Introduction:

This report summarizes queuing analyses results for Metro Blue Line station entrances and also identify the number of fare gates required at each station entrance specified below:

- **Pico North Entrance**
- **Pico South Entrance**
- **Grand East Entrance**
- **Grand West Entrance**
- **Florence North Entrance**
- **103rd Street/ Watts Towers West Entrance**
- **Rosa Parks Willowbrook/ Imperial North**
- **Rosa Parks Willowbrook/ Imperial Mezzanine**
- **Willow South Entrance**

Key Source of Input Data and List of Assumptions:

1. **Projected Ridership Growth**: For Blue Line stations (Pico, Grand, Florence, 103rd street, Rosa Parks-Willowbrook, Willow), ridership demand is modeled based on ridership projections provided by LACMTA (***Blue Line - FY13 Station by hour boardings alightings.xlsx and RailActivity_May2013_Apr2014.xlsx) via email dated 10/06/14.***

   Ridership data for year 2013 and year 2014 was provided. The worst case ridership between 2013 and 2014 was considered for Queuing Analysis. Maximum passenger boarding and alighting for all stations is either between 4pm and 5pm or 5pm and 6pm during 2013 or 2014 PM peak period. Total maximum boarding and alighting for each station is considered for worst case scenario. **Tables 1 and 2** show the worst case peak period ridership data for 2013 and 2014. Based on the worst case peak hour ridership, all stations recorded the worst case ridership during 2013 except Pico. The worst case ridership for Pico is between 5pm and 6pm for 2014. **Table 3** includes the worst case ridership selected from year 2013 or year 2014 ridership data.

2013 - Peak Hour Ridership				
Station Name	Duration	Boarding	Alighting	2013 Max Total
PICO	5pm to 6pm	380	339	719
GRAND	4pm to 5pm	465	359	824
GRAND	5pm to 6pm	419	382	802
FLORENCE	5pm to 6pm	363	601	964
103RD/ WATTS	4pm to 5pm	324	393	717
103RD/ WATTS	5pm to 6pm	290	379	669
ROSA PARK - WILLOWBOORK IMPERIAL WILMINGTON	5pm to 6pm	1,041	1,151	2,192
WILLOW	5pm to 6pm	505	550	1,055
WILLOW	4pm to 5pm	654	453	1,107

Table 1: 2013 Peak Hour Ridership

2014 - Peak Hour Ridership				
Station Name	Duration	Boarding	Alighting	2014 Max Total
PICO	5pm to 6pm	397	359	756
GRAND	5pm to 6pm	400	357	757
FLORENCE	5pm to 6pm	361	517	877
103RD/ WATTS	5pm to 6pm	307	400	707
ROSA PARK - WILLOWBOORK IMPERIAL WILMINGTON	5pm to 6pm	966	1,025	1,991
WILLOW	5pm to 6pm	347	474	821
WILLOW	6pm to 7pm	371	600	972

Table 2: 2014 Peak Hour Ridership

Based on LACMTA's service planning department observations and input, ridership assumptions for Pico and Rosa parks is as follows: The worst case peak hour ridership for Pico station is 756 passengers including boarding and alighting. 80% of 756 peak hour passengers (605 passengers) are assumed to pass through the fare gates at each North and South entrance of Pico station. The worst case peak hour ridership for Rosa Parks - Willowbrook station is 2192. 28% of 2192 passengers (614 passengers) are assumed to utilize North Entrance fare gates. 72% of 2192 passengers (1578 passengers) are assumed to utilize Mezzanine level fare gates.

Worst Case Peak Hour Ridership (Per Metro's 2013 or 2014 Ridership Data)					
Station Name	**Duration**	**Boarding**	**Alighting**	**Max Total (Boarding + Alighting)**	**Per Metro Service Planning Input for two stations involving transfer between Green/Blue at Rosa Parks and Expo/Blue at Pico**
PICO - 2014	5pm to 6pm	397	359	**756**	**80% of 756 = 605 passengers**
GRAND - 2013	4pm to 5pm	465	359	824	-
FLORENCE - 2013	5pm to 6pm	363	601	964	-
103RD/ WATTS - 2013	4pm to 5pm	324	393	717	-
ROSA PARK - WILLOWBOORK IMPERIAL WILMINGTON - 2013	5pm to 6pm	1,041	1,151	**2,192**	**North Entrance - 28% of 2192 = 614 passengers** **Mezzanine Level - 72% of 2192 = 1578 passengers**
WILLOW - 2013	4pm to 5pm	654	453	1,107	None

Table 3: The Worst Case Peak Hour Ridership

As directed by LACMTA's email dated 10/06/14 **(see appendix for reference)**, 78.46% ridership growth was applied to calculate 2024 ridership projections. A demand model was created based on year 2024 ridership projections to estimate the amount of passengers each station must service during a peak surge that lasts one or two minutes long. However as per 01/26/15 conference call discussion **(see appendix for reference)** with LACMTA Operations Planning and Service Planning department, LACMTA's service planning had noted that 78.46% growth included Regional Connector ridership with Blue and Gold Line ridership data. LACMTA service planning requested CH2MHILL team to assume ridership growth at station level instead of line level as shown in **Table 4**. LACMTA service planning provided following growth percentage for each station:

Metro Service Planning Data based on Systems Analysis	
Station Name	**Growth Percentage - for Projected 2024 Ridership**
Pico	150%
Grand	-35%
Florence	27%
103rd Street	25%
Rosa Parks/ Willow Brook	17%
Willow	15%

Table 4: Growth Percentage for Projected 2024 Ridership

Per 01/26/2015 conference call discussion with LACMTA Operations and Service Planning department, LACMTA requested CH2MHILL to apply the worst case ridership growth of 27% to the worst case peak hour ridership (between year 2013 and year 2024) for Queuing Analysis of all stations except Pico. Initial Queuing Analysis for Pico station considered 78.46% growth percentage. However, as indicated in **Table 4** including growth rate of Pico station is 150%. Initial Queuing Analysis with 78.46% concluded that planned number of fare gates are not sufficient for Pico station. Therefore, LACMTA requested CH2MHILL team that Queuing Analysis with 150% ridership growth at Pico is not required to be analyzed.

2. For preliminary analysis, ADA gates that only cater to elevator passenger flow will be considered negligible due to varying elevator utilization factors, service times and capacities. The peak surge flow will still be applied to the remaining regular turnstile gates to represent the worst-case situation. Where an ADA gate is planned to be installed amongst the regular turnstiles in fare gate entrances, its throughput will be considered the same as a regular turnstile for this analysis. A demand model has been created to estimate the amount of people each station must service during a peak surge that lasts one or two minutes long

3. Peak hour ridership data was available for year 2013 and 2014. As shown in **Tables 1 and 2**, maximum boarding and alighting have been considered for the analysis. For example, Pico's worst case ridership was recorded in year 2014 and worst case ridership for all the remaining stations was recorded during year 2014. Total of maximum boarding and alighting could be for different peak hour duration. For example, as shown in **Table 3**, maximum boarding and alighting for Pico, Florence and Rosa Parks is between 5pm to 6pm and maximum boarding and alighting for Grand, 103rd street and Willow is between 4pm to 5pm.

4. **Gate Utilization:** All station entrances of Pico, Grand, Florence, 103rd street, Rosa Parks-Willowbrook and Willow have been analyzed to evaluate the gate capacity for each station entrance. Based on LACMTA's input and a worst case scenario, it is assumed that 100% of passengers during 1-2 minute surge will utilize each entrance/platform at Florence, 103rd street, Rosa Parks- Willowbrook and Willow. It is assumed that 70% of passengers will utilize each station entrance at Pico and Grand during 1-2 minute surge. Three scenarios have been considered to analyze queuing associated with each station entrance.

No.	Station Name/ Entrance	Overall Platform Length (ft.)	Distance Between Platform midpoint and planned Fare Gates (ft.)	Drawing Reference Contract # CO630	Gate Utilization
1	Pico - North	264	132	A-1.1	70%
	Pico - South	264	132	A-1.1	70%
2	Grand - LATTC - East	270	135	A-2.1	70%
	Grand - LATTC - West	270	135	A-2.1	70%
3	Florence - North	270	270	A-6.1	100%
4	103rd St./ Watts Towers - West	270	135	A-7.1	100%
5	Rosa Parks/ Willowbrook - North	288	190	A-8.1	100%
	Rosa Parks/ Willowbrook - Mezzannine	288	60	A-8.1	100%
6	Willow - South	270	135	A-13.1	100%

Table 5: Gate Utilization and Location of Planned Fare Gates

- **Scenario 1:** Planned Number of Fare Gates based on station layout and infrastructure limitations (Turnstiles and ADA Fare Gates)
- **Scenario 2:** Maximum number of fare gates based on EQA (Equipment Quantity Analysis).
- **Scenario 3:** Minimum number of fare gates required to meet queuing design criteria (wait times less than 55 sec.).

5. **Headway and Trains Per Hour (TPH):** ***As per data LACMTA provided in October 2014***

- AM and PM Peak period headway: 5 minute
- Peak period TPH: 12

6. **Rosa Parks/ Willowbrook Station Improvement Project:** *Queuing Analysis for Rosa Parks/ Willowbrook was performed based on station configuration provided under infrastructure drawing (A-8.1 C0630) by Metro. Current Queuing Analysis includes two entrances for Rosa Parks, North Entrance (28% passengers utilize North Entrance) and Mezzanine entrance (72% passengers utilize Mezzanine Entrance). It is noted that Rosa Parks/ Willowbrook Station Improvement project is underway. Conceptual plans will be finalized. Project improvements include but not limited to platform extension, pedestrian crossing, and improvements to vertical circulation. Ridership distribution assumption shall be revised for the future Queuing Analysis. Based on final conceptual plans for Rosa Parks/ Willowbrook, Queuing Analysis shall be performed for Rosa Parks/ Willowbrook station layout for the revised station platform arrangements including additional entrances, modified quantity of planned fare gates and revised passenger access. Equipment Quantity Analysis shall be revised per the revised Rosa Parks/ Willowbrook station layout.*

7. **Peak Hour Surge:**

- The peak surge demand (the highest amount of arrivals at a fare gate within a one-to-two minute time period) is dependent upon the number of trains that arrive at each station during a peak hour. Based on the July 2008 data collection effort at LACMTA, it is assumed that a percentage of total hourly passengers will all arrive at once causing a peak influx to the fare gates. In a peak hour where a total of 100 passengers pass through a set of fare gates, only 10 of the 100 passengers might arrive in the first surge, representing 10% of the hourly total; while 30 passengers might arrive in the next surge, representing 30% of the hourly total. In order to plan for the peak influx during a peak hour, the highest observed percentage that arrived in a surge is used in the demand model to capture the worst-case scenario.
- The arrival surge is affected by the distance from the midpoint of the station platforms to the planned fare gate areas. The longer the distance that passengers are required to walk to exit the station, the more spread out the arrival surge becomes. The data presented in the report reflects a 1 to 2 minute arrival surge in cases when the distance from the midpoint of the platform to the planned fare gate area is less than or about equal to 200 feet, but only the 2 minute arrival surge when the distance is well over 200 feet.

- To be consistent with all the prior queuing analysis for LACMTA, queuing analysis for Blue Line assumes the same number of trains for side and center platform. Please note that in case of Blue Line stations with center platform (Pico, Grand, Florence, 103rd street, Rosa Parks – Willowbrook, and Willow), queuing analysis assumes the worst case ridership/passengers arriving during 1-minute surge using 12 TPH/ 15% instead of 24 TPH and 7.5% factor. With this worst case approach, queuing analysis results could verify if the number of fare gates which could be accommodated at Pico, Grand, Florence, 103rd street, Rosa Parks – Willowbrook, and Willow based on station plans/architectural drawings are sufficient. Also to consider the same peak percentage factor (15% instead of 7.5%) of hourly passengers for 1-minute surge for center and side platform is evaluating the worst case fare gate capacity for the stations with center platform. For example, with 100 peak hour passengers, 1-minute arrival surge would be 15 passengers with 12 TPH (15% of hourly passenger) and 7.5 ~ 8 passengers with 24 TPH (7.5% of hourly passenger). Based on headway/TPH, it is assumed that 15% of total peak hourly passengers arrive during a 1-minute surge. Table below shows peak hour surge

Line	Number of trains per peak hour	Headway (min.)	Peak percentage of total hourly passengers that arrive during a 1-minute surge
Regional Connector (LACMTA)	24	2.5	7.5%
Gold Line Foothill Extension (LACMTA)	12	5	15%
Exposition 1 Line/ **Blue Line (LACMTA)**	**12**	**5**	**15%**
Red + Purple lines (LACMTA)	12	5	15%
Gold Line (LACMTA)	8	7.5	23%
Green Line (LACMTA)	8	7.5	23%

Table 6: Peak Hour Surge

- Based on a previous system wide queuing study for PATH NY & NJ and discussions with LACMTA, a maximum queuing time of 55-seconds during surge has been considered as an acceptable service standard. A minimum number of fare gates were suggested based on keeping the 'maximum queuing time' below a 55 second service standard during the worst case scenario to achieve acceptable service standard.

- The level of service factor in the suggested 'Distance Required Behind the Gates' is provided based on the guideline by John J. Fruin Ph. D in the text *Pedestrian Planning and Design*. A Level of Service 'D' represents a pedestrian area occupancy of 3-7 square feet per person and an average inter-person spacing of 2-3 feet. Space is provided for standing

without personal contact with others, but circulation through the queuing area is severely restricted and forward movement is only possible as a group. This level of area occupancy is not recommended for long-term periods of waiting, but may be acceptable in a metro station with a maximum 55 second wait.

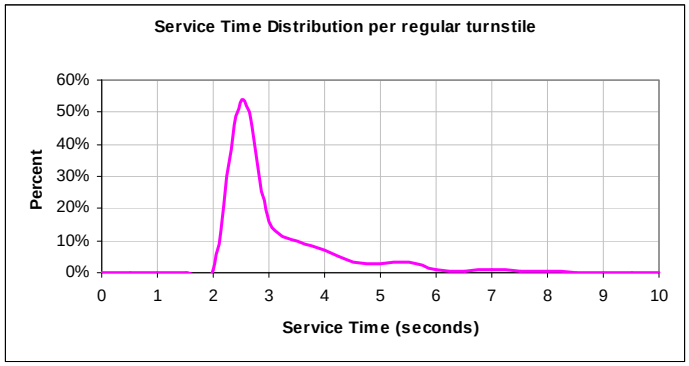
- **Surge Scenarios:** In order to capture variation in the service time of fare gates, the service time is assumed to have a chi-squared distribution ranging from 2 to 10 seconds for the worst case scenario and 1.7 to 4 seconds for the CUBIC estimated service scenario. The average service times used to predict the worst case scenario fluctuate around 3 seconds per person, while CUBIC estimates that the average service time is 2 seconds per person. Modeling with a higher service time enables the representation of a worst-case scenario during peak times and can account for the learning curve of riders using a new gating system.

Blue Line stations / Fare Gate Entrance Area (location)	Arrival Model		Delay Model			
	Surge (sec.)		Service Time		Worst Case Delay	
	Surge Scenario 1	Surge Scenario 2	Cubic Estimate (sec.)	Worst Case Estimate (sec.)	CUBIC Estimate (sec.)	Worst Case Estimate (sec.)
Pico North	60	120	2	3	1.7 to 4	2 to 10
Pico South	60	120	2	3	1.7 to 4	2 to 10
Grand East	60	120	2	3	1.7 to 4	2 to 10
Grand West	60	120	2	3	1.7 to 4	2 to 10
Florence North	60	120	2	3	1.7 to 4	2 to 10
103rd street/ Watts Towers West	60	120	2	3	1.7 to 4	2 to 10
Rosa Parks/ Willowbrook North	60	120	2	3	1.7 to 4	2 to 10
Rosa Parks/ Willowbrook Mezzanine	60	120	2	3	1.7 to 4	2 to 10
Willow South	60	120	2	3	1.7 to 4	2 to 10

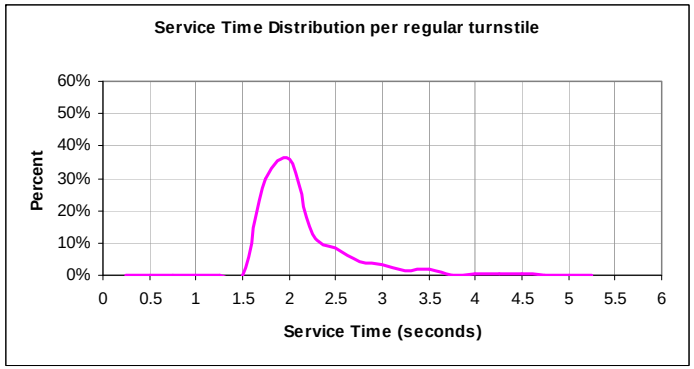
Table 7 – Surge Scenario Summary

The figures below represent the chi-squared distribution of the total amount of time it takes to get through a fare gate by the percentage of people who were serviced within that time.

Worst Case Scenario (3 second average service time)



Cubic Estimate Scenario (2 second average service time)



Results:

The following table describes the results presented in the conclusions for each station.

Field	Description
No. of Fare Gates	Number of turnstile and ADA fare gates in an array.
Surge Time (seconds)	The length of time between the first and the last person arriving at the turnstiles during a surge.
Maximum Wait (seconds)	The maximum time a person entering at the peak of the queue length would have to wait in the given scenario.
Maximum Number of Passengers in Queue	The expected maximum amount of people that will be delayed at the fare gates.
Maximum Queue Length Per Gate (feet)	The suggested queue space that would be needed behind each turnstile to accommodate people waiting in the queue, based on the maximum number of people in the queue.

CH2MHILL

LACMTA Blue Line Queuing Analysis - Assumptions and Input Data										
Station Name/ Entrance/ Year of Worst Case Ridership Data	Platform Type	Worst Case Ridership (Year 2013 or Year 2014): Peak of the Peak One Hour Passengers ON/OFF (Boardings and Alightings) as per Data provided by LACMTA	Year 2024 Ridership Projection (after applying 27% ridership growth on all stations except Pico. *78.46% ridership growth was applied for Pico*) - Peak of the Peak One Hour Passengers ON/OFF - Boardings/Alightings as per Data provided by Metro	Passengers per peak 1-2 minutes surge: 15% of peak one hour passengers during 1-minute surge 12 TPH/ 5-min headway Note 1	Gate Utilization Percentage (%)	1-minute surge based on gate utilization	Estimated Distance between Station Platform Midpoint and Planned Fare Gates (ft.) Note 4	*Scenario 1* Planned Number of Fare Gates based on Station Layout and Infrastructure Limitations (Turnstile and ADA Fare Gates) *Note 4 & 6*	*Scenario 2* Maximum number of fare gates required based on Equipment Quantity Analysis (EQA) *Note 6*	*Scenario 3* Minimum number of fare gates required to meet queuing design criteria Note 5 & 6
Pico - North - Year 2014 (80% of 756) - *Using 78.46% Riderrship Growth*	CENTER	605	1079	162	70%	113	132	2	6	4
Pico - South - Year 2014 (80% of 756) - *Using 78.46% Riderrship Growth*	CENTER	605	1079	162	70%	113	132	2	6	4
Grand - LATTC - East - Year 2013	CENTER	824	1046	157	70%	110	135	2	5	3
Grand - LATTC - West - Year 2013	CENTER	824	1046	157	70%	110	135	2	5	3
Florence - North - Year 2013	CENTER	964	1225	184	100%	184	270	2	9	5
103rd St./ Watts Towers - West - Year 2013	CENTER	717	911	137	100%	137	135	2	7	4
Rosa Parks/ Willowbrook - North - Year 2013 (28% of 2192 = 614)	CENTER	614	780	117	100%	117	190	3	6	4
Rosa Parks/ Willowbrook - Mezzannine - Year 2013 (72% of 2192 = 1578)	MEZZANINE LEVEL to CENTER	1578	2004	301	100%	301	60	5	14	8
Willow - South - Year 2013	CENTER	1107	1406	211	100%	211	135	3	10	6

Notes/ Assumptions:

Note 1: AM or PM Peak Period Headway: 5 min. headway/ 12 Trains Per Hour (TPH) as per LACMTA future operating plan.

Note 2: 78.46% of ridership growth is assumed for Pico (per LACMTA email 10/06/14). 27% ridership growth is assumed for all other stations to calculate 2024 ridership.

Note 3: Peak of the peak hour ridership is based on data provided for year 2013 and year 2014 by LACMTA (via email dated 10/06/14). Worst case peak hour ridership data (total of alightings and boardings) were used. For PICO, 2014 peak hour ridership data was used and for all other stations, 2013 ridership data was used.

Note 4: Station plan/ architectural drawings provided by LACMTA for Contract C0630.
(a) PICO Drawing No. A-1.1 (b) GRAND Drawing No. A-2.1 (c) Florence Drawing No. A-6.1
(d) 103rd St/ Watts Towers Drawing No. A-7.1 (e) Rosa Parks Willowbrook Drawing No. A-8.1 (f) Willow Drawing No. A-13.1
For Rosa Parks Mezzanine level, worst case distance between midpoint of station platform and southern part of existing fare gates (60 ft.) is considered.

Note 5: Queue Size Criteria: Bold red text indicates that station entrance has significant queues with passenger wait times greater than 55 seconds.
0 - No significant queues: wait times less than 5 sec. 1 - Slight queues: wait times between 5-30 sec.
2 - Noticeable queues: wait times between 30-55 sec. 3 - Significant queues: wait times greater than 55 sec.

Note 6: Scenario Description:
Scenario 1: Planned Number of Fare Gates based on Station Layout and Infrastructure Limitations (Turnstile and ADA Fare Gates)
Scenario 2: Max No. of fare gates required based on suggested Equipment Quantity Analysis (EQA)
Scenario 3: Min. No. of fare gates required to meet the queuing design criteria (wait times less than 55 sec.)

Note 7: Bold red text indicates that maximum queue length (linear ft.) is more than the Distance between Station Platform Midpoint and Planned Fare Gate. This condition may create overcrowding on the platform due to significant queues with long passenger wait times and significant queue length behind the gates.

Table 8: Input Data

Blue Line Project stations / Gate entrance area (location)/ The Worst Case Ridership Year	1-minute passenger surge based on gate utilization / (Percentage gate utilization for each station entrance)	Planned No. of fare gates station entrance can accommodate based on station plan and infrastructure limitations Scenario 1 Note 4	Max No. of fare gates required based on suggested EQA Scenario 2	Min. No. of fare gates required to meet the queuing design criteria (wait times less than 55 sec.) Scenario 3 Note 1 & 5	Maximum queue length - fare gates station entrance can accommodate based on station plan and infrastructure limitations (In linear ft.) Scenario 1 Note 4 & 6	Maximum queue length – fare gates required based on suggested EQA (In linear ft.) Scenario 2	Maximum queue length – minimum fare gates required to meet queuing design criteria (In linear ft.) Scenario 3 Note 1 & 5	Maximum Wait Times (Second)/Queue Size Type (see below the table)		
								Scenario No. 1 Note 5	Scenario No. 2 Note 5	Scenario No. 3 Note 5
Pico North – Year 2014	70%	2	6	4	72	6	21	111/ 3	7/ 1	29/ 1
Pico South – Year 2014	70%	2	6	4	72	6	21	111/ 3	7/ 1	29/ 1
Grand/ LATTC East – Year 2013	70%	2	5	3	68	11	35	97/ 3	18/ 1	52/ 2
Grand/ LATTC West – Year 2013	70%	2	5	3	68	11	35	97/ 3	18/ 1	52/ 2
Florence North – Year 2013	100%	2	9	5	140	8	34	234/ 3	10/ 1	54/ 2
103rd St./ Watts Towers - West - Year 2013	100%	2	7	4	97	6	31	157/ 3	9/ 1	50/ 2
Rosa Parks / Willowbrook North - Year 2013	100%	3	6	4	41	6	23	64/ 3	11/ 1	37/ 2
Rosa Parks / Willowbrook Mezzanine - Year 2013	100%	5	14	8	80	8	37	123/ 3	14/ 1	54/ 2
Willow South – Year 2013 Platform	100%	3	10	6	98	10	33	161/ 3	12/ 1	52/ 2

Note 1: Minimum number of fare gates required to meet queuing design criteria (passenger wait times greater than 55 seconds).
Note 2: AM or PM Peak Period Headway (12 TPH/ 5 min.) as directed by LACMTA.
Note 3: Peak of the peak hour ridership is based on data provided by LACMTA (RailActivity_May2013_Apr2014.xls and FY13 Station by hour boardings alightings.xlsx)
Note 4: Station plan/ architectural drawings (C0-0630) provided by LACMTA.
Note 5: Queue Size Criteria: Bold red text indicates that station entrance has significant queues with passenger wait times greater than 55 seconds.
0 - No significant queues: wait times less than 5 sec. 1 - Slight queues: wait times between 5-30 sec.
2 - Noticeable queues: wait times between 30-55 sec. 3 - Significant queues: wait times greater than 55 sec.
Note 6: Bold red text indicates that maximum queue length (linear ft.) is more than the Distance between Station Platform Midpoint and Planned Fare Gate. This condition may create overcrowding on the platform due to significant queues with long passenger wait times and significant queue length behind the gates

Table 9: Results Summary

Metro Blue Line – Pico North/ South Station Entrance	
Passengers per Peak Surge (1-2 minutes)	**113** (70% of 162 passengers for 1-minute surge utilize **Pico North/ South** station entrance fare gates)
Scenario 1 - Planned number of fare gates station entrance can accommodate based on station plan and infrastructure limitations	2
Scenario 2 - Maximum number of fare gates based on suggested Equipment Quantity Analysis (EQA)	6
Scenario 3 - Minimum number of fare gates required to meet queuing design criteria (wait times less than 55 sec.)	4

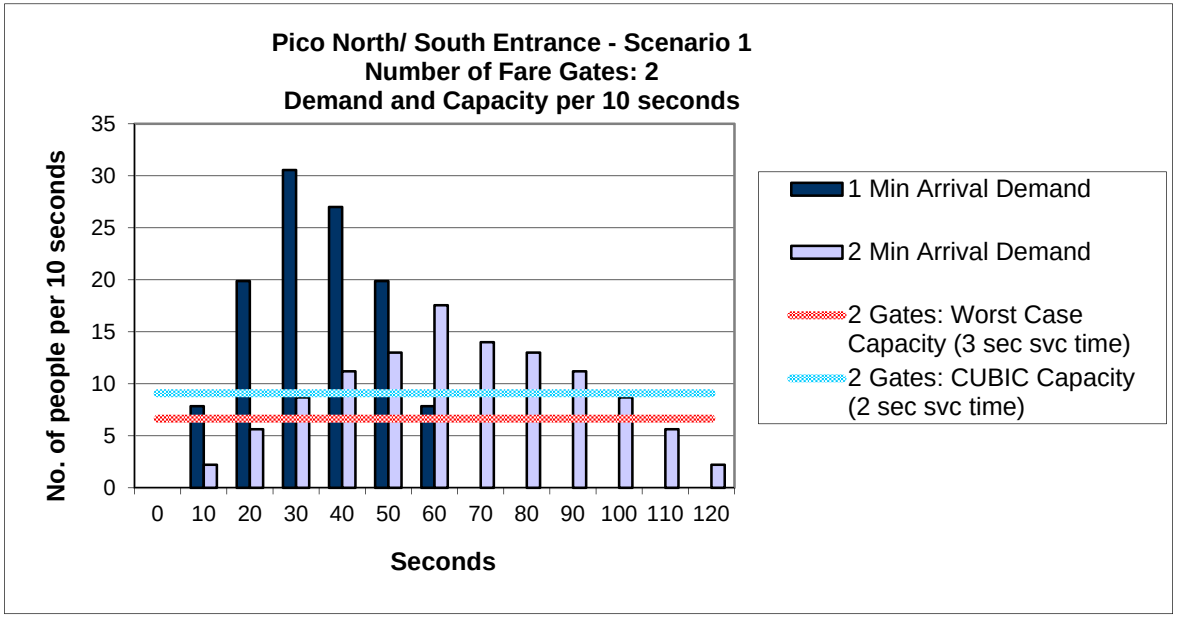
Station assumptions:
Ridership demand is modeled based on year 2024 peak hour ridership projections. A demand model has been created to estimate the amount of passengers each station must service during a peak surge that lasts one or two minutes long. Peak of the peak hour ridership for Pico includes maximum total of peak hour passenger boarding and alighting for year 2014.

Initial Queuing Analysis for Pico station considered 78.46% growth percentage. However, as indicated in **Table 4** including growth rate of Pico station is 150%. Initial Queuing Analysis with 78.46% concluded that planned number of fare gates are not sufficient for Pico station. Therefore, LACMTA requested that Queuing Analysis with 150% ridership growth at Pico is not required as 150% ridership growth is much worse than 78.46%, previously assumed.

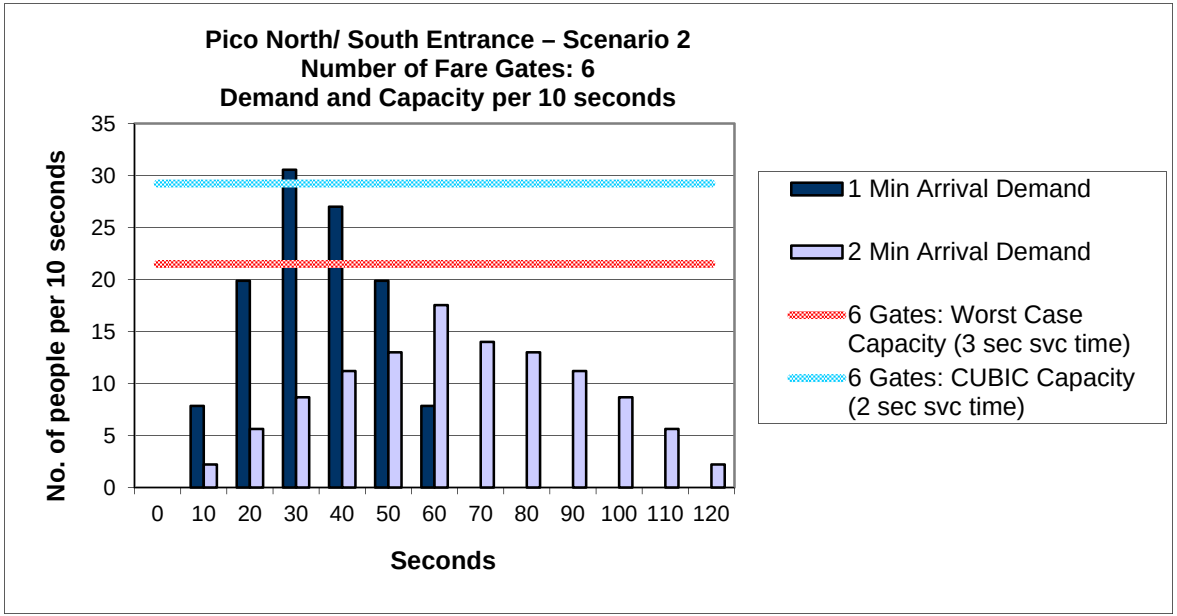
For **Pico North/ South**, maximum total peak of the peak hour (5pm to 6pm) passenger boarding (397) and alighting (359) is **756 during year 2014**. As per LACMTA service planning input on Pico, a station involving transfer between Expo and Blue line, 80% of 756, 605 passengers will utilize **Pico** Blue Line fare gates during peak hour. 78.46% ridership growth has been applied to 605 passengers to calculate year 2024 ridership projections at **Pico (1079 passengers)**. Based on 12 Trains per Hour (**TPH)/** 5 minute headway, it is assumed (as per **Table 6**) that 15% of peak one hour surge go through the fare gates during 1-minute surge. **70**% of gate utilization is assumed at each **Pico North/ South** entrances. Therefore, **70**% of 1-minute passenger surge (**15**% **of 1079** passengers = 162 passengers) utilize **Pico North/ South** station entrance fare gates. 70% of 1-minute surge (162 passengers), **113** passengers utilize **Pico North/ South** station entrance fare gates.

Results:

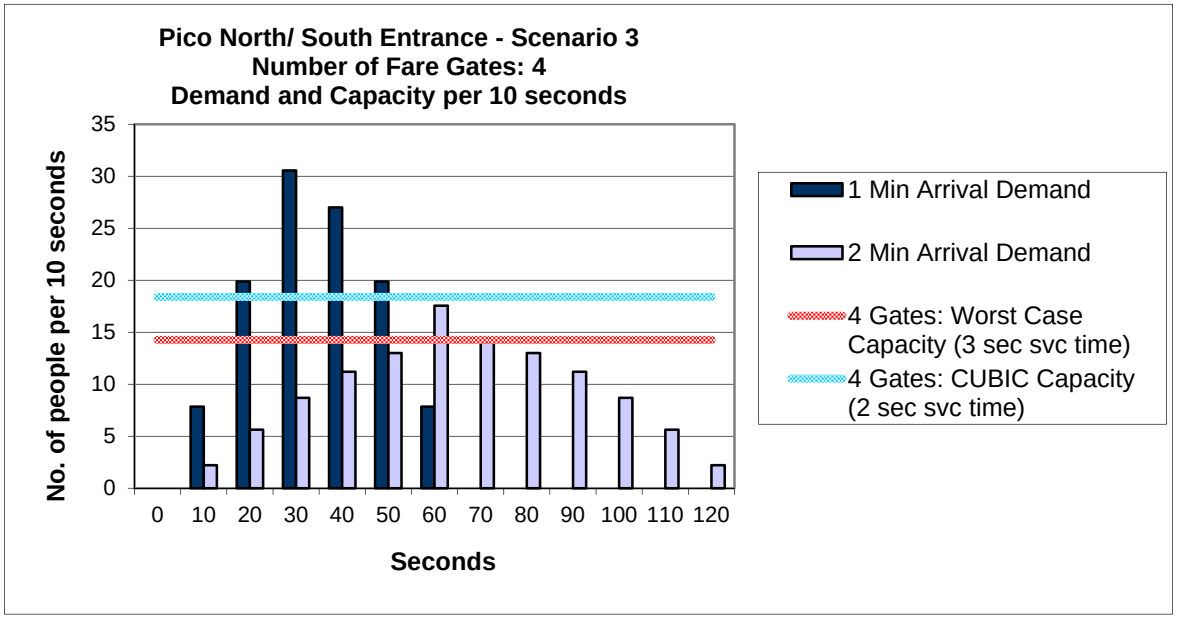
Scenario 1 – Planned number of fare gates station entrance can accommodate based on station plan drawings and infrastructure limitations / Number of Fare Gates: 2



Scenario 2 – Maximum Number of fare gates based on suggested Equipment Quantity Analysis (EQA) with 1-2 minute arrival surge/ Number of Fare Gates: 6



Scenario 3 – Minimum number of fare gates required to meet queuing design criteria (wait time less than 55 seconds) with 1-2 minute arrival surge/ Number of Fare Gates: 4



Metro Blue Line Pico North/ South Station Entrance - Worst Case (3 second average service time)					
No. of Fare Gates	**Scenarios**	**Surge Time (seconds)**	**Maximum Wait (seconds)**	**Maximum Number of People in Queue**	**Maximum Queue Length Per Gate (feet)**
2	**Scenario 1**	60	**111**	72	72
2	**Scenario 1**	120	**64**	39	39
6	Scenario 2	60	7	17	6
6	Scenario 2	120	0	0	0
4	Scenario 3	60	29	42	21
4	Scenario 3	120	4	4	2

Metro Blue Line Pico North/ South Station Entrance - CUBIC Estimate (2 second average service time)					
No. of Fare Gates	**Scenarios**	**Surge Time (seconds)**	**Maximum Wait (seconds)**	**Maximum Number of People in Queue**	**Maximum Queue Length Per Gate (feet)**
2	**Scenario 1**	60	**68**	60	60
2	Scenario 1	120	31	23	23
6	Scenario 2	60	1	2	1
6	Scenario 2	120	0	0	0
4	Scenario 3	60	12	26	13
4	Scenario 3	120	0	0	0

Metro Blue Line – Pico North/ South Station Entrance Conclusions:

- Based on demand (2024 ridership projections and 1-2 minute surge) and station assumptions, summary of the model results. See tables on page 16 for reference:

  - **Scenario 1** shows significant queues (maximum passenger wait time greater than 55 seconds) for 3 second average service time during 1-minute and 2-minute surge and shows significant queues for 2-second average service time during 1-minute surge.

  - **Scenarios 1** shows noticeable queues for 2 second average service time during 2-minute surge.

  - **Scenarios 2 and 3** do not show significant queues for 2 second and 3 second average service time. **Scenarios 2 and 3** as specified above, maximum passengers wait time is less than 55 seconds (a maximum queuing time of 55-seconds during surge has been considered an acceptable service standard).

  - Per 2024 peak hour ridership projections, model iterations suggest that installing minimum **four (4) fare gates** could have 29 **seconds of maximum passenger wait time** (less than 55 seconds of design criteria for significant queues) and therefore **four (4) fare** gates could be sufficient for **Pico North/ South** station entrance.

Metro Blue Line – Grand – LATTC East/ West Station Entrance	
Passengers per Peak Surge (1-2 minutes)	**110** (70% of 157 passengers for 1-minute surge utilize **Grand East/ West** station entrance fare gates)
Scenario 1 - Planned number of fare gates station entrance can accommodate based on station plan and infrastructure limitations	2
Scenario 2 - Maximum number of fare gates based on suggested Equipment Quantity Analysis (EQA)	5
Scenario 3 - Minimum number of fare gates required to meet queuing design criteria (wait times less than 55 sec.)	3

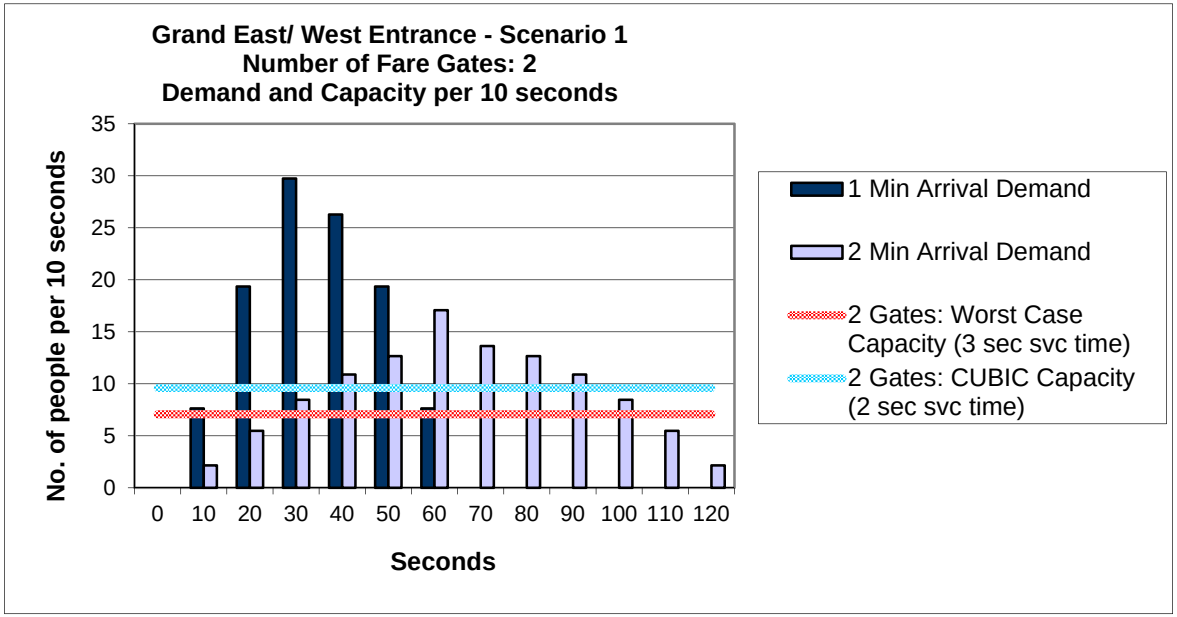
Station assumptions:
Ridership demand is modeled based on year 2024 peak hour ridership projections. A demand model has been created to estimate the amount of passengers each station must service during a peak surge that lasts one or two minutes long. Peak of the peak hour ridership includes maximum total of peak hour passenger boarding and alighting from data provided for year 2013.

Initial Queuing Analysis for **Grand East/ West** station entrances considered 78.46% growth percentage. However, LACMTA service planning noted that 78.46% ridership growth included Regional Connector ridership with Blue and Gold Line ridership data. LACMTA service planning requested CH2MHILL team to assume ridership growth at station level instead of line level as indicated in **Table 4**. Per 01/26/2015 conference call discussion with LACMTA Operations and service planning staff, LACMTA requested CH2MHILL team to apply the worst case ridership growth of 27% to the worst case peak hour ridership (between year 2013 and year 2014) for all the stations except Pico.

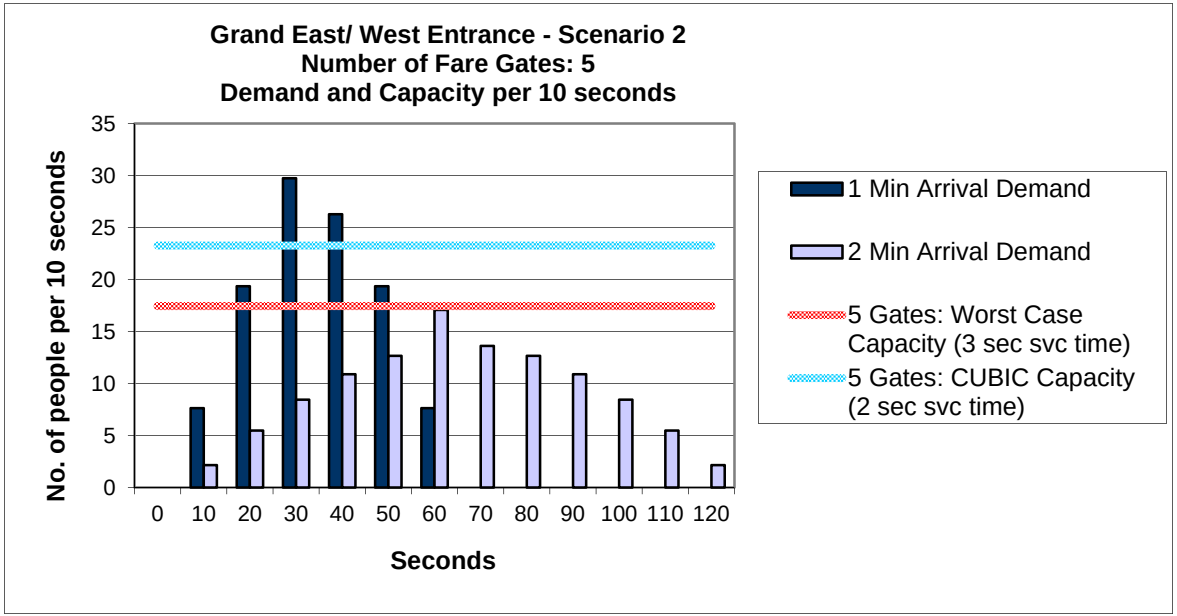
For **Grand East/ West**, maximum total peak of the peak hour (4pm to 5pm) passenger boarding (465) and alighting (359) is **824 during year 2013**. As per Metro service planning input on **Grand station**. 27% ridership growth has been applied to 824 passengers to calculate year 2024 ridership projections at **Grand (1046 passengers)**. Based on 12 Trains per Hour (**TPH)/** 5 minute headway, it is assumed (as per **Table 6**) that 15% of peak one hour surge go through the fare gates during 1-minute surge. **70**% of gate utilization is assumed at each **Grande East/ West** station entrances. Therefore, **70**% of 1-minute passenger surge (**15**% **of 1046** passengers = 157 passengers) utilize **Grand East/ West** station entrance fare gates. 70% of 1-minute surge (157 passengers), **110** passengers utilize **Grand East/ West** station entrance fare gates.

Results:

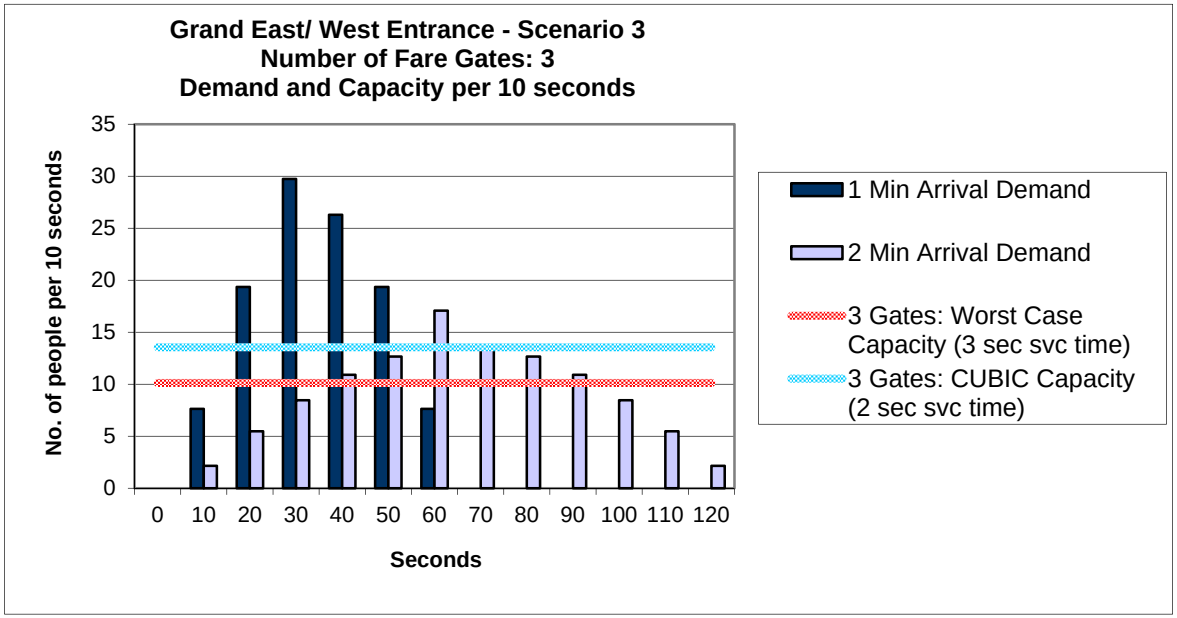
Scenario 1 – Planned number of fare gates station entrance can accommodate based on station plan drawings and infrastructure limitations / Number of Fare Gates: 2



Scenario 2 – Maximum Number of fare gates based on suggested Equipment Quantity Analysis (EQA) with 1-2 minute arrival surge/ Number of Fare Gates: 5



Scenario 3 – Minimum number of fare gates required to meet queuing design criteria (wait time less than 55 seconds) with 1-2 minute arrival surge/ Number of Fare Gates: 3



Metro Blue Line Grand East/ West Station Entrance - Worst Case (3 second average service time)					
No. of Fare Gates	**Scenarios**	**Surge Time (seconds)**	**Maximum Wait (seconds)**	**Maximum Number of People in Queue**	**Maximum Queue Length Per Gate (feet)**
2	**Scenario 1**	60	**97**	68	68
2	Scenario 1	120	55	38	38
5	Scenario 2	60	18	27	11
5	Scenario 2	120	0	0	0
3	Scenario 3	60	52	53	35
3	Scenario 3	120	15	17	12

Metro Blue Line Grand East/ West Station Entrance - CUBIC Estimate (2 second average service time)					
No. of Fare Gates	**Scenarios**	**Surge Time (seconds)**	**Maximum Wait (seconds)**	**Maximum Number of People in Queue**	**Maximum Queue Length Per Gate (feet)**
2	**Scenario 1**	60	**59**	56	56
2	Scenario 1	120	19	17	17
5	Scenario 2	60	3	9	4
5	Scenario 2	120	0	0	0
3	Scenario 3	60	28	38	25
3	Scenario 3	120	2	4	3

Metro Blue Line – Grand East/ West Station Entrance Conclusions:

- Based on demand (2024 ridership projections and 1-2 minute surge) and station assumptions, summary of the model results. See tables on page 22 for reference:

  - **Scenario 1** shows significant queues (maximum passenger wait time greater than 55 seconds) for 3 second average service time during 1-minute and shows significant queues for 2-second average service time during 1-minute surge.

  - **Scenarios 1** shows noticeable queues for 3 second average service time during 2-minute surge.

  - **Scenarios 1** shows slight queues for 2 second average service time during 2-minute surge.

  - **Scenarios 2 and 3** do not show significant queues for 2 second and 3 second average service time. **Scenarios 2 and 3** as specified above, maximum passengers wait time is less than 55 seconds (a maximum queuing time of 55-seconds during surge has been considered an acceptable service standard).

  - Per 2024 peak hour ridership projections, model iterations suggest that installing minimum **three (3) fare gates** could have 52 **seconds of maximum passenger wait time** (less than 55 seconds of design criteria for significant queues) and therefore **three (3) fare** gates could be sufficient for **Grand East/ West** station entrance

Metro Blue Line – Florence North Station Entrance	
Passengers per Peak Surge (1-2 minutes)	**184** (100% of 184 passengers for 1-minute surge utilize **Florence North** station entrance fare gates)
Scenario 1 - Planned number of fare gates station entrance can accommodate based on station plan and infrastructure limitations	2
Scenario 2 - Maximum number of fare gates based on suggested Equipment Quantity Analysis (EQA)	9
Scenario 3 - Minimum number of fare gates required to meet queuing design criteria (wait times less than 55 sec.)	5

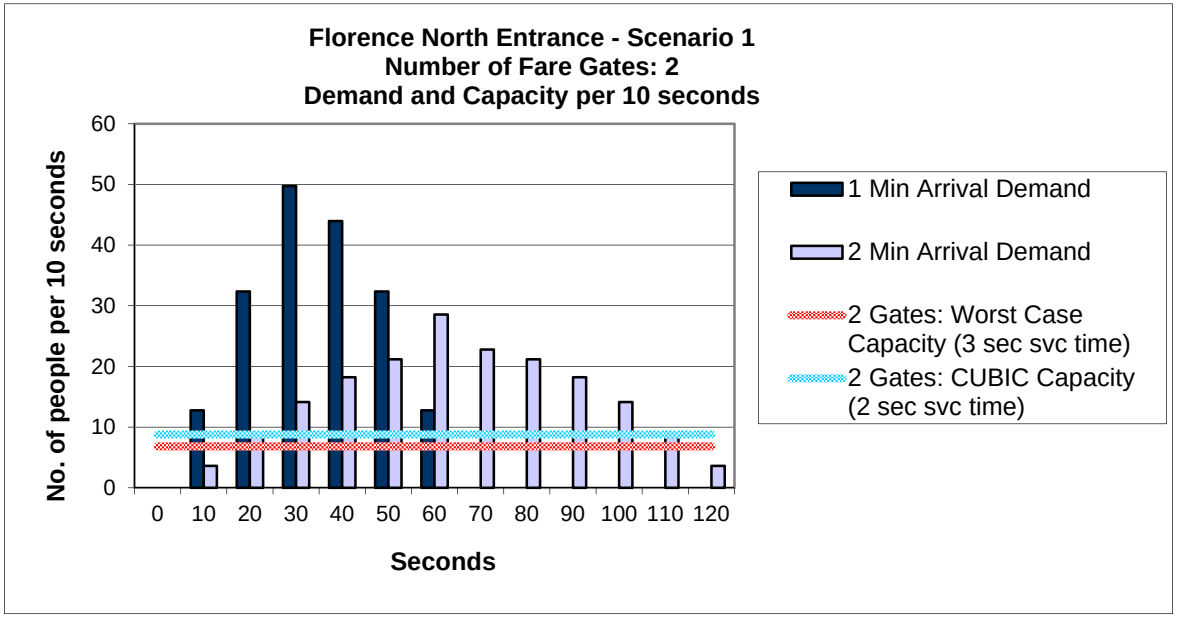
Station assumptions:
Ridership demand is modeled based on year 2024 peak hour ridership projections. A demand model has been created to estimate the amount of passengers each station must service during a peak surge that lasts one or two minutes long. Peak of the peak hour ridership includes maximum total of peak hour passenger boarding and alighting from data provided for year 2013.

Initial Queuing Analysis for **Florence North** station entrances considered 78.46% growth percentage. However, LACMTA service planning noted that 78.46% ridership growth included Regional Connector ridership with Blue and Gold Line ridership data. LACMTA service planning requested CH2MHILL team to assume ridership growth at station level instead of line level as indicated in **Table 4**. Per 01/26/2015 conference call discussion with LACMTA Operations and service planning staff, LACMTA requested CH2MHILL team to apply the worst case ridership growth of 27% to the worst case peak hour ridership (between year 2013 and year 2014) for all the stations except Pico.

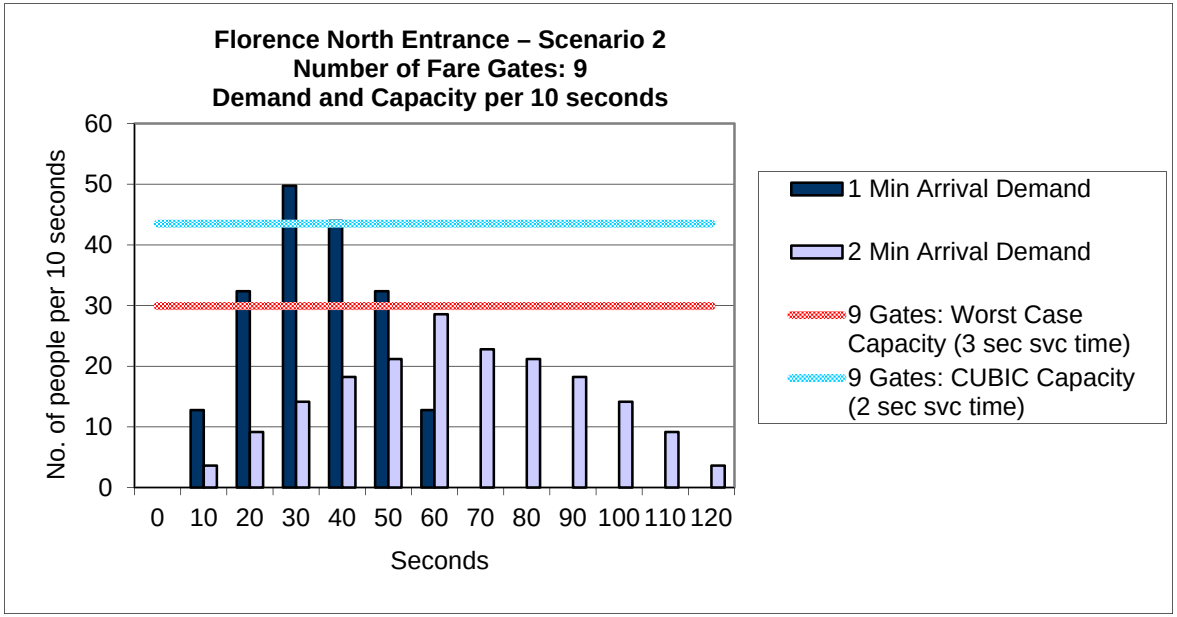
For **Florence North**, maximum total peak of the peak hour (5pm to 6pm) passenger boarding (363) and alighting (601) is **964 during year 2013**. As per Metro service planning input on **Florence station**. 27% ridership growth has been applied to 964 passengers to calculate year 2024 ridership projections at **Florence (1225 passengers)**. Based on 12 Trains per Hour (**TPH)/** 5 minute headway, it is assumed (as per **Table 6**) that 15% of peak one hour surge go through the fare gates during 1-minute surge. **100**% of gate utilization is assumed at **Florence North** station entrance. Therefore, **100**% of 1-minute passenger surge (**15**% **of 1225** passengers = 184 passengers) utilize **Florence North** station entrance fare gates. **100**% of 1-minute surge (184 passengers), **184** passengers utilize **Florence North** station entrance fare gates.

Results:

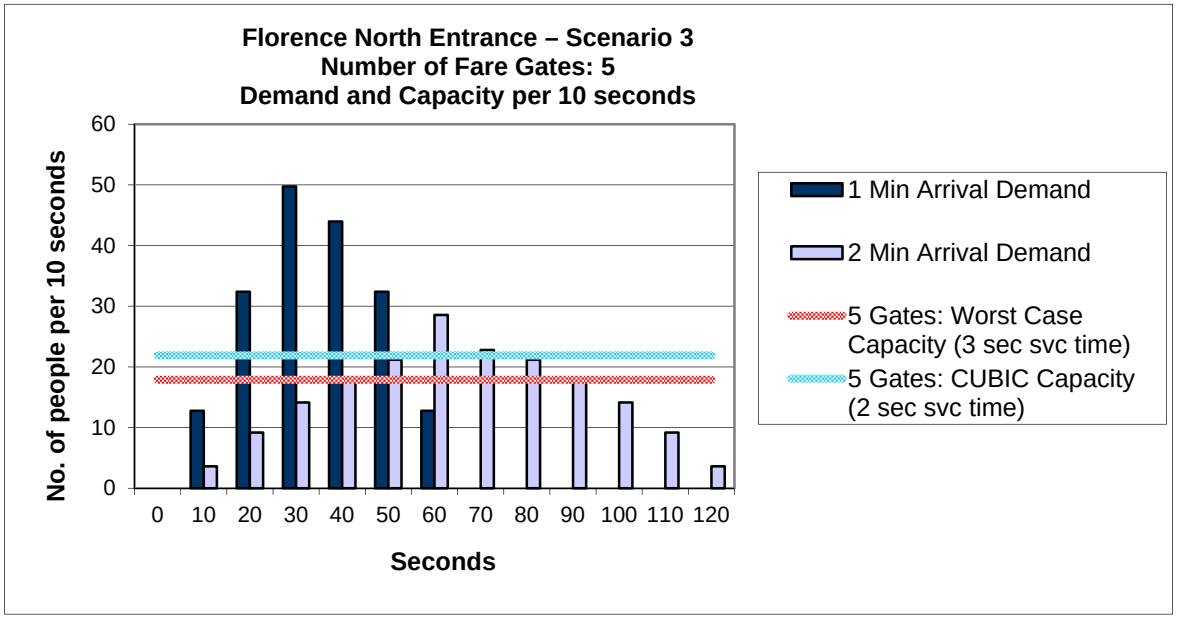
Scenario 1 – Planned number of fare gates station entrance can accommodate based on station plan drawings and infrastructure limitations / Number of Fare Gates: 2



Scenario 2 – Maximum Number of fare gates based on suggested Equipment Quantity Analysis (EQA) with 1-2 minute arrival surge/ Number of Fare Gates: 9



Scenario 3 – Minimum number of fare gates required to meet queuing design criteria (wait time less than 55 seconds) with 1-2 minute arrival surge/ Number of Fare Gates: 5



Metro Blue Line Florence North Station Entrance - Worst Case (3 second average service time)					
No. of Fare Gates	**Scenarios**	**Surge Time (seconds)**	**Maximum Wait (seconds)**	**Maximum Number of People in Queue**	**Maximum Queue Length Per Gate (feet)**
2	Scenario 1	60	**234**	140	140
2	Scenario 1	120	**177**	105	105
9	Scenario 2	60	10	37	8
9	Scenario 2	120	0	0	0
5	Scenario 3	60	54	85	34
5	Scenario 3	120	7	22	9

Metro Blue Line Florence North Station Entrance - CUBIC Estimate (2 second average service time)					
No. of Fare Gates	**Scenarios**	**Surge Time (seconds)**	**Maximum Wait (seconds)**	**Maximum Number of People in Queue**	**Maximum Queue Length Per Gate (feet)**
2	Scenario 1	60	**126**	130	130
2	Scenario 1	120	**84**	83	83
9	Scenario 2	60	2	6	1
9	Scenario 2	120	0	0	0
5	Scenario 3	60	25	67	27
5	Scenario 3	120	1	6	2

Metro Blue Line – Florence North Station Entrance Conclusions:

- Based on demand (2024 ridership projections and 1-2 minute surge) and station assumptions, summary of the model results. See tables on page 28 for reference:

  - **Scenario 1** shows significant queues (maximum passenger wait time greater than 55 seconds) for 3 second and 2-second average service time during 1-minute and 2-minute surge.

  - **Scenarios 2 and 3** do not show significant queues for 2 second and 3 second average service time. **Scenarios 2 and 3** as specified above, maximum passengers wait time is less than 55 seconds (a maximum queuing time of 55-seconds during surge has been considered an acceptable service standard).

  - Per 2024 peak hour ridership projections, model iterations suggest that installing minimum **five (5) fare gates** could have 54 **seconds of maximum passenger wait time** (less than 55 seconds of design criteria for significant queues) and therefore **five (5) fare** gates could be sufficient for **Florence North** station entrance.

Metro Blue Line – 103rd Street/ Watts Towers West Station Entrance	
Passengers per Peak Surge (1-2 minutes)	**137** (100% of 137 passengers for 1-minute surge utilize **103rd Street** station entrance fare gates)
Scenario 1 - Planned number of fare gates station entrance can accommodate based on station plan and infrastructure limitations	2
Scenario 2 - Maximum number of fare gates based on suggested Equipment Quantity Analysis (EQA)	7
Scenario 3 - Minimum number of fare gates required to meet queuing design criteria (wait times less than 55 sec.)	4

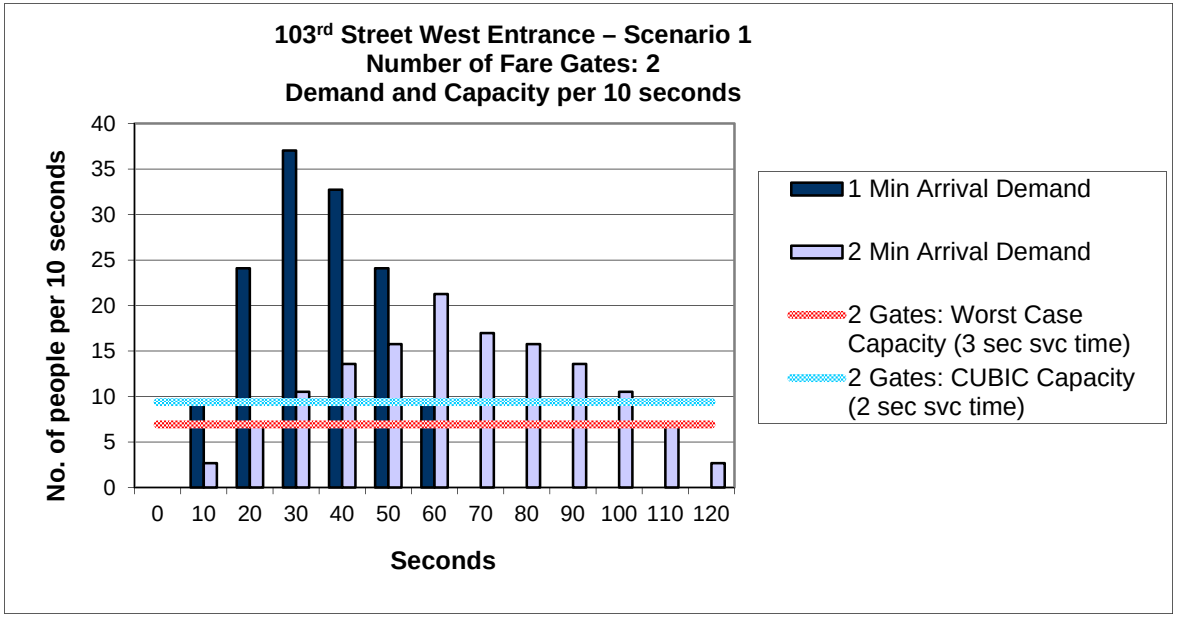
Station assumptions:
The demand model is driven by peak period ridership projection (year 2024) provided by LACMTA via email in October 2014. Ridership demand is modeled based on year 2024 peak hour ridership projections. A demand model has been created to estimate the amount of passengers each station must service during a peak surge that lasts one or two minutes long. Peak of the peak hour ridership includes maximum total of peak hour passenger boarding and alighting from data provided for year 2013.

Initial Queuing Analysis for **103rd Street west** station entrances considered 78.46% growth percentage. However, LACMTA service planning noted that 78.46% ridership growth included Regional Connector ridership with Blue and Gold Line ridership data. LACMTA service planning requested CH2MHILL team to assume ridership growth at station level instead of line level as indicated in **Table 4**. Per 01/26/2015 conference call discussion with LACMTA Operations and service planning staff, LACMTA requested CH2MHILL team to apply the worst case ridership growth of 27% to the worst case peak hour ridership (between year 2013 and year 2014) for all the stations except Pico.

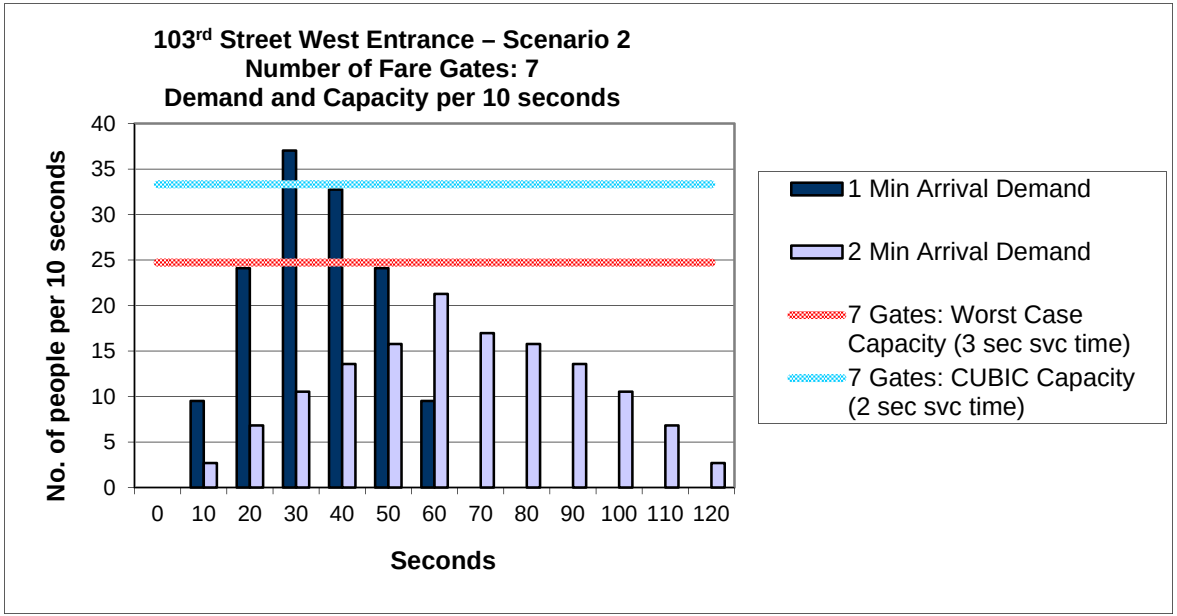
For **103rd Street west**, maximum total peak of the peak hour (4pm to 5pm) passenger boarding (324) and alighting (393) is **717 during year 2013**. As per Metro service planning input on **103rd Street station**. 27% ridership growth has been applied to 717 passengers to calculate year 2024 ridership projections at **103rd street (911 passengers)**. Based on 12 Trains per Hour (**TPH)/** 5 minute headway, it is assumed (as per **Table 6**) that 15% of peak one hour surge go through the fare gates during 1-minute surge. **100**% of gate utilization is assumed at **103rd Street west** station entrance. Therefore, **100**% of 1-minute passenger surge (**15**% **of 911** passengers = 137 passengers) utilize **103rd Street west** station entrance fare gates. **100**% of 1-minute surge (137 passengers), **137** passengers utilize **103rd Street west** station entrance fare gates.

Results:

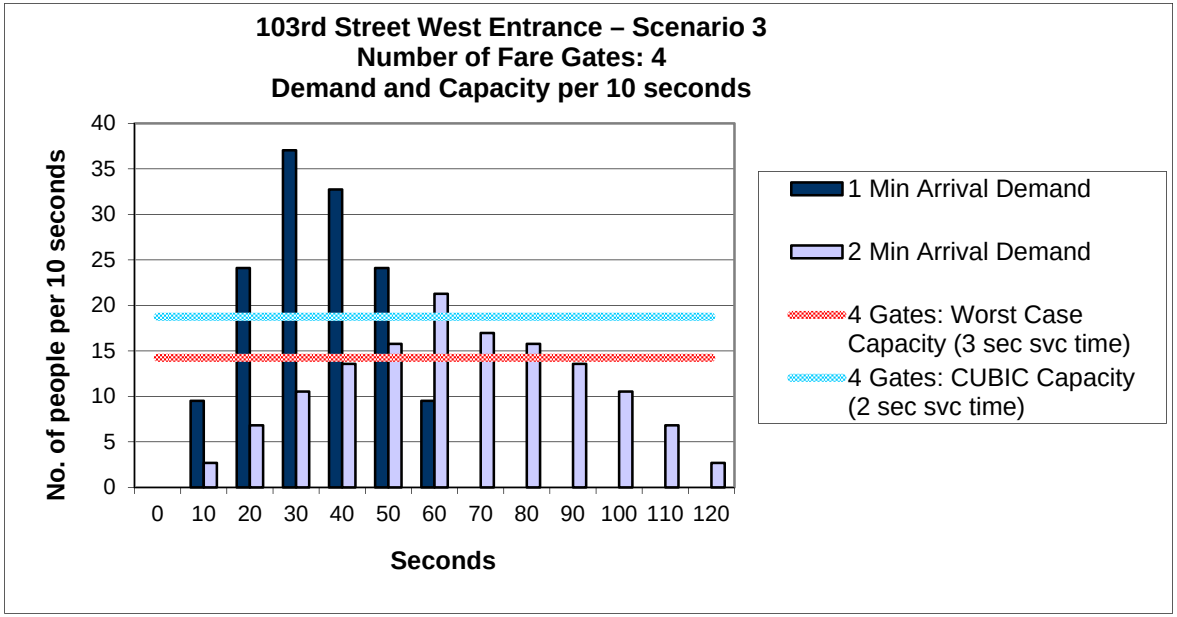
Scenario 1 – Planned number of fare gates station entrance can accommodate based on station plan drawings and infrastructure limitations / Number of Fare Gates: 2



Scenario 2 – Maximum Number of fare gates based on suggested Equipment Quantity Analysis (EQA) with 1-2 minute arrival surge/ Number of Fare Gates: 7



Scenario 3 – Minimum number of fare gates required to meet queuing design criteria (wait time less than 55 seconds) with 1-2 minute arrival surge/ Number of Fare Gates: 4



Metro Blue Line 103rd Street West Station Entrance - Worst Case (3 second average service time)					
No. of Fare Gates	**Scenarios**	**Surge Time (seconds)**	**Maximum Wait (seconds)**	**Maximum Number of People in Queue**	**Maximum Queue Length Per Gate (feet)**
2	Scenario 1	60	157	97	97
2	Scenario 1	120	84	59	59
7	Scenario 2	60	9	20	6
7	Scenario 2	120	0	0	0
4	Scenario 3	60	50	63	31
4	Scenario 3	120	3	14	7

Metro Blue Line 103rd Street West Station Entrance - CUBIC Estimate (2 second average service time)					
No. of Fare Gates	**Scenarios**	**Surge Time (seconds)**	**Maximum Wait (seconds)**	**Maximum Number of People in Queue**	**Maximum Queue Length Per Gate (feet)**
2	Scenario 1	60	79	85	85
2	Scenario 1	120	40	43	43
7	Scenario 2	60	0	4	1
7	Scenario 2	120	0	0	0
4	Scenario 3	60	24	43	22
4	Scenario 3	120	1	2	1

Metro Blue Line – 103rd Street West Station Entrance Conclusions:

- Based on demand (2024 ridership projections and 1-2 minute surge) and station assumptions, summary of the model results. See tables on page 34 for reference:

  - **Scenario 1** shows significant queues (maximum passenger wait time greater than 55 seconds) for 3 second average service time during 1-minute and 2-minute surge and shows significant queues for 2-second average service time during 1-minute surge.

  - **Scenarios 1** shows noticeable queues for 2 second average service time during 2-minute surge.

  - **Scenarios 2 and 3** do not show significant queues for 2 second and 3 second average service time. **Scenarios 2 and 3** as specified above, maximum passengers wait time is less than 55 seconds (a maximum queuing time of 55-seconds during surge has been considered an acceptable service standard).

  - Per 2024 peak hour ridership projections, model iterations suggest that installing minimum **four (4) fare gates** could have 50 **seconds of maximum passenger wait time** (less than 55 seconds of design criteria for significant queues) and therefore **four (4) fare** gates could be sufficient for **103rd Street West** station entrance.

Metro Blue Line – Rosa Parks/ Willowbrook North Station Entrance	
Passengers per Peak Surge (1-2 minutes)	**117** (100% of 117 passengers for 1-minute surge utilize **Rosa Parks North** station entrance fare gates)
Scenario 1 - Planned number of fare gates station entrance can accommodate based on station plan and infrastructure limitations	3
Scenario 2 - Maximum number of fare gates based on suggested Equipment Quantity Analysis (EQA)	6
Scenario 3 - Minimum number of fare gates required to meet queuing design criteria (wait times less than 55 sec.)	4

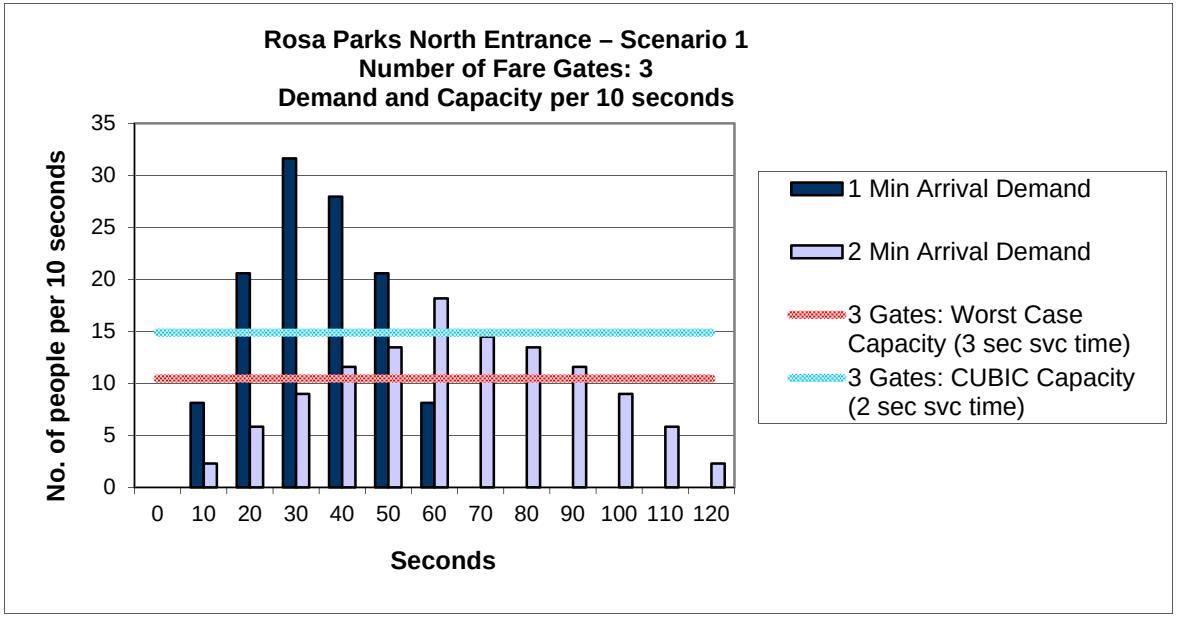
Station assumptions:
Ridership demand is modeled based on year 2024 peak hour ridership projections. A demand model has been created to estimate the amount of passengers each station must service during a peak surge that lasts one or two minutes long. Peak of the peak hour ridership includes maximum total of peak hour passenger boarding and alighting from data provided for year 2013.

Initial Queuing Analysis for **Rosa Parks North** station entrances considered 78.46% growth percentage. However, LACMTA service planning noted that 78.46% ridership growth included Regional Connector ridership with Blue and Gold Line ridership data. LACMTA service planning requested CH2MHILL team to assume ridership growth at station level instead of line level as indicated in **Table 4**. Per 01/26/2015 conference call discussion with LACMTA Operations and service planning staff, LACMTA requested CH2MHILL team to apply the worst case ridership growth of 27% to the worst case peak hour ridership (between year 2013 and year 2014) for all the stations except Pico.

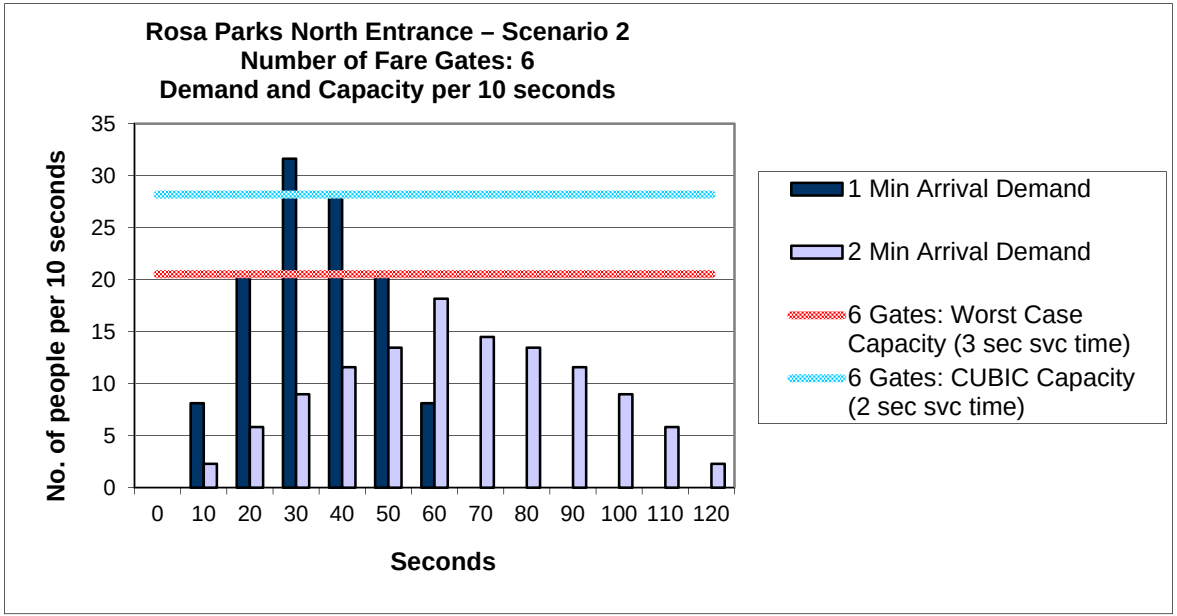
For **Rosa Parks**, maximum total peak of the peak hour (5pm to 6pm) passenger boarding (1041) and alighting (1151) is **2192 during year 2013**. As per Metro service planning input on **Rosa Parks station**, a station involving transfer between Green and Blue line, 28% of 2192, 614 passengers will utilize **Rosa Parks North and 72% of 2192**, 1578 passengers will utilize **Rosa Parks Mezzanine** fare gates during peak hour. 27% ridership growth has been applied to 614 to calculate year 2024 ridership projections at **Rosa Parks North (780 passengers)**. Based on 12 Trains per Hour (**TPH)/** 5 minute headway, it is assumed (as per **Table 6**) that 15% of peak one hour surge go through the fare gates during 1-minute surge. **100**% of gate utilization is assumed at **Rosa Parks North** station entrance. Therefore, **100**% of 1-minute passenger surge (**15% of 780** passengers = 117 passengers) utilize **Rosa Parks North** station entrance fare gates. **100**% of 1-minute surge (117 passengers), **117** passengers utilize **Rosa Parks North** station entrance fare gates.

Results:

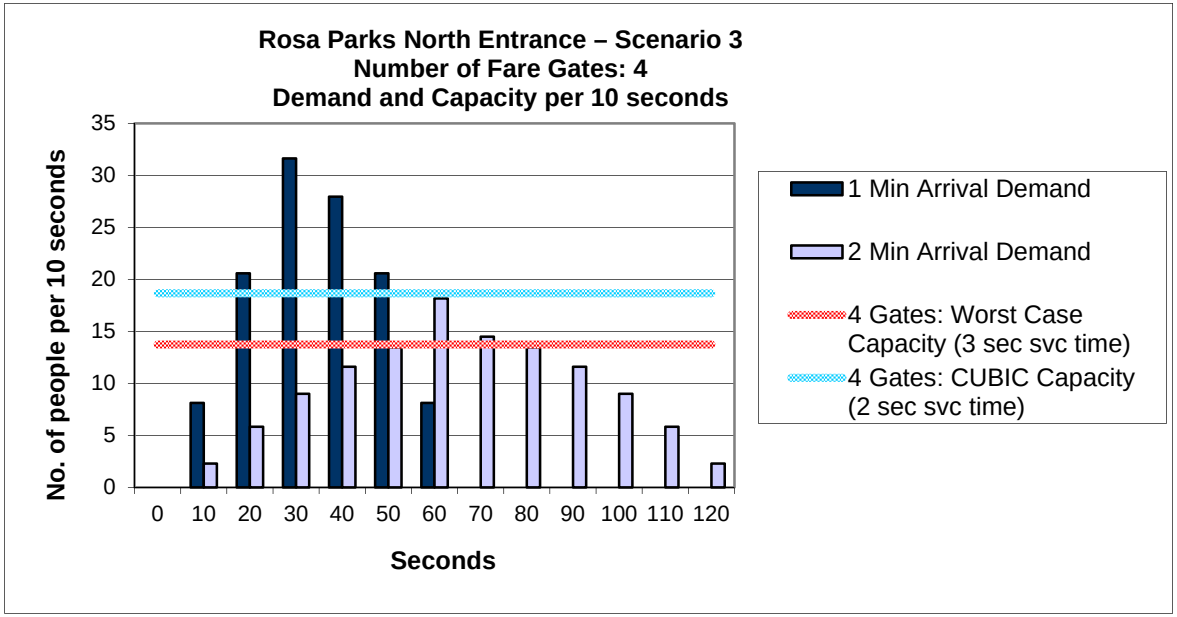
Scenario 1 – Planned number of fare gates station entrance can accommodate based on station plan drawings and infrastructure limitations / Number of Fare Gates: 3



Scenario 2 – Maximum Number of fare gates based on suggested Equipment Quantity Analysis (EQA) with 1-2 minute arrival surge/ Number of Fare Gates: 6



Scenario 3 – Minimum number of fare gates required to meet queuing design criteria (wait time less than 55 seconds) with 1-2 minute arrival surge/ Number of Fare Gates: 4



Metro Blue Line Rosa Parks North Station Entrance - Worst Case (3 second average service time)					
No. of Fare Gates	**Scenarios**	**Surge Time (seconds)**	**Maximum Wait (seconds)**	**Maximum Number of People in Queue**	**Maximum Queue Length Per Gate (feet)**
3	Scenario 1	60	**64**	62	41
3	Scenario 1	120	18	22	14
6	Scenario 2	60	11	19	6
6	Scenario 2	120	0	0	0
4	Scenario 3	60	37	45	23
4	Scenario 3	120	1	4	2

Metro Blue Line Rosa Parks North Station Entrance - CUBIC Estimate (2 second average service time)					
No. of Fare Gates	**Scenarios**	**Surge Time (seconds)**	**Maximum Wait (seconds)**	**Maximum Number of People in Queue**	**Maximum Queue Length Per Gate (feet)**
3	Scenario 1	60	31	42	28
3	Scenario 1	120	2	3	2
6	Scenario 2	60	1	4	1
6	Scenario 2	120	0	0	0
4	Scenario 3	60	14	25	13
4	Scenario 3	120	0	0	0

Metro Blue Line – Rosa Parks North Station Entrance Conclusions:

- Based on demand (2024 ridership projections and 1-2 minute surge) and station assumptions, summary of the model results. See tables on page 40 for reference:

  - **Scenario 1** shows significant queues (maximum passenger wait time greater than 55 seconds) for 3 second average service time during 1-minute.

  - **Scenario 1** shows noticeable queues for 2 second average service time during 1-minute

  - **Scenario 1** shows slight queues for 3-second average service time during 1-minute surge.

  - **Scenarios 1** shows no significant queues for 2 second average service time during 2-minute surge.

  - **Scenarios 2 and 3** do not show significant queues for 2 second and 3 second average service time. **Scenarios 2 and 3** as specified above, maximum passengers wait time is less than 55 seconds (a maximum queuing time of 55-seconds during surge has been considered an acceptable service standard).

  - Per 2024 peak hour ridership projections, model iterations suggest that installing minimum **four (4) fare gates** could have 37 **seconds of maximum passenger wait time** (less than 55 seconds of design criteria for significant queues) and therefore **four (4) fare** gates could be sufficient for **Rosa Parks North** station entrance.

  - ***Queuing Analysis for Rosa Parks/ Willowbrook was performed based on station configuration provided under infrastructure drawing (A-8.1 C0630) by Metro. Current Queuing Analysis includes two entrances for Rosa Parks, North Entrance (28% passengers utilize North Entrance) and Mezzanine entrance (72% passengers utilize Mezzanine Entrance). It is noted that Rosa Parks/ Willowbrook Station Improvement project is underway. Conceptual plans will be finalized. Project improvements include but not limited to platform extension, pedestrian crossing, and improvements to vertical circulation. Ridership distribution assumption shall be revised for the future Queuing Analysis. Based on final conceptual plans for Rosa Parks/ Willowbrook, Queuing Analysis shall be performed for Rosa Parks/ Willowbrook station layout for the revised station platform arrangements including additional entrances, modified quantity of planned fare gates and revised passenger access. Equipment Quantity Analysis shall be revised per the revised Rosa Parks/ Willowbrook station layout.***

Metro Blue Line – Rosa Parks/ Willowbrook Mezzanine Station Entrance	
Passengers per Peak Surge (1-2 minutes)	**301** (100% of 301 passengers for 1-minute surge utilize **Rosa Parks Mezzanine** station entrance fare gates)
Scenario 1 - Planned number of fare gates station entrance can accommodate based on station plan and infrastructure limitations	5
Scenario 2 - Maximum number of fare gates based on suggested Equipment Quantity Analysis (EQA)	14
Scenario 3 - Minimum number of fare gates required to meet queuing design criteria (wait times less than 55 sec.)	8

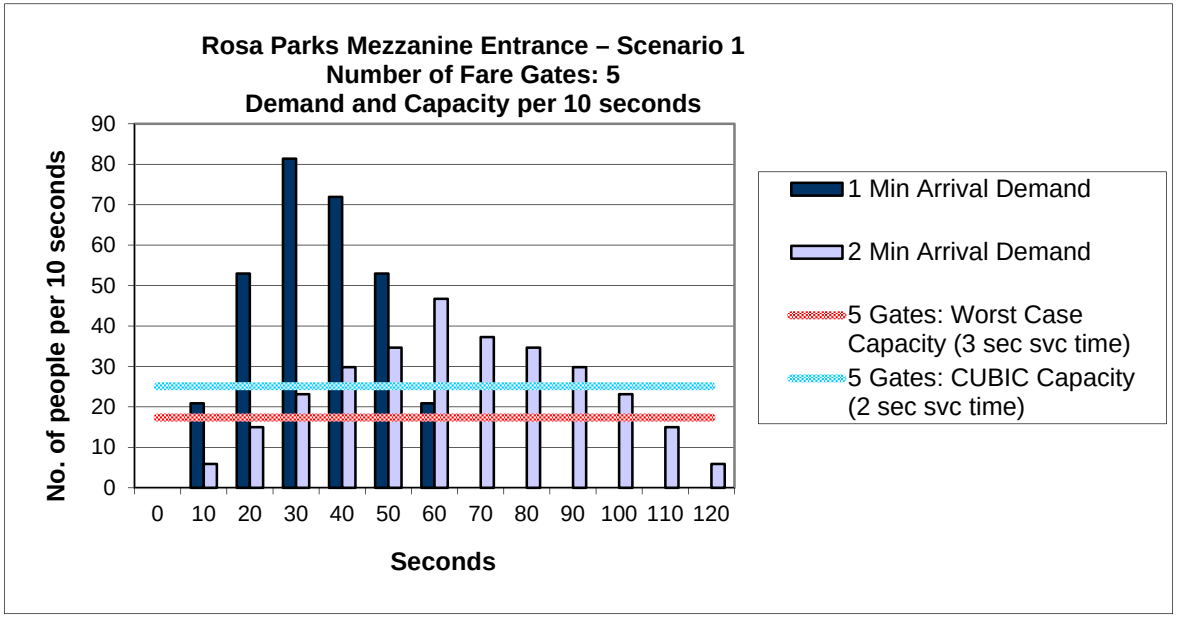
Station assumptions:
Ridership demand is modeled based on year 2024 peak hour ridership projections. A demand model has been created to estimate the amount of passengers each station must service during a peak surge that lasts one or two minutes long. Peak of the peak hour ridership includes maximum total of peak hour passenger boarding and alighting from data provided for year 2013.

Initial Queuing Analysis for **Rosa Parks Mezzanine** station entrances considered 78.46% growth percentage. However, LACMTA service planning noted that 78.46% ridership growth included Regional Connector ridership with Blue and Gold Line ridership data. LACMTA service planning requested CH2MHILL team to assume ridership growth at station level instead of line level as indicated in **Table 4**. Per 01/26/2015 conference call discussion with LACMTA Operations and service planning staff, LACMTA requested CH2MHILL team to apply the worst case ridership growth of 27% to the worst case peak hour ridership (between year 2013 and year 2014) for all the stations except Pico.

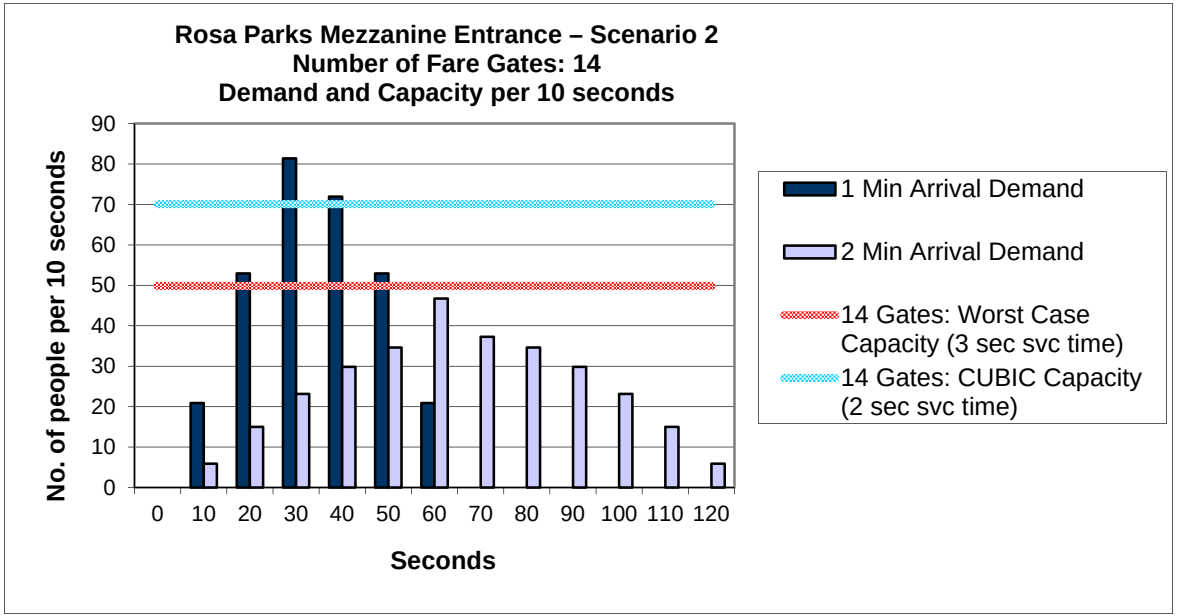
For **Rosa Parks Mezzanine**, maximum total peak of the peak hour (5pm to 6pm) passenger boarding (1041) and alighting (1151) is **2192 during year 2013**. As per Metro service planning input on **Rosa Parks station**, a station involving transfer between Green and Blue line, 28% of 2192, 614 passengers will utilize **Rosa Parks North and** 72% of 2192, 1578 passengers will utilize **Rosa Parks Mezzanine** fare gates during peak hour. 27% ridership growth has been applied to 1578 passengers to calculate year 2024 ridership projections at **Rosa Parks Mezzanine (2004 passengers)**. Based on 12 Trains per Hour (**TPH)/** 5 minute headway, it is assumed (as per **Table 6**) that 15% of peak one hour surge go through the fare gates during 1-minute surge. **100**% of gate utilization is assumed at **Rosa Parks Mezzanine** station entrance. Therefore, **100**% of 1-minute passenger surge (**15**% **of 2004** passengers = 301 passengers) utilize **Rosa Parks Mezzanine** station entrance fare gates. **100**% of 1-minute surge (301 passengers), **301** passengers utilize **Rosa Parks Mezzanine** station entrance fare gates.

Results:

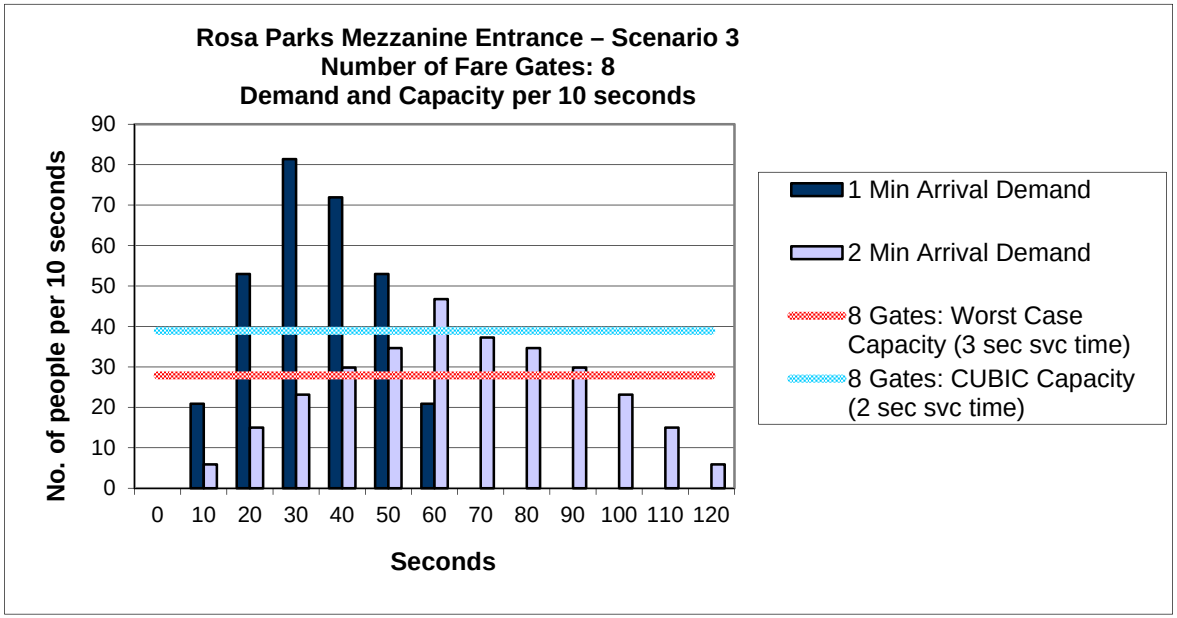
Scenario 1 – Planned number of fare gates station entrance can accommodate based on station plan drawings and infrastructure limitations / Number of Fare Gates: 5



Scenario 2 – Maximum Number of fare gates based on suggested Equipment Quantity Analysis (EQA) with 1-2 minute arrival surge/ Number of Fare Gates: 14



Scenario 3 – Minimum number of fare gates required to meet queuing design criteria (wait time less than 55 seconds) with 1-2 minute arrival surge/ Number of Fare Gates: 8



Metro Blue Line Rosa Parks Mezzanine Station Entrance - Worst Case (3 second average service time)					
No. of Fare Gates	**Scenarios**	**Surge Time (seconds)**	**Maximum Wait (seconds)**	**Maximum Number of People in Queue**	**Maximum Queue Length Per Gate (feet)**
5	Scenario 1	60	**123**	201	80
5	Scenario 1	120	**64**	121	48
14	Scenario 2	60	14	59	8
14	Scenario 2	120	0	0	0
8	Scenario 3	60	54	148	37
8	Scenario 3	120	14	37	9

Metro Blue Line Rosa Parks Mezzanine Station Entrance - CUBIC Estimate (2 second average service time)					
No. of Fare Gates	**Scenarios**	**Surge Time (seconds)**	**Maximum Wait (seconds)**	**Maximum Number of People in Queue**	**Maximum Queue Length Per Gate (feet)**
5	Scenario 1	60	**69**	161	64
5	Scenario 1	120	31	64	26
14	Scenario 2	60	2	13	2
14	Scenario 2	120	0	0	0
8	Scenario 3	60	27	105	26
8	Scenario 3	120	1	3	1

Metro Blue Line – Rosa Parks Mezzanine Station Entrance Conclusions:

- Based on demand (2024 ridership projections and 1-2 minute surge) and station assumptions, summary of the model results. See tables on page 46 for reference:

  - **Scenario 1** shows significant queues (maximum passenger wait time greater than 55 seconds) for 3 second average service time during 1-minute and 2-minute surge and shows significant queues for 2-second average service time during 1-minute surge.

  - **Scenarios 1** shows noticeable queues for 2 second average service time during 2-minute surge.

  - **Scenarios 2 and 3** do not show significant queues for 2 second and 3 second average service time. **Scenarios 2 and 3** as specified above, maximum passengers wait time is less than 55 seconds (a maximum queuing time of 55-seconds during surge has been considered an acceptable service standard).

  - Per 2024 peak hour ridership projections, model iterations suggest that installing minimum **eight (8) fare gates** could have 54 **seconds of maximum passenger wait time** (less than 55 seconds of design criteria for significant queues) and therefore **eight (8) fare** gates could be sufficient for **Rosa Parks Mezzanine** station entrance

  - ***Queuing Analysis for Rosa Parks/ Willowbrook was performed based on station configuration provided under infrastructure drawing (A-8.1 C0630) by Metro. Current Queuing Analysis includes two entrances for Rosa Parks, North Entrance (28% passengers utilize North Entrance) and Mezzanine entrance (72% passengers utilize Mezzanine Entrance). It is noted that Rosa Parks/ Willowbrook Station Improvement project is underway. Conceptual plans will be finalized. Project improvements include but not limited to platform extension, pedestrian crossing, and improvements to vertical circulation. Ridership distribution assumption shall be revised for the future Queuing Analysis. Based on final conceptual plans for Rosa Parks/ Willowbrook, Queuing Analysis shall be performed for Rosa Parks/ Willowbrook station layout for the revised station platform arrangements including additional entrances, modified quantity of planned fare gates and revised passenger access. Equipment Quantity Analysis shall be revised per the revised Rosa Parks/ Willowbrook station layout.***

Metro Blue Line – Willow South Station Entrance	
Passengers per Peak Surge (1-2 minutes)	**211** (100% of 211 passengers for 1-minute surge utilize **Willow South** station entrance fare gates)
Scenario 1 - Planned number of fare gates station entrance can accommodate based on station plan and infrastructure limitations	3
Scenario 2 - Maximum number of fare gates based on suggested Equipment Quantity Analysis (EQA)	10
Scenario 3 - Minimum number of fare gates required to meet queuing design criteria (wait times less than 55 sec.)	6

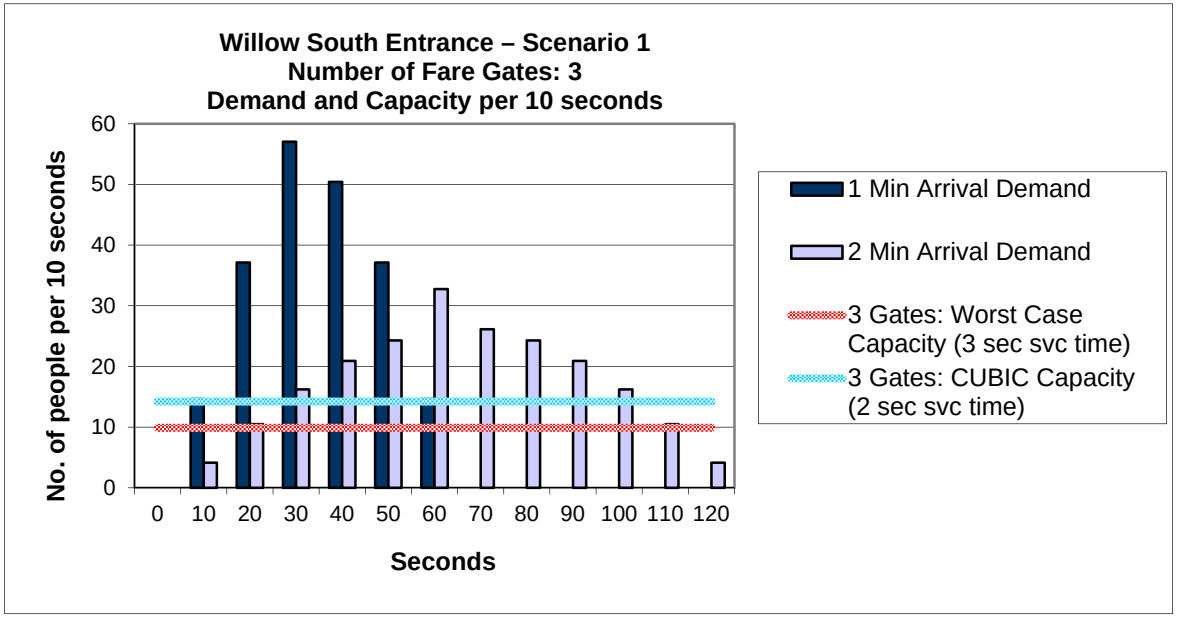
Station assumptions:
Ridership demand is modeled based on year 2024 peak hour ridership projections. A demand model has been created to estimate the amount of passengers each station must service during a peak surge that lasts one or two minutes long. Peak of the peak hour ridership includes maximum total of peak hour passenger boarding and alighting from data provided for year 2013.

Initial Queuing Analysis for **Willow South** station entrances considered 78.46% growth percentage. However, LACMTA service planning noted that 78.46% ridership growth included Regional Connector ridership with Blue and Gold Line ridership data. LACMTA service planning requested CH2MHILL team to assume ridership growth at station level instead of line level as indicated in **Table 4**. Per 01/26/2015 conference call discussion with LACMTA Operations and service planning staff, LACMTA requested CH2MHILL team to apply the worst case ridership growth of 27% to the worst case peak hour ridership (between year 2013 and year 2014) for all the stations except Pico.

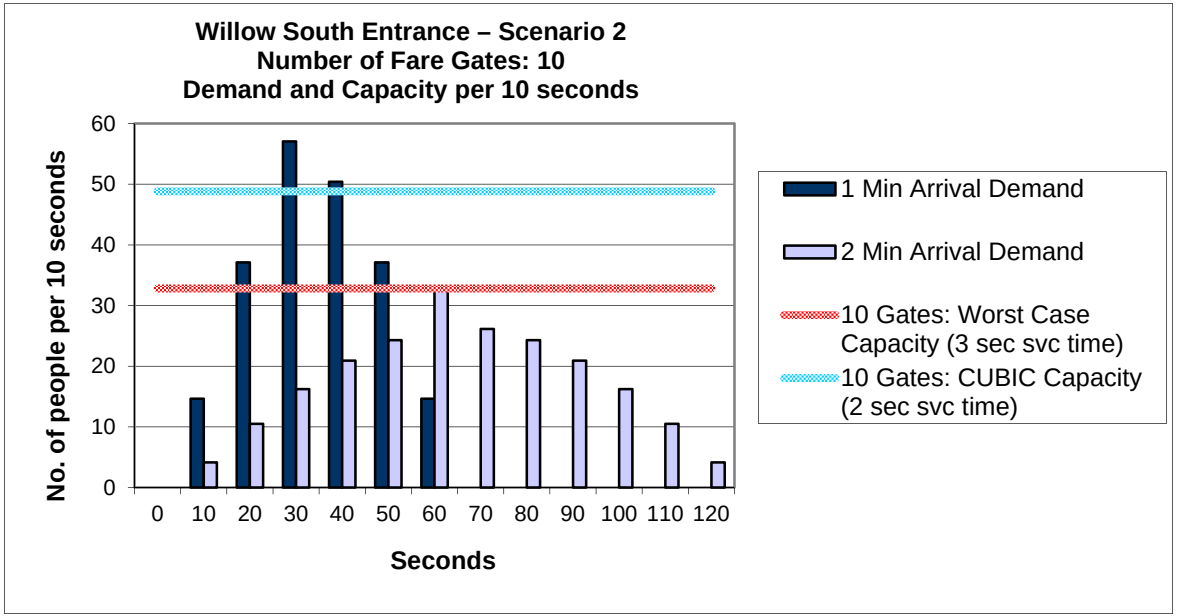
For **Willow South**, maximum total peak of the peak hour (4pm to 5pm) passenger boarding (654) and alighting (453) is **1107 during year 2013**. 27% ridership growth has been applied to 1107 passengers to calculate year 2024 ridership projections at **Willow South (1406 passengers)**. Based on 12 Trains per Hour (**TPH)/** 5 minute headway, it is assumed (as per **Table 6**) that 15% of peak one hour surge go through the fare gates during 1-minute surge. **100**% of gate utilization is assumed at **Willow South** station entrance. Therefore, **100**% of 1-minute passenger surge (**15**% **of 1406** passengers = 211 passengers) utilize **Willow South** station entrance fare gates. **100**% of 1-minute surge (211 passengers), **211** passengers utilize **Willow South** station entrance fare gates.

Results:

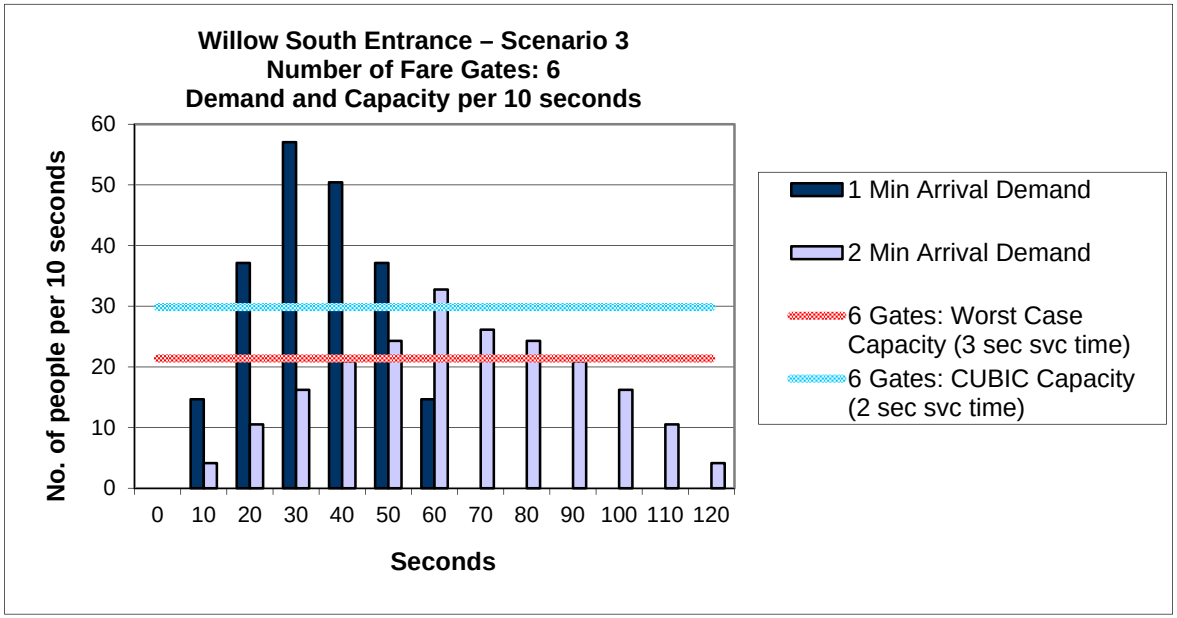
Scenario 1 – Planned number of fare gates station entrance can accommodate based on station plan drawings and infrastructure limitations / Number of Fare Gates: 3



Scenario 2 – Maximum Number of fare gates based on suggested Equipment Quantity Analysis (EQA) with 1-2 minute arrival surge/ Number of Fare Gates: 10



Scenario 3 – Minimum number of fare gates required to meet queuing design criteria (wait time less than 55 seconds) with 1-2 minute arrival surge/ Number of Fare Gates: 6



Metro Blue Line Willow South Station Entrance - Worst Case (3 second average service time)					
No. of Fare Gates	**Scenarios**	**Surge Time (seconds)**	**Maximum Wait (seconds)**	**Maximum Number of People in Queue**	**Maximum Queue Length Per Gate (feet)**
3	Scenario 1	60	161	147	98
3	Scenario 1	120	109	102	68
10	Scenario 2	60	12	50	10
10	Scenario 2	120	0	0	0
6	Scenario 3	60	52	98	33
6	Scenario 3	120	13	21	7

Metro Blue Line Willow South Station Entrance - CUBIC Estimate (2 second average service time)					
No. of Fare Gates	**Scenarios**	**Surge Time (seconds)**	**Maximum Wait (seconds)**	**Maximum Number of People in Queue**	**Maximum Queue Length Per Gate (feet)**
3	Scenario 1	60	93	125	83
3	Scenario 1	120	47	70	47
10	Scenario 2	60	3	9	2
10	Scenario 2	120	0	0	0
6	Scenario 3	60	22	60	20
6	Scenario 3	120	1	3	1

Metro Blue Line – Willow South Station Entrance Conclusions:

- Based on demand (2024 ridership projections and 1-2 minute surge) and station assumptions, summary of the model results. See tables on page 52 for reference:

  - **Scenario 1** shows significant queues (maximum passenger wait time greater than 55 seconds) for 3 second average service time during 1-minute and 2-minute surge and shows significant queues for 2-second average service time during 1-minute surge.

  - **Scenarios 1** shows noticeable queues for 2 second average service time during 2-minute surge.

  - **Scenarios 2 and 3** do not show significant queues for 2 second and 3 second average service time. **Scenarios 2 and 3** as specified above, maximum passengers wait time is less than 55 seconds (a maximum queuing time of 55-seconds during surge has been considered an acceptable service standard).

  - Per 2024 peak hour ridership projections, model iterations suggest that installing minimum **six (6) fare gates** could have 52 **seconds of maximum passenger wait time** (less than 55 seconds of design criteria for significant queues) and therefore **six (6) fare** gates could be sufficient for **Willow South** station entrance

Appendix

- **10/06/2014 email from Metro confirming projected ridership growth**

100614 LACMTA
Email Ridership Gro

- **01/26/15 email from Metro confirming revised projected ridership growth**

012615 LACMTA
Email with Revise Ri

Parikh, Anip/NJO

From: Preusser, Patrick <PreusserP@metro.net>
Sent: Monday, October 06, 2014 1:35 PM
To: Simon, John/LAC; Parikh, Anip/NJO
Cc: Li, Janice/NYC; Newton, Rick/STL
Subject: RE: Orange Line Assumptions - Follow-up BL 10/06/2014
Attachments: Boardings Projection 2014 V3 Rail - Metro Forecast 04_23_2014.xls; FY13 Station by hour boardings alightings.xlsx; RailActivity_May2013_Apr2014.xls

Third e-mail

Information from the first two files were used to derive platform occupancy loads for the preliminary gating analysis of MBL stations, using the 2013 boardings and alightings in second attachment together with a 2013-2023 (10-year out) increase of 78.46% reflected in the first attachment. We have included a third attachment with more recent boardings and alighting data provided by Service Planning (June 2014) for all rail lines covering the period of May 2013 through April 2014.

Patrick Preusser
Deputy Executive Officer, Rail Operations
Los Angeles County Metropolitan Transportation Authority
☎ 213.922.7974 | ☎ 213.842.5936 (mobile) | ✉ preusserp@metro.net | http://www.metro.net/
Vision: *Safe, clean, reliable, on-time, courteous service dedicated to providing Los Angeles County with a world class transportation system.*

From: Preusser, Patrick
Sent: Monday, October 06, 2014 10:32 AM
To: 'John.Simon@ch2m.com'; 'Anip.Parikh@ch2m.com'
Cc: 'Janice.Li@ch2m.com'; 'Rick.Newton@ch2m.com'
Subject: RE: Orange Line Assumptions - Follow-up BL 10/06/2014

Second e-mail

Patrick Preusser
Deputy Executive Officer, Rail Operations
Los Angeles County Metropolitan Transportation Authority
☎ 213.922.7974 | ☎ 213.842.5936 (mobile) | ✉ preusserp@metro.net | http://www.metro.net/
Vision: *Safe, clean, reliable, on-time, courteous service dedicated to providing Los Angeles County with a world class transportation system.*

From: Preusser, Patrick
Sent: Monday, October 06, 2014 10:32 AM

Parikh, Anip/NJO

From: Preusser, Patrick <PreusserP@metro.net>
Sent: Monday, January 26, 2015 5:14 PM
To: Parikh, Anip/NJO; Simon, John/LAC; Wasz, Gregory; Arteaga, Mauro; Chu, Chaushie; Burke, Paul
Cc: Li, Janice/NYC
Subject: RE: Fare Gate Project: Blue Line Ridership Growth Assumption

Hi Anip,

We have reviewed the assumptions and confirm with the following exception:

No need to reanalyze Pico station at a 27% growth factor. Systems Analysis provided a growth rate of 150% for this station. We already know this station has problems at a 78.46% growth rate; therefore, no need to model this station at a 27% growth rate.

Thanks.

Patrick Preusser
Deputy Executive Officer, Rail Operations
Los Angeles County Metropolitan Transportation Authority
☎ 213.922.7974 | ☎ 213.842.5936 (mobile) | ✉ preusserp@metro.net | http://www.metro.net/
Vision: *Safe, clean, reliable, on-time, courteous service dedicated to providing Los Angeles County with a world class transportation system.*

From: Anip.Parikh@ch2m.com [mailto:Anip.Parikh@ch2m.com]
Sent: Monday, January 26, 2015 12:51 PM
To: Preusser, Patrick; John.Simon@ch2m.com; Wasz, Gregory; Arteaga, Mauro; Chu, Chaushie; Burke, Paul
Cc: Janice.Li@ch2m.com
Subject: RE: Fare Gate Project: Blue Line Ridership Growth Assumption

Good Afternoon Patrick,

Please confirm the assumptions and input data provided in the email below. To make sure all are on the same page, please note that we will proceed with the Blue Line Queuing Analysis after receiving confirmation email.

I have copied Janice Li so she could update the Equipment Quantity Analysis (EQA) based on the revised ridership growth assumptions.

Following summarizes today's conference call discussion:

1. 78.46% ridership growth was applied in preliminary queuing analysis based on Metro's October 2014 data . However, Metro's review of the Preliminary Queuing Analysis report, Metro service planning had concern that 78.46% growth included Regional Connector ridership with Blue and Gold Line ridership data. Metro service planning requested to consider ridership growth at station level instead of line level.

2. Metro provided revised Station Growth.xlsx spreadsheet that includes Boarding ridership data for year 2014 and includes growth percentage for each station.

3. As specified in "**Station Growth.xlsx"** growth percentages for each station is as follows:

Station	For 2024 Ridership Growth Percentage
Willow	15%
Willowbrook	17%
Florence	27%
103rd	25%
Grand	-35%
Pico	150%

However, based on today's conference call discussion, Metro requested to **utilize 27% growth percentage for all stations** as a worst case scenario instead of considering separate ridership growth percentage for each station. (Few examples, 150% of growth shall not be considered for Pico considering the results from Preliminary Queuing Analysis with 78.46% projected growth. 35% of negative growth shall not be considered for Grand). Please see revised assumptions per Metro's request.

Note that Ridership baseline data (2013 or 2014 peak of the peak hour total of boarding and alighting data) as shown in the table below and gate utilization percentage for each station entrance assumptions remained the same. Ridership growth assumptions was revised to 27% for all stations instead of 78.46%.

Worst Case Peak Hour Ridership (Per Metro's 2013 or 2014 Ridership Data)					
Station Name	**Duration**	**Boarding**	**Alighting**	**Max Total (Boarding + Alighting)**	**Per Metro Service Planning Input for two stations involving transfer between Green/Blue at Rosa Parks and Expo/Blue at Pico**
PICO - 2014	5pm to 6pm	396	359	**756**	**80% of 756 = 605 passengers**
GRAND - 2013	4pm to 5pm	465	359	824	-
FLORENCE - 2013	5pm to 6pm	363	601	964	-
103RD/ WATTS - 2013	4pm to 5pm	324	393	717	-
ROSA PARK - WILLOWBOORK IMPERIAL WILMINGTON - 2013	5pm to 6pm	1,041	1,151	**2,192**	**North Entrance - 28% of 2192 = 614 passengers** **Mezzanine Level - 72% of 2192 = 1578 passengers**
WILLOW - 2013	4pm to 5pm	654	453	1,107	None

Revised Input Assumptions: LA			
Station Name/ Entrance - Worst Case Peak of the Peak Hour Ridership Data	Worst Case (2013 or 2014) Peak of the Peak One Hour Passengers ON/OFF - Boardings and Alightings per Data provided by Metro	2024 (after applying 27% growth) - Peak of the Peak One Hour Passengers ON/OFF - Boardings/Alightings per Data provided by Metro	Passengers per peak 1-2 minute surge: 15% of peak one hour passengers during 1-minute surge 12 TPH/ 5-min headway
Pico - North - Year 2014(80% of 756)	605	768	115
Pico - South - Year 2014(80% of 756)	605	768	115
Grand - LATTC - East - Year 2013	824	1046	157
Grand - LATTC - West - Year 2013	824	1046	157
Florence - North - Year 2013	964	1225	184
103rd St./ Watts Towers - West - Year 2013	717	911	137
Rosa Parks/ Willowbrook - North - Year 2013 (28% of 2192 = 614)	614	779	117
Rosa Parks/ Willowbrook - Mezzannine - Year 2013 (72% of 2192 = 1578)	1578	2004	301
Willow - South - Year 2013	1107	1406	211

Please let me know if any questions.

Regards,
Anip

From: Parikh, Anip/NJO
Sent: Monday, January 26, 2015 1:56 PM
To: 'Preusser, Patrick'; Simon, John/LAC; Wasz, Gregory; Arteaga, Mauro; Chu, Chaushie; Burke, Paul