$$E(w) = 0.0066 \text{ HOURS} = 0.3988 \text{ MINUTES}$$

WAIT

$$E(t) = 0.0246 \text{ HOURS} = 1.476 \text{ MINUTES}$$

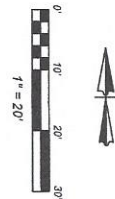
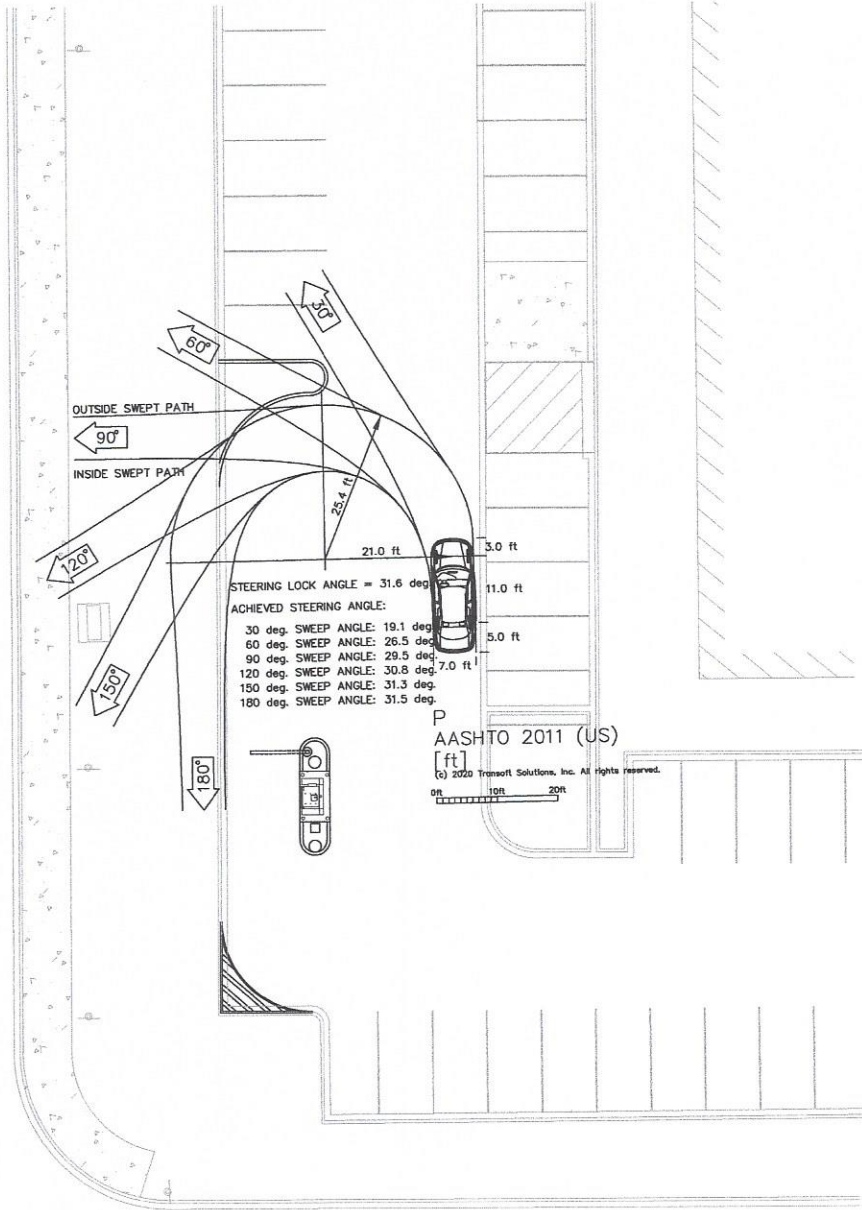
DOES THE QUEUE HAVE SUFFICIENT STORAGE FOR ALL VEHICLES ARRIVING 99% OF THE TIME

$$M = \left[\frac{\ln 0.01 - \ln Q_M}{\ln e} \right] - 1 = \left[\frac{(-4.6052) - (-1.3101)}{-1.3101} \right] - 1 = 2.52 - 1$$

$= 1.5$
SAY 2

APPENDIX C

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PERMIT SET
 JOB NO. 288-13-12
 DATE: AUGUST 2018
 ATT-4

CAR TURNING
 TEMPLATE

Issue #	Date	Description
1		

USAA ATM
 AURORA CITY CENTER
 515 CHAMBERS RD
 AURORA, COLORADO 80017

