APPENDIX C

MILESTONE 2
TRAFFIC OPERATIONS ANALYSIS
OF THE AT-GRADE CROSSINGS

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CRENSHAW TRANSIT CORRIDOR PROJECT

Project No. PS-4330-1968

Milestone 2
Traffic Operations Analysis of the At-Grade Crossings

Prepared for:

Metro

Prepared by:

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August 2009

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Milestone 2 Traffic Operations Analysis of the At-Grade Crossings

Crenshaw Transit Corridor Project PS-4330-1968

Prepared for:

Metro
Los Angeles County
Metropolitan Transportation Authority

Prepared by:
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August 2009

Quality Review Tracking*

REVISED DRAFT

Version #	Date	Reviewer Signature	Description/Comments
Submitted to PB	8/19/2009	Task Manager:	

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*Task Manager and PB Reviewer signatures indicate a thorough technical and editorial review has been conducted by the signatory in accordance with the approved Crenshaw Quality Management Plan.

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1.0 EXECUTIVE SUMMARY

As a supplement to *Draft Chapters of the Alternatives Analysis/Draft Environmental Impact Statement* (AA/DEIS/DEIR) for the proposed Crenshaw Transit Corridor Project (project) and to support preliminary engineering, this study presents the Milestone 2 operational analysis and the initial safety check for three proposed at-grade crossings based on *Policy for Grade Crossing listed below for Light Rail Transit* (Los Angeles County Metropolitan Transportation Authority [Metro], December 4, 2003):

1. Florence Avenue/Redondo Boulevard
2. Florence Avenue/Centinela Avenue
3. Florence Avenue/Aviation Boulevard/Manchester Avenue (Manchester Boulevard in the City of Inglewood)

The three proposed at-grade crossing locations were analyzed under existing and four future scenarios for both a.m. and p.m. peak hours to evaluate the potential impacts of the light rail transit (LRT) on vehicular delay and queue lengths:

- Existing 2009
- 2030 No Build
- 2030 with Potential Improvements (to accommodate future cumulative traffic growth)
- 2030 with LRT
- 2030 with LRT and Potential Mitigation (to accommodate both project and cumulative traffic growth)

These scenarios were evaluated using the micro-simulation software tool VISSIM. VISSIM was selected for analysis because of its ability to properly model the impacts of LRT on vehicular traffic. It is also capable of modeling the effects of transit pre-emption.

This study resulted in the following findings:

- Potential significant project intersection impact was identified at the Florence/Manchester/Aviation intersection during both a.m. and p.m. peak hours. Potential mitigations include:
  - Extension of the Florence Avenue southbound right-turn bay to 415 feet would be required because of the forecasted high southbound right-turn volume using Manchester Avenue westbound during the a.m. peak hour. Extending the length of the turn bay would allow right-turning vehicles to queue up without blocking southbound through vehicles. This improvement would require roadway widening and may involve property acquisition.
  - Addition of southbound right-turn overlap phase would be required because of the projected high southbound right-turn volume (from southbound Florence Avenue to westbound Manchester Avenue) during the a.m. peak hour. This overlap phase would require the installation of a new signal head that allows this

movement (from eastbound Manchester Avenue to northbound Florence Avenue) to have a "green arrow" while the eastbound protected left-turn movement is active.

- Addition of a protected phase for the westbound left-turn movement (from westbound Manchester Boulevard to southbound Aviation Boulevard), which would require the installation of a new signal head, would allow the movement to operate as protected/permitted. The westbound left turn currently operates as permissive only. The eastbound left turn currently operates with protected/permissive phasing. This improvement would be required because of the projected high eastbound through volume during the p.m. peak hour, which would result in few gaps for the permissive westbound left-turn movement to operate.

These mitigation measures are sufficient to allow the future 2030 with LRT scenario to operate at approximately the same level of delay as the future 2030 no build scenario at the Florence/Manchester/Aviation intersection. However, this intersection would remain operating at LOS F during the a.m. peak hour.

Increasing the LRT train frequency from 10-minute headways to 5-minute headway at this intersection would cause even greater vehicle delay and significant queuing on the cross streets interrupted by the LRT train operations. Previously proposed mitigation for the proposed 10-minute headway would not fully mitigate the project's significant intersection impact resulting from the LRT operations at 5-minute headways.

To improve the LOS under future with the project's 10-minute headways scenario or to fully mitigate the intersection impact with the 5-minute headways scenario, significant roadway widening of Manchester Avenue to allow a third through traffic lane would be required in each direction. As the impact of the right-of-way acquisition would be difficult to estimate at this planning stage of the project, the feasibility of widening Manchester Avenue would require further consultation with both the City of Los Angeles and the City of Inglewood

- Potential significant project intersection impact was identified at the Florence/ Centinela intersection during the a.m. and p.m. peak hours, with the proposed 10-minute headways for the LRT operations. However, because this intersection is projected to operate at an acceptable LOS D with the LRT operations, mitigation measures are not recommended, unless requested by the City of Inglewood.
- Increasing the train frequency from 10-minute headways to 5-minute headway at this intersection would cause even greater vehicle delay that may require roadway improvements to accommodate the increased train operations. Potential mitigation measures to mitigate the project's intersection under this alternative scenario include:
    - Convert the current left-turn lane from eastbound Florence to northbound Centinela to dual left-turn lanes with protected only left-turn phasing. This improvement would be necessary for the p.m. peak hour.

- ► Convert the right-turn lane from westbound Florence to northbound Centinela to one exclusive right-turn lane and a shared right/through lane to two exclusive right-turn lanes with phasing that provides for overlapping with the left turn movement from southbound Centinela Avenue to eastbound Florence Ave. This would require an arrow signal for the westbound right turn lane.
- ► Add an arrow signal to the southbound right-turn movement so that it can be overlapped with the eastbound left-turn movement.

- Implementation of these measures would mitigate the project significant intersection impacts related to the alternative LRT operation scenario at 5-minute headways, and would improve the operating conditions from LOS E to LOS C during both a.m. and p.m. peak hour.
- In addition, Additional ROW would be needed at this intersection for placement of crossing gates, which may require slight encroachment into La Colina Drive or Florence Avenue. With the anticipated traffic queuing on Centinela Avenue southbound lanes due to the gate operations, it is recommended that La Colina Drive remain unsignalized and left-turn movements from La Colina Drive to northbound Centinela Avenue be restricted during the peak periods. In the event that that La Colina Drive is determined to be signalized in the later Advanced Conceptual/Preliminary Engineering design phases, realignment of La Colina Drive or modification to the stop bar locations at this location may be required. However, inclusion of La Colina Drive in the signal phasing and operation may potentially result in additional vehicle delay and queuing at this intersection and may require physical or operational improvements to ensure acceptable operating conditions at this location.
- No significant traffic impact or queuing impact was identified at the Florence/Redondo intersection with 10- or 5-minute headways for LRT operations at the Florence/Redondo intersection.
- A queuing analysis was completed to identify if sufficient queuing storage is provided to accommodate both the "influence zone" queue that forms at a signal and "gate spillback" queue formed from the at-grade crossing. The analysis indicates that LRT operations may cause significant queuing conditions at the Florence/Aviation/ Manchester and Florence/Centinela intersections. Potential anti-queuing control could be installed, such as installation of "DO NOT BLOCK INTERSECTION" sign and "KEEP CLEAR" marking. Design option such as grade separation should also be considered at Florence/Aviation/ Manchester and Florence/Centinela intersections.
- A preliminary safety review was conducted for all grade crossings as part of the design process to determine whether adverse safety conditions, in conjunction with adverse operations, would potentially trigger the need for grade separation. Additional data such as accident history, access routes to school and site-specific assessment are required to complete the evaluation during the Preliminary Engineering Phase of the project.

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2.0 INTRODUCTION

2.1 Background

In October 2008, Fehr & Peers submitted an initial operation and safety assessment for the at-grade LRT crossings proposed under the LRT Alternative in the proposed Crenshaw Transit Corridor Project (project). Based on *Policy for Grade Crossing for Light Rail Transit* (Metro, December 4, 2003), the initial review recommended that a detailed operational analysis be conducted at five proposed at-grade crossings for further disposition whether at-grade crossings would be feasible:

- Florence Avenue/Aviation Boulevard/Manchester Avenue
- Florence Avenue/Centinela Avenue
- Florence Avenue/Redondo Boulevard
- Crenshaw Boulevard/Exposition Boulevard
- Crenshaw Boulevard/Rodeo Road

A design option of grade-separation has been considered and analyzed for the Crenshaw Boulevard/Exposition Boulevard intersection and Crenshaw Boulevard/Rodeo Road intersection in *Draft Chapters of the AA/DEIS/DEIR* for the project. The decision on the inclusion of this grade separation design option in the definition of the LRT Alternative will be made at the time of the selection of the Locally Preferred Alternative.

After consultation with the project team, it was determined that a detailed Milestone 2 operational analysis should be conducted to evaluate the feasibility of at-grade operations at the remaining three at-grade crossing intersections:

- Florence Avenue/Aviation Boulevard/Manchester Avenue
- Florence Avenue/Centinela Avenue
- Florence Avenue/Redondo Boulevard

2.2 Organization of this Report

This report is organized into the following seven chapters:

- Chapter 1 – Executive Summary
- Chapter 2 – Introduction
- Chapter 3 – Existing 2009 Conditions Analysis
- Chapter 4 – Future 2030 No Build Conditions Analysis
- Chapter 5 – Future 2030 With LRT Conditions Analysis (10-Minute Headways)
- Chapter 6 – Alternative Analysis with 5-Minute Headways
- Chapter 7 – Influence Zone Queues And Crossing Spillback Queues Analysis
- Chapter 8 – Initial At-grade Crossing Safety Assessment
- Chapter 9 – Conclusions

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3.0 EXISTING 2009 CONDITIONS ANALYSIS

3.1 Development of Microsimulation Models

Each of the study intersections was analyzed under existing 2009 conditions. The existing conditions analysis serves two purposes:

- Validate and calibrate the model to ensure accurate results under future without LRT conditions and future with LRT conditions
- Evaluate the current operational characteristics of the roadway network

In order to properly model the impacts of queue spillback on adjacent intersections and the effects of signal coordination, each model consisted of the study intersection and at least one intersection upstream and downstream of the study intersection. For the purpose of this analysis, previous 2008 traffic count data used in *Draft Chapters of the AA/DEIS/DEIR* were obtained for the three analyzed intersections. New peak period traffic counts were conducted at three other locations adjacent to the proposed crossings, including Centinela Avenue/Warren Lane, Hindry Avenue/Manchester Avenue, and Bellanca Avenue/Manchester Boulevard in March 2009. Previous 2008 counts were adjusted by 1 percent and balanced with new counts to represent 2009 traffic conditions in the study corridor. This methodology was developed in consultation with the City of Los Angeles Department of Transportation (LADOT) staff.

The measures of effectiveness (MOE) used for the analysis were LOS and queue length. LOS is a term that describes the operating performance of an intersection or roadway. LOS is measured quantitatively and reported on a scale from A to F, with A representing the best performance and F the worst. The *Highway Capacity Manual 2000* (HCM 2000) (Transportation Research Board, 2000) methodology was used in this study to remain consistent with "state-of-the-practice" professional standards. The VISSIM software is a stochastic simulation tool. Multiple runs were performed for each scenario to provide statistically sound results. However, the random nature of simulation creates variations even with similar traffic conditions.

The VISSIM model was validated to existing 2009 conditions using the criteria contained in *Guidelines for Applying Traffic Microsimulation Modeling Software* (California Department of Transportation, 2002) and additional criteria developed by Fehr & Peers. The default VISSIM parameters for geometrics and driver behavior were iteratively adjusted until the model was validated to observed traffic queuing conditions.

3.2 Existing Intersection Operating Conditions

The LOS results of the existing 2009 conditions analysis are provided in Table 3-1. All three intersections are operating at good levels of service, with LOS C or better during the a.m. and p.m. peak hours.

Table 3-1. Existing 2009 Intersection Levels of Service

Intersection		A.M. Peak Period		P.M. Peak Period	
ID	Location	Avg. Delay (Sec / Veh)	LOS	Avg. Delay (Sec / Veh)	LOS
1	Florence/Manchester/Aviation	28.5	C	17.4	B
2	Florence/Centinela	15.2	B	19.7	B
3	Florence/Redondo	10.0	A	5.4	A

4.0 FUTURE 2030 NO BUILD CONDITIONS ANALYSIS

4.1 Future 2030 No Build Conditions

The study intersections were then analyzed under projected future 2030 traffic volumes. The purpose of this analysis is to provide a future benchmark that can be compared against the future 2030 with LRT scenarios. The future 2030 traffic projections were developed based on the following annual growth rates used in *Draft Chapters of the AA/DEIS/DEIR*, as summarized below:

- Florence/Centinela intersection and Florence/Redondo intersection
  - eastbound: a.m. = 0.9%, p.m. = 1.0%
  - westbound: a.m. = 1.0%, p.m. = 1.0%
  - southbound: a.m. = 0.8%, p.m. = 0.5%
  - northbound: a.m. = 0.5%, p.m. = 0.8%
- Florence/Manchester/Aviation intersection
  - eastbound: a.m. = 1.8%, p.m. = 1.6%
  - westbound: a.m. = 2.1%, p.m. = 1.9%
  - southbound: a.m. = 0.8%, p.m. = 0.6%
  - northbound: a.m. = 0.7%, p.m. = 0.9%

The future projections were made using an iterative process that maintains a balance between increasing the approach volumes by the desired amount and keeping the proportions of the individual movements similar to existing 2009 conditions. The results of the future 2030 no build conditions analysis are presented in Table 4-1, under future 2030 No Build conditions, except for the intersection of Florence/Manchester/Aviation, which is projected to operate at poor LOS conditions under both peak hours, the remaining two intersections are projected to continue operating at good levels of service during both peak hours.

Table 4-1. Future 2030 No Build Peak Hour Levels of Service

Intersection		A.M. Peak Period		P.M. Peak Period	
ID	Location	Avg. Delay (Sec / Veh)	LOS	Avg. Delay (Sec / Veh)	LOS
1	Florence/Manchester/Aviation	85.0	F	60.4	E
2	Florence/Centinela	22.0	C	23.5	C
3	Florence/Redondo	13.6	B	6.0	A

4.2 Future 2030 with Potential Improvements

Table 4-2 indicated that the Florence/Manchester/Aviation intersection would operate at unacceptable LOS E or F under background 2030 traffic conditions during both the a.m. and p.m. peak periods. A future scenario was developed to identify possible roadway improvements that would be needed at this location to accommodate future cumulative background traffic growth. Following is the list of possible improvements:

- Extension of the Florence Avenue southbound right-turn bay to 415 feet from the current length of approximately 85 feet was considered because of the projected high southbound right-turn volume during the a.m. peak hour. Extending the length of the turn bay would allow right-turning vehicles to queue up without blocking southbound through vehicles. This improvement would require roadway widening and may involve property acquisition.
- Addition of a southbound right-turn overlap phase was considered because of the projected high southbound right-turn volumes during the a.m. peak hour. This overlap phase would require the installation of a new signal head that allows this movement to have a "green arrow" while the eastbound protected left-turn movement is active.
- The suggested improvement of the addition of a protected phase for the westbound left-turn movement would require the installation of a new signal head and would allow the movement to operate as protected/permitted. The eastbound left turn currently operates with protected/permissive phasing. This improvement was considered because of the projected high eastbound through volume during the p.m. peak hour, which results in few gaps for the permissive westbound left-turn movement to operate.

Table 4-2 shows the results of these potential improvements. The proposed improvements could be implemented to improve the traffic conditions at this location to accommodate future traffic growth not related to the proposed LRT operations.

Table 4-2. Future 2030 with Potential Improvements Peak Hour Level of Service

Intersection		A.M. Peak Period		P.M. Peak Period	
ID	Location	Avg. Delay (Sec / Veh)	LOS	Avg. Delay (Sec / Veh)	LOS
1	Florence/Manchester/Aviation	43.4	D	26.1	C
2	Florence/Centinela	22.0	C	23.5	C
3	Florence/Redondo	13.6	B	6.0	A

5.0 FUTURE 2030 WITH LRT CONDITIONS ANALYSIS

5.1 Future 2030 with LRT Conditions

Two future 2030 plus LRT conditions were analyzed:

- Future 2030 with LRT conditions
- Future 2030 with LRT conditions and potential mitigation

LRT was added to 2030 No Build Condition at the crossing location with 10-minute headways in both directions. Transit signal pre-emption was included in the analysis. The following general assumptions were included in the model:

- The crossing would be protected with quad gates and consideration for pedestrian gates would be evaluated.
- The gates would be down for approximately 45 seconds each time a train passes.
- The trains were offset from each other so that a train entered the model every five minutes (one from each direction every 10 minutes).

5.1.1 Florence Avenue/Manchester Avenue/Aviation Boulevard Intersection

This intersection has an LRT crossing spaced approximately 120 feet from the intersection. Because of this spacing, some eastbound vehicles will queue between the intersection and the LRT crossing. To avoid vehicles becoming trapped between the stop bar and the LRT crossing when a train arrives, the model was built under the assumption that vehicles would keep the LRT crossing clear at all times. The pre-emption/gate actuation assumptions that were used at this location are described below.

At the beginning of the pre-emption event, the gates will come down, then the eastbound through vehicles queued up between the signal and the LRT crossing will be allowed to clear for a period of about 10 seconds. This will allow any vehicles that inadvertently queue up on the LRT crossing to clear the track before the train arrives, but will not allow any vehicles queued up behind the gates to go through.

Following this clearance interval, the following movements will be permitted during pre-emption:

- Northbound through (circular green)
- Northbound right (circular green)
- Southbound through (circular green)
- Westbound right turn (right-turn-on-red [RTOR])
- Eastbound right turn (RTOR)

The following movements will be completely restricted throughout the entire pre-emption event:

- Southbound right (blank-out sign)
- Northbound left (blank-out sign)
- Eastbound through (circular red)
- Westbound through (circular red)
- Westbound left (circular red)

5.1.2 Florence Avenue/Centinela Avenue

This intersection has an LRT crossing spaced approximately 15 feet from the intersection. This is insufficient space for southbound vehicles to queue between the intersection and the LRT crossing. The intersection was modeled so that southbound vehicles would stop before the LRT crossing. Since this is so far from the intersection, it was assumed the southbound RTOR would be completely restricted at all times. Signage (e.g., "KEEP CLEAR") should be installed advising motorists to not stop on the tracks, and restricting this southbound RTOR movement. The pre-emption assumptions that were used at this location are described below.

At the beginning of pre-emption, the gates will come down, and then the following movements will be permitted during pre-emption:

- Eastbound through (circular green)
- Westbound through (circular green)

The following movements will be completely restricted throughout the entire pre-emption event:

- Southbound through (gate and circular red)
- Eastbound left (circular red)
- Westbound right (circular red)

The LOS results of the future 2030 with LRT scenario are shown in Table 5-1. With the addition of the LRT operations, the proposed crossing intersection at Florence/Manchester/Aviation is projected to operate at poor LOS in both peak hours (LOS E in the a.m. peak hour and LOS F in the p.m. peak hour). The other two crossings at Florence/Centinela and Florence/Redondo are projected to continue operate at LOS D or better during both peak hours with the LRT operations.

Table 5-1. Future 2030 with LRT Condition Peak Hour Level of Service

Intersection		A.M. Peak Period		P.M. Peak Period	
ID	Location	Avg. Delay (Sec / Veh)	LOS	Avg. Delay (Sec / Veh)	LOS
1	Florence/Manchester/Aviation	156.5	F	60.6	E
2	Florence/Centinela	33.7	C	36.3	D
3	Florence/Redondo	14.4	B	6.8	A

5.2 Potential Project Traffic Effect

The following thresholds of significance for traffic impacts were used in this analysis based on the CEQA determination described in Draft Chapters of the AA/DEIS/DEIR:

- Final LOS C - impact is significant if the delay is increased by 10 or more seconds
- Final LOS D - impact is significant if the delay is increased by 7.5 or more seconds
- Final LOS E/F - impact is significant if the delay is increased by five or more seconds

5.2.1 Significant Project Traffic Impacts

Table 5-2 shows a comparison of the LOS results for the existing 2009, future 2030 no build, future 2030 with potential improvements, future 2030 with LRT operations of 10-minute headways and future 2030 with LRT and potential mitigation scenarios.

Two of three crossings may potentially be impacted by the LRT operations, including:

- Florence Avenue/Manchester Avenue/Aviation Boulevard
- Florence Avenue/Centinela Avenue

5.2.2 Mitigation Measures

Potential mitigation measures are proposed for the Florence Avenue/Manchester Avenue/Aviation Boulevard intersection. These roadway improvements are:

- Extension of southbound right-turn pocket to 415 feet;
- Addition of new southbound right-turn overlap phase to allow for overlapping movement with eastbound left turn. This would require the addition of a right turn arrow for this movement.
- Addition of new westbound left-turn protected phase

The analysis shows that the Florence Avenue/Manchester Avenue/Aviation Boulevard intersection would operate at approximately LOS F with estimated 85 seconds of delay under the 2030 with LRT and potential mitigation conditions. This is approximately the same amount of delay that may be experienced at this intersection under the future 2030 no build scenario. These mitigations are sufficient to decrease delay for the plus LRT

Table 5-2. Summary of Intersection Level of Service Analysis with 10-Minute Headway for LRT Operations

	2009		2030 No Build		2030 w/ Potential Improvements		2030 with LRT 10-Minute Headways				2030 with LRT (10-Minute Headways) and Potential Mitigation			
Location	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay Change over No Build	Significant Impact?	Delay	LOS	Delay Change over No Build	Residual Impact?
A.M. Peak Hour Level of Service														
Florence/ Manchester/ Aviation	28.5	C	85	F	43.4	D	156.5	F	71.5	YES	84.7	F	-0.3	NO
Florence/ Centinela	15.2	B	22	C	22	C	33.7	C	11.7	YES	This location would remain impacted. However, with final LOS C w/LRT operations, no traffic mitigation is proposed unless requested by the City of Inglewood.			
Florence/ Redondo	10	A	13.6	B	13.6	B	14.4	B	0.8	NO	Not Required			
P.M. Peak Hour Level of Service														
Florence/ Manchester/ Aviation	17.4	B	60.4	E	26.1	C	60.6	E	0.2	YES	42.8	D	-17.6	NO
Florence/ Centinela	19.7	B	23.5	C	23.5	C	36.3	D	12.8	YES	This location would remain impacted. However, with final LOS D w/LRT operations, no traffic mitigation is proposed unless requested by the City of Inglewood.			
Florence/ Redondo	5.4	A	6	A	6	A	6.8	A	0.8	NO	Not Required			

scenario to the same amount of delay that would be expected at this intersection if no changes are made.

There is a sufficient increase in delay at the Florence/Centinela intersection to change traffic operations from LOS C to LOS D. According to the CEQA impact criteria, this intersection would remain impacted during both the a.m. and p.m. peak hours. However, because this intersection would operate at an acceptable LOS D with the LRT operations, additional mitigation measures are not recommended, unless requested by the City of Inglewood.

Additional ROW would be needed at this intersection for placement of crossing gates, which may require slight encroachment into La Colina Drive or Florence Avenue. With the anticipated traffic queuing on Centinela Avenue southbound lanes due to the gate operations, it is recommended that La Colina Drive remain unsignalized and left-turn movements from La Colina Drive to northbound Centinela Avenue be restricted during the peak periods.

In the event that that La Colina Drive is determined to be signalized in the later Advanced Conceptual/Preliminary Engineering design phases, realignment of La Colina Drive or modification to the stop bar locations at this location may be required. However, inclusion of La Colina Drive in the signal phasing and operation may potentially result in additional vehicle delay and queuing at this intersection and may require physical or operational improvements to ensure acceptable operating conditions at this location.

5.2.3 Visual Simulation of Traffic Queuing Conditions

Chart 5-1 through Chart 5-8 illustrate the hourly profile of the vehicle queuing conditions for the critical movement during each signal cycle at Florence Avenue/Aviation Boulevard/Manchester intersection under the 2030 with LRT and potential mitigation scenario (green line). The distance to upstream intersections is also indicated on each chart. Unsignalized intersections are represented with an orange dashed line, and signalized intersections are represented with a blue dashed line. This scenario is compared to the traffic queuing conditions under 2030 with potential improvements (red line) conditions to quantify the effect of the transit pre-emption for the LRT operations.

Chart 5-1. Florence/Manchester/Aviation: Eastbound Through Queue in A.M. Peak Hour

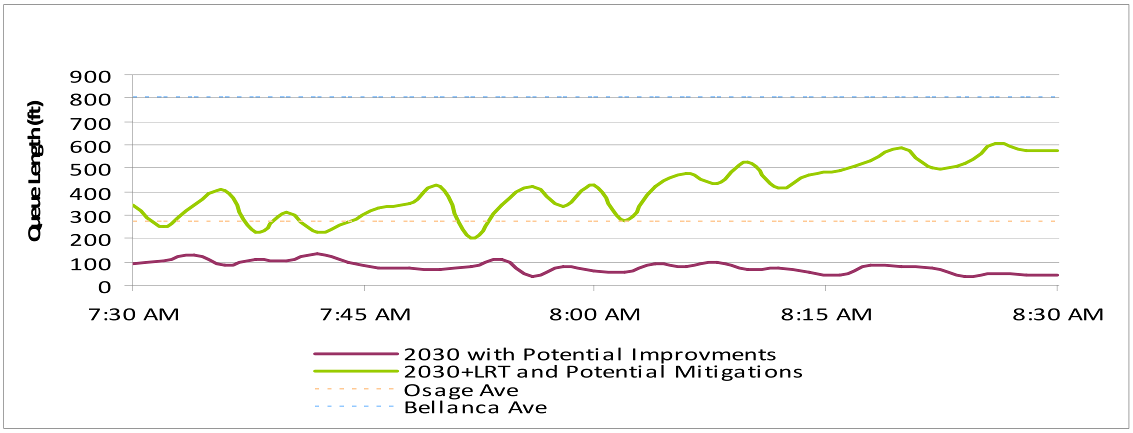


Chart 5-2. Florence/Manchester/Aviation: Westbound Through Queue in A.M. Peak Hour

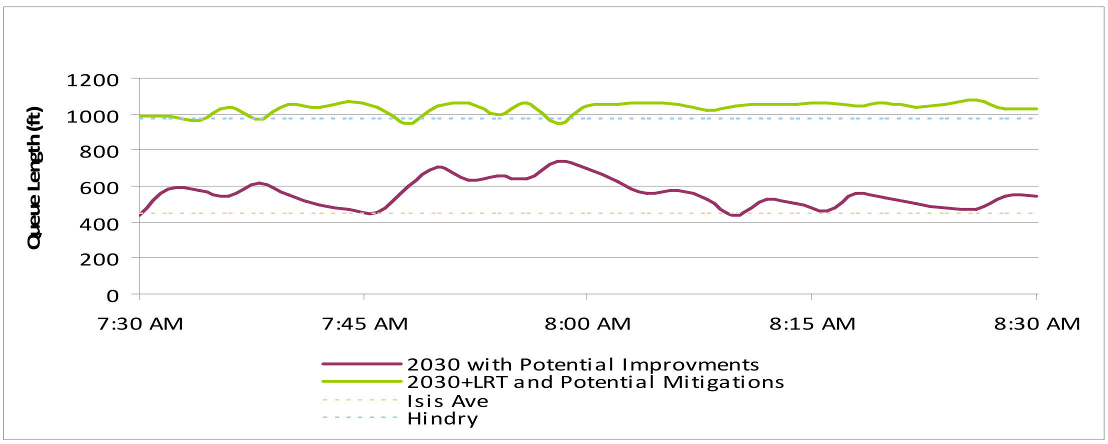


Chart 5-3. Florence/Manchester/Aviation: Southbound Right-Turn Queue in A.M. Peak Hour

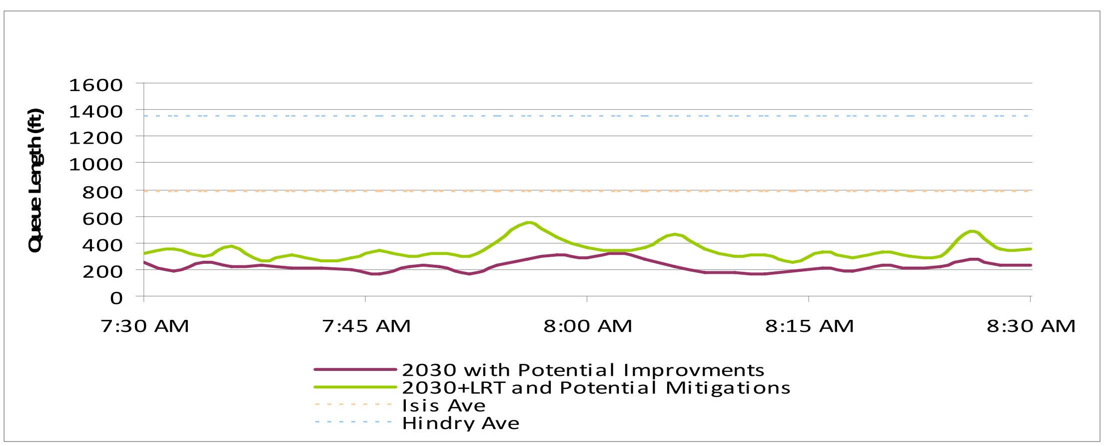


Chart 5-4. Florence/Manchester/Aviation: Northbound Left-Turn Queue in A.M. Peak Hour

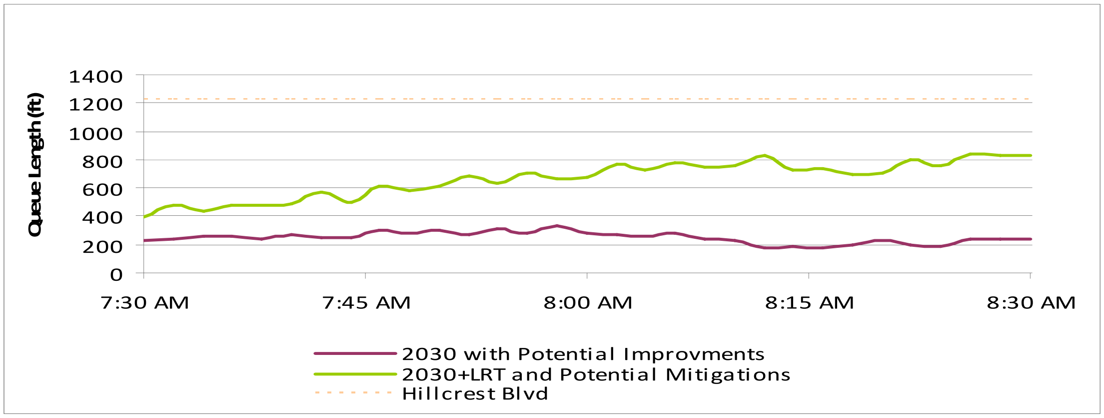


Chart 5-5. Florence/Manchester/Aviation: Eastbound Through Queue in P.M. Peak Hour

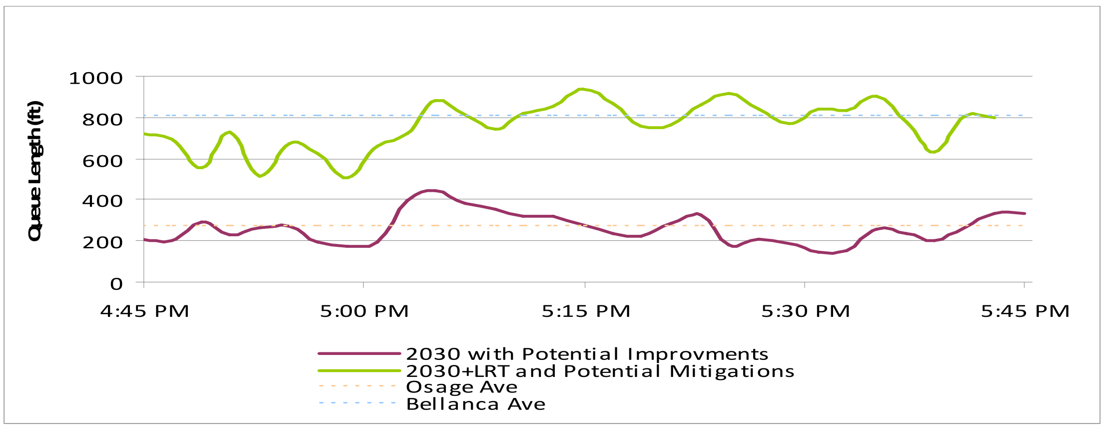


Chart 5-6. Florence/Manchester/Aviation: Westbound Left-Turn Queue in P.M. Peak Hour

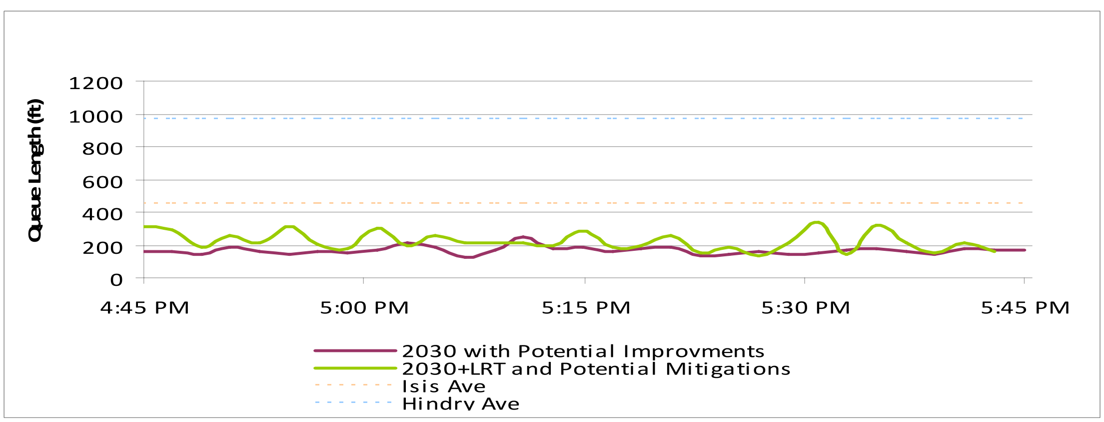


Chart 5-7. Florence/Manchester/Aviation: Southbound Right-Turn Queue in P.M. Peak Hour

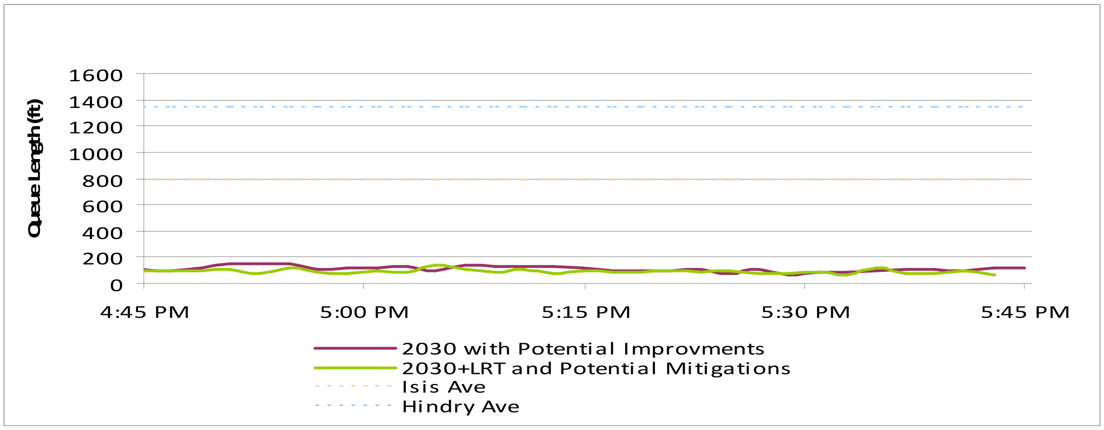
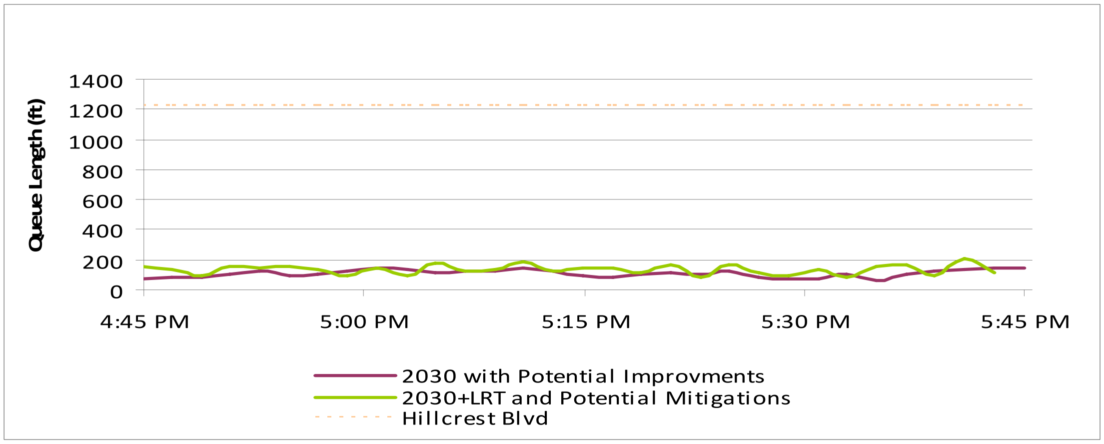


Chart 5-8. Florence/Manchester/Aviation: Northbound Left-Turn Queue in P.M. Peak Hour



In addition, Figure 5-1 and Figure 5-2 show the screen captures from the VISSIM micro-simulation models for the a.m. peak hour and p.m. peak hour, respectively. A significant eastbound queue is expected in the p.m. peak hour. This queue is long enough to spillback into the next upstream signalized intersection, Bellanca Avenue.

Figure 5-1. Future 2030 with LRT and Potential Mitigation Traffic Queuing Conditions Snapshot at Aviation Boulevard/Manchester Avenue Intersection in A.M. Peak Hour

Figure 5-2. Future 2030 with LRT and Potential Mitigation Traffic Queuing Conditions Snapshot at Aviation Boulevard/Manchester Avenue Intersection in P.M. Peak Hour

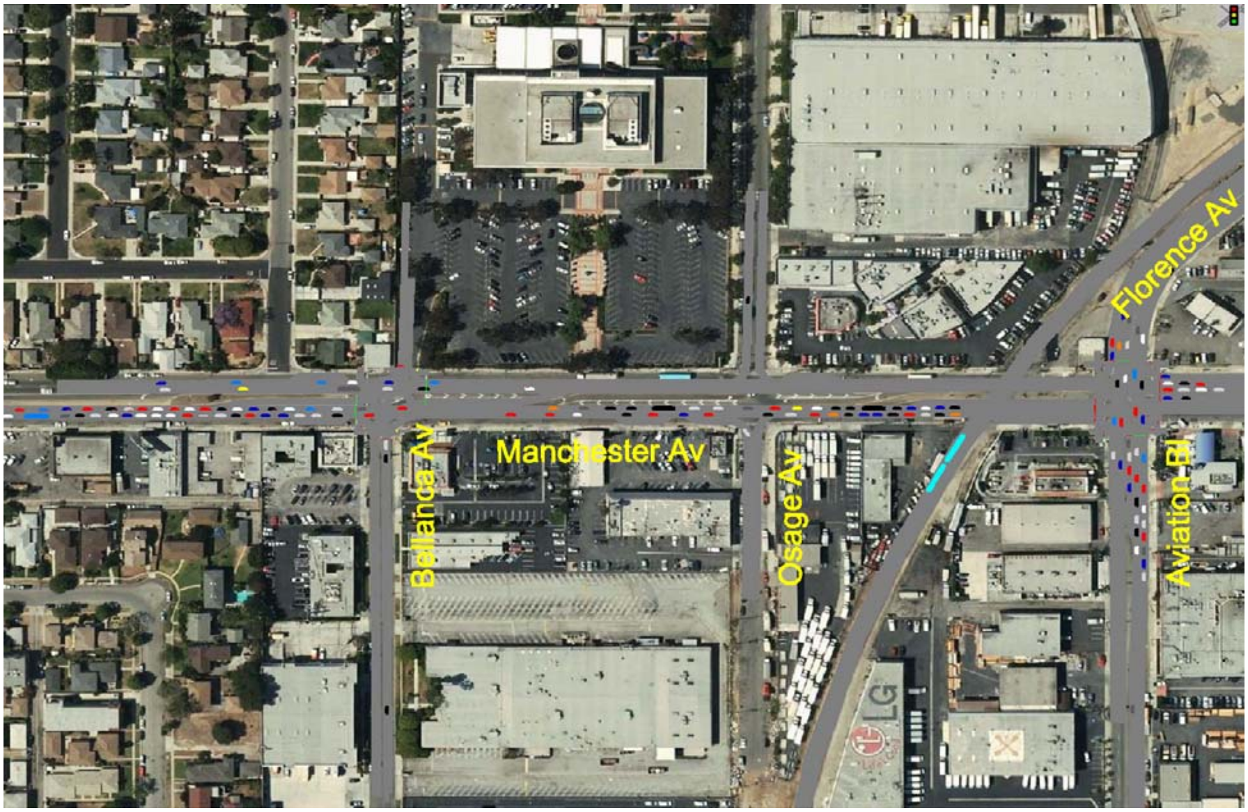


Chart 5-9 through Chart 5-14 illustrate the hourly profile of the vehicle queuing conditions for the critical movement during each signal cycle at the intersection of Florence Avenue/Centinela Avenue under the 2030 plus LRT with potential mitigation scenario (green line). As shown in Chart 5-9 through Chart 5-14, there is a large queue that forms in the p.m. peak hour for the southbound approach movement under the future 2030 with LRT and potential mitigation scenario.

Chart 5-9. Florence/Centinela: Southbound Through Queue in A.M. Peak Hour

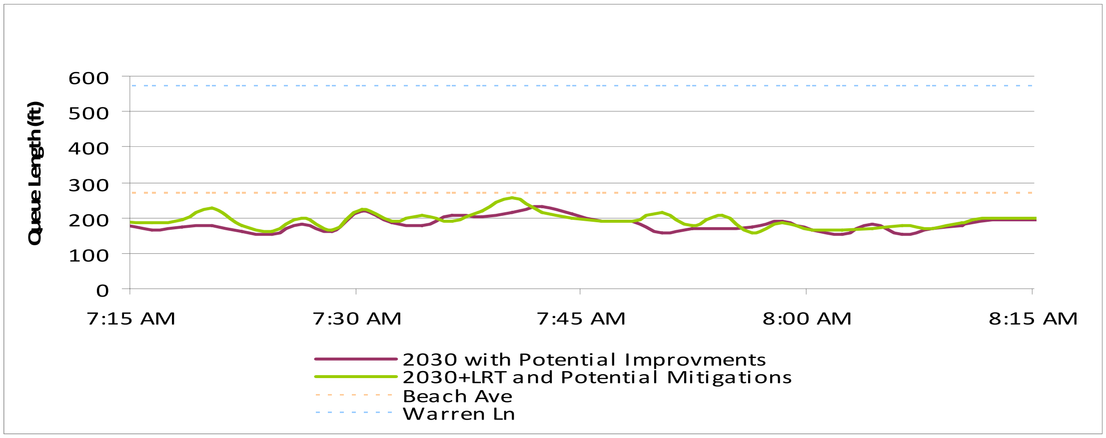


Chart 5-10. Florence/Centinela: Eastbound Left-Turn Queue in A.M. Peak Hour

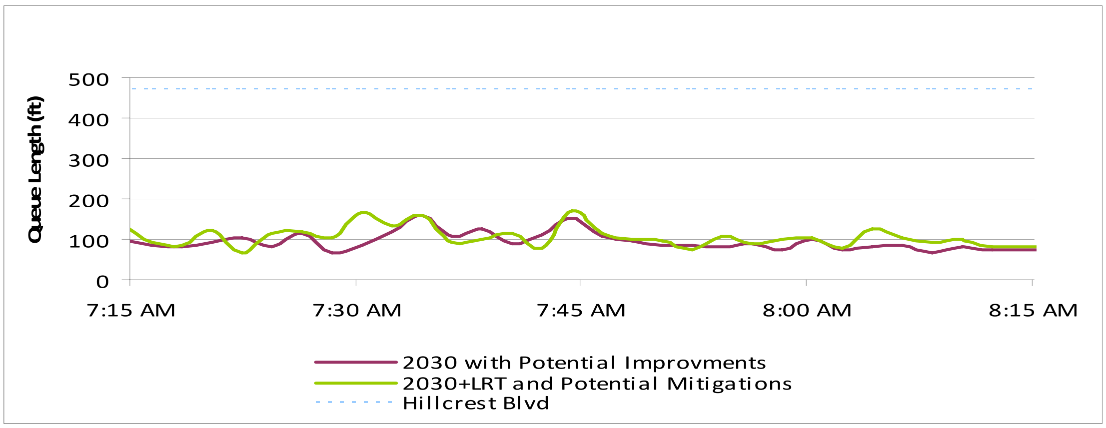


Chart 5-11. Florence/Centinela: Westbound Right-Turn Queue – A.M. Peak Hour

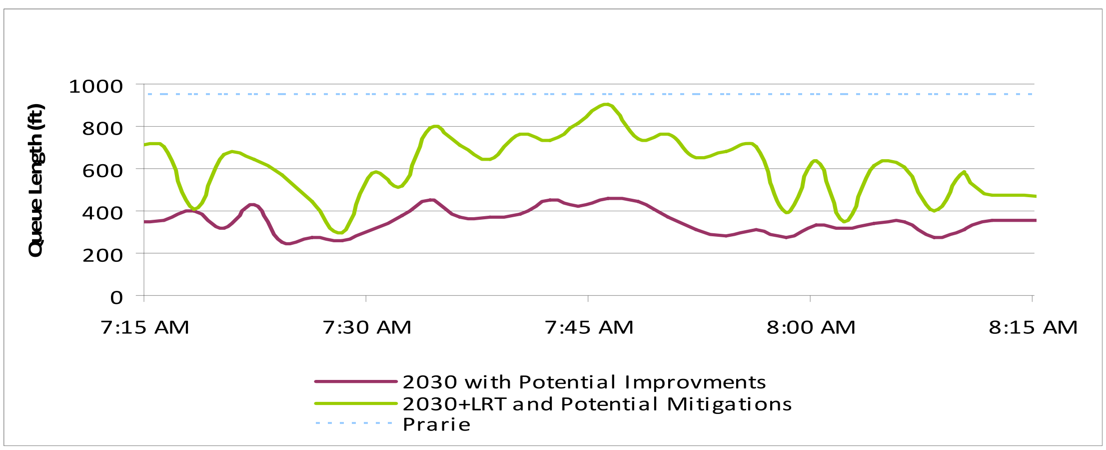


Chart 5-12. Florence/Centinela: Southbound Right-Turn or Left-Turn Queue - P.M. Peak

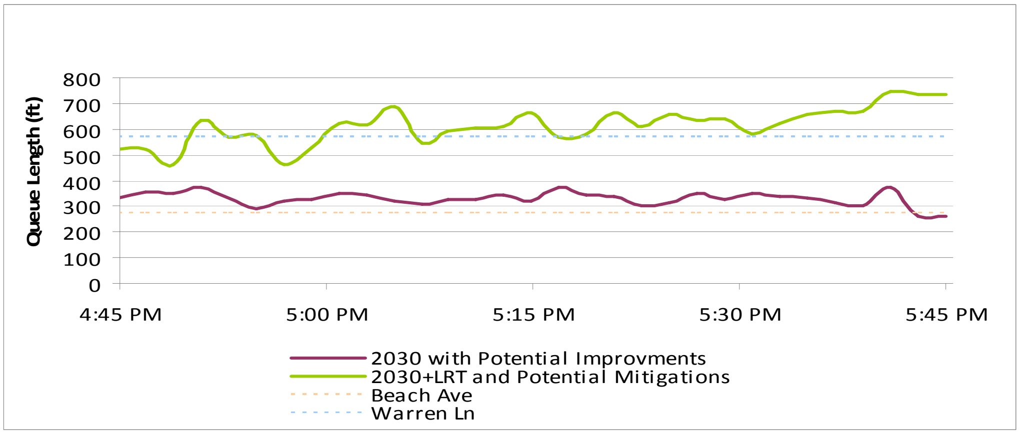


Chart 5-13. Florence/Centinela: Eastbound Left-Turn Queue - P.M. Peak

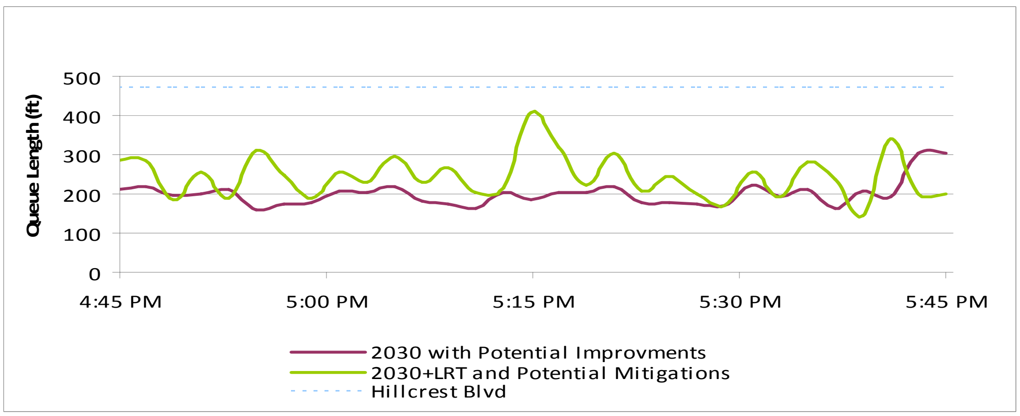


Chart 5-14. Florence/Centinela: Westbound Right-Turn Queue - P.M. Peak

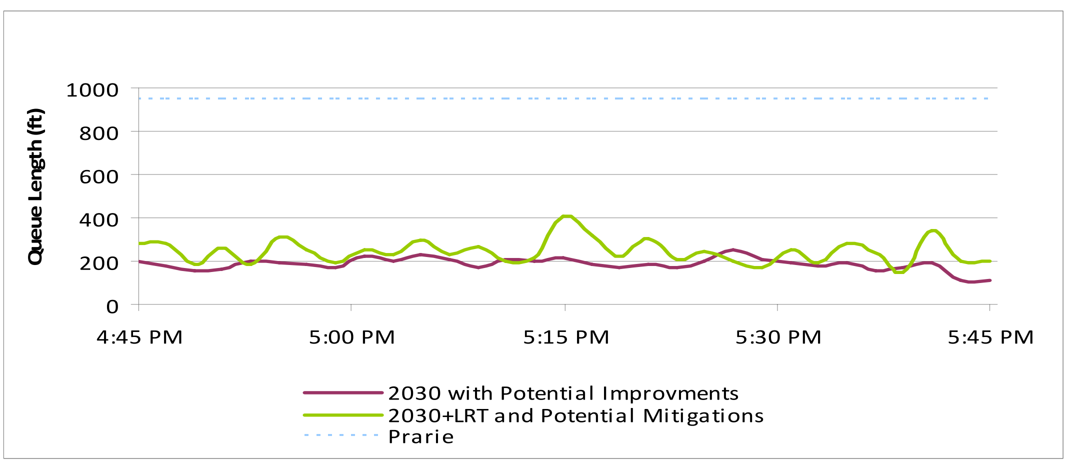


Figure 5-3 and Figure 5-4 show the snapshots of the traffic queuing conditions during the a.m. and p.m. peak hour, respectively.

Figure 5-3. Future 2030 with LRT and Potential Mitigations Traffic Queuing Conditions Snapshot at Florence Avenue/Centinela Avenue Intersection in A.M. Peak Hour

Figure 5-4. Future 2030 with LRT and Potential Mitigations Traffic Queuing Conditions Snapshot at Florence Avenue/Centinela Avenue Intersection in P.M. Peak Hour

Chart 5-15 through Chart 5-18 illustrate the hourly profile of the vehicle queuing conditions for the critical movement during each signal cycle at the intersection of Florence Avenue/Redondo Boulevard under the 2030 plus LRT and potential mitigation scenarios (green line). As shown in Chart 5-15 through Chart 5-18, there is no significant queuing issue at the Florence/Redondo intersection. Figure 5-5 and Figure 5-6 show the snapshots of the traffic queuing conditions during the a.m. and p.m. peak hour, respectively.

Chart 5-15. Florence/Redondo: Southbound Right-Turn Queue in A.M. Peak Hour

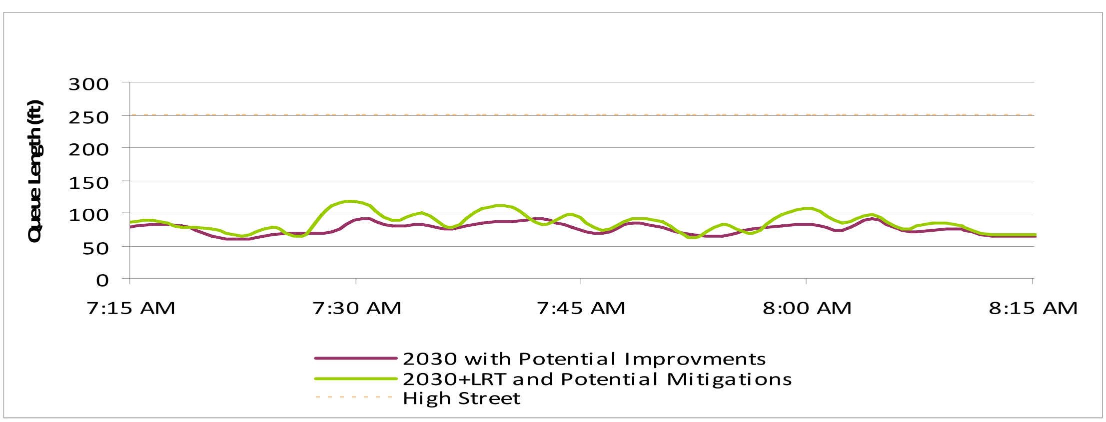


Chart 5-16. Florence/Redondo: Eastbound Left-Turn Queue in A.M. Peak Hour

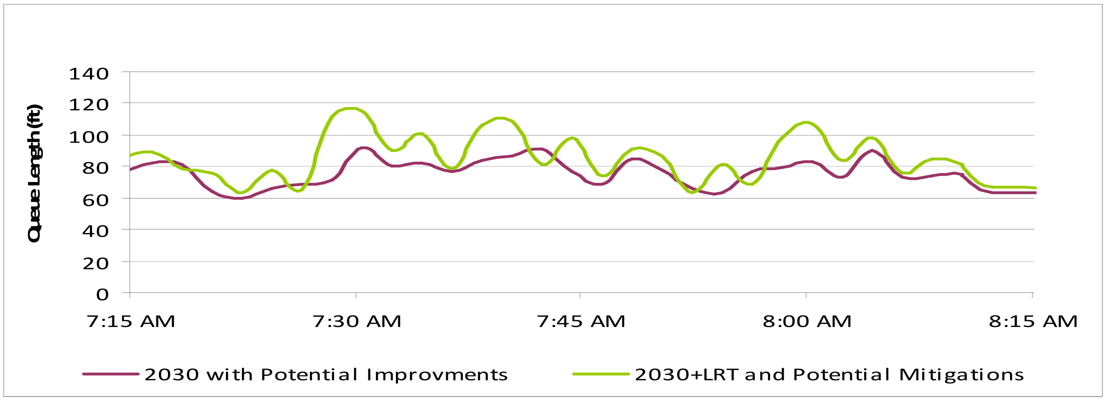


Chart 5-17. Florence/Redondo: Southbound Right-Turn Queue in P.M. Peak Hour

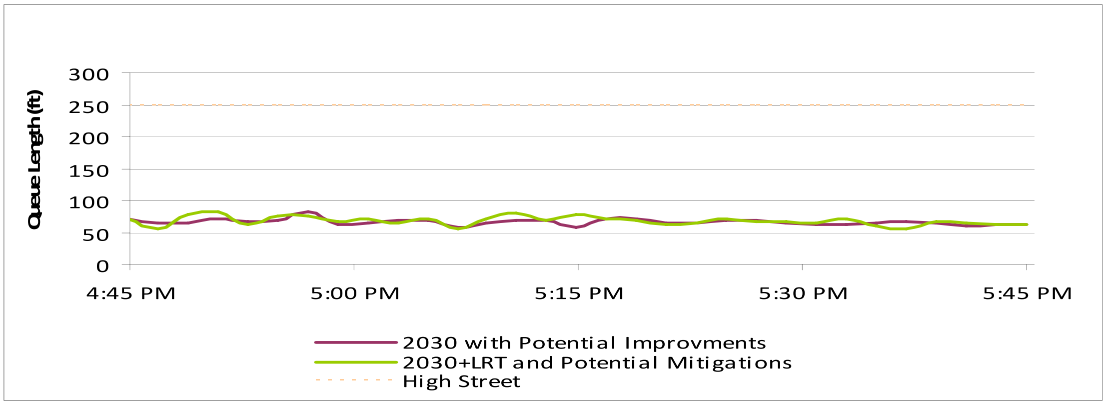


Chart 5-18. Florence/Redondo: Eastbound Left Queue in P.M. Peak Hour

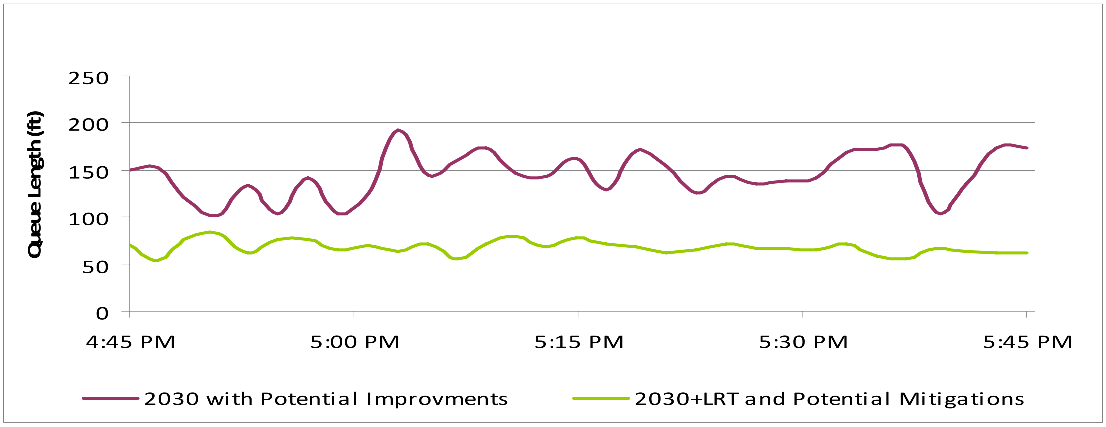


Figure 5-5. Future 2030 with LRT and Potential Mitigations Traffic Queuing Conditions Snapshot at Florence Avenue/Redondo Boulevard Intersection in A.M. Peak Hour

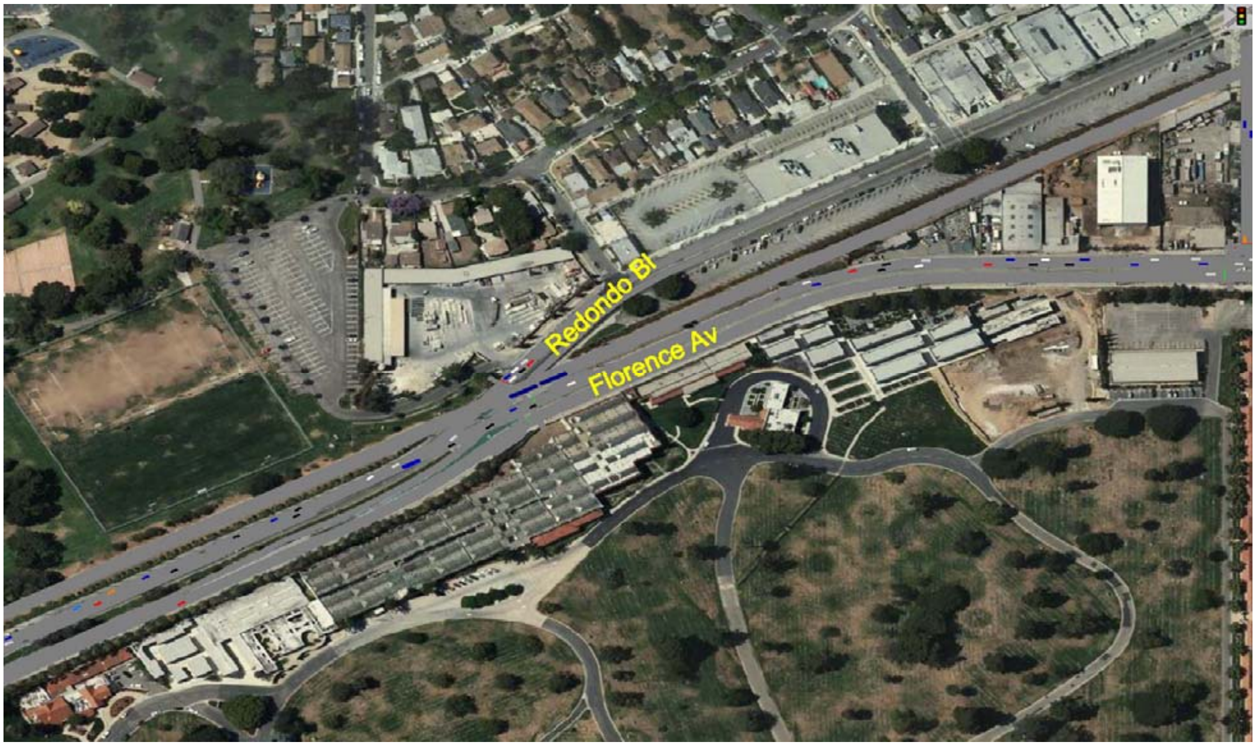
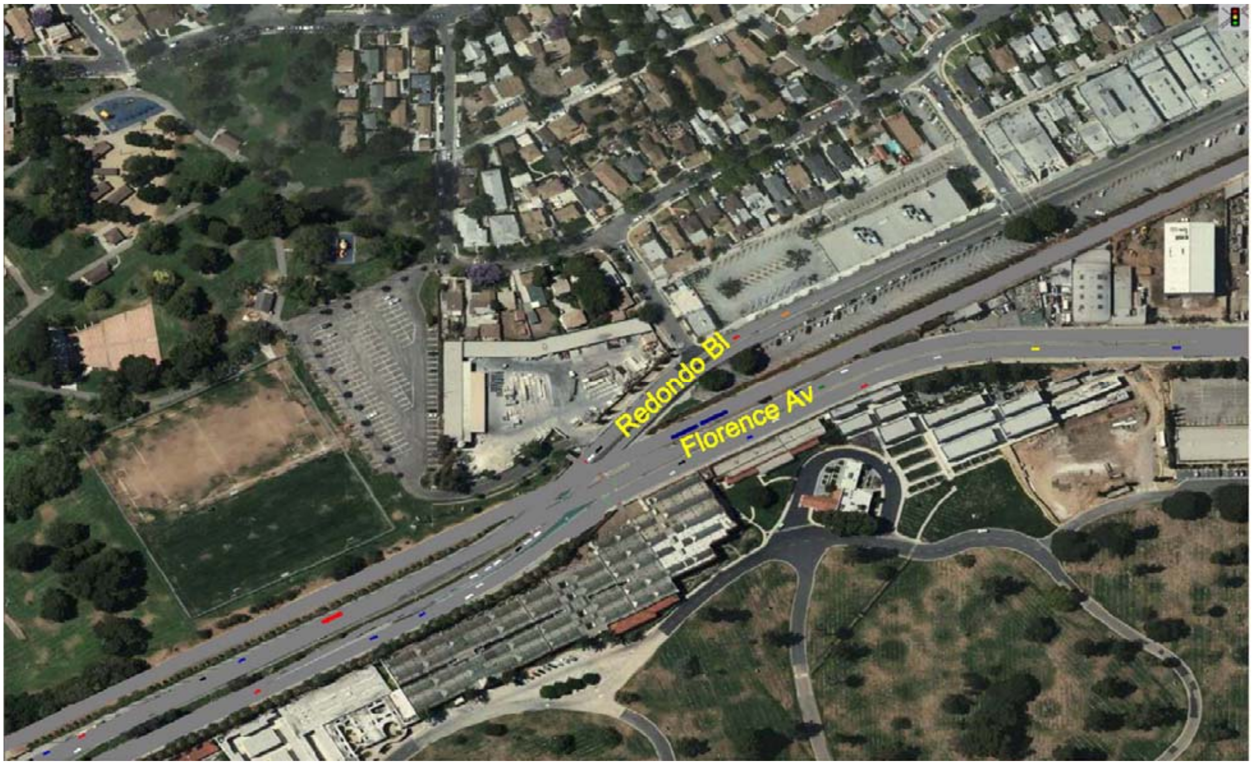


Figure 5-6. Future 2030 with LRT and Potential Mitigation Traffic Queuing Conditions Snapshot at Florence Avenue/Redondo Boulevard Intersection in P.M. Peak Hour



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6.0 ALTERNATIVE ANALYSIS WITH FIVE-MINUTE HEADWAYS

An alternative analysis was performed to understand the effect of increasing the LRT train frequency from 10-minute headways to 5-minute headways and to determine the feasibility of operating the LRT trains at five-minute headways.

Quantitative simulation and impact analysis were performed for the Florence/Centinela and Florence/Redondo intersections, and qualitative analysis was provided for the Florence/Aviation/Manchester intersection, as presented below.

6.1 Florence/Aviation/Manchester Intersection

Increasing the train frequency from 10-minute headways to 5-minute headway at the Florence/Aviation/Manchester intersection would cause even greater vehicle delay and queuing on the cross streets interrupted by the LRT train operations. Previously proposed mitigation for the proposed 10-minute headway operation in Section 5.2 would not fully mitigate the project's significant traffic impact resulting from the LRT operations at 5-minute headways. Additional mitigation or design option (such as grade separation) would need to be explored jointly with Metro and LADOT.

6.2 Florence/Centinela Intersection

With the alternative 5-minute headways operations, the Florence/Centinela intersection is projected to experience a significant project traffic impact during both peak hours, as shown in Table 6-1. The projected LOS for this intersection would change from LOS C to LOS E in both peak hours from 2030 No Build to 2030 with Project conditions.

To mitigate the potential impact related to the LRT operations at 5-minute headways, the following improvements can be considered at the Florence/Centinela intersection:

- Convert the current eastbound left-turn lane to dual left-turn lanes with protected only left-turn phasing. This improvement would be necessary for the p.m. peak hour.
- Convert the westbound right-turn lane from one exclusive right-turn lane and a shared right/through lane to two exclusive right-turn lanes with phasing that provides for overlapping with the southbound left turn movement. This would require an arrow signal to the westbound right turn lane.
- Add an arrow signal to the southbound right-turn movement so that it can be overlapped with the eastbound left-turn movement.

Implementation of the proposed mitigation would mitigate the project's significant traffic impacts as a result of the LRT operations with 5-minute headways at the Florence/Centinela intersection. It would also improve the intersection operating conditions from LOS E to LOS C during both peak hours. Table 6-1 summarizes the intersection analysis results for this location.

6.3 Florence/Redondo Intersection

The Florence/Redondo intersection is projected to experience a significant traffic impact to delay under future plus LRT conditions at 5-minute headways in the a.m. peak hour. The projected LOS for this intersection is expected to change from LOS B to LOS D in the a.m. peak hour and remain operating LOS A in the p.m. peak hour due to the increased train frequency. This increase in delay is not because of the LRT operations directly at Florence/Redondo intersection, but because of queues spilling back from the downstream Florence/Centinela intersection into the intersection at Florence/Prairie, and these queues in turn spilling back into the intersection at Florence/Redondo. As the impacts at the downstream Florence/Centinela are addressed with the proposed mitigation described in the previous Section 6.2, those queues would not spillback into the intersection at Florence/Redondo, which would then result in acceptable levels of delay with no residual impact at Florence/Redondo.

As shown in Table 6-1, implementation of the proposed mitigation at the downstream Florence/Centinela intersection would mitigate the significant traffic impacts in the a.m. peak hour. It would also improve the intersection operating conditions from LOS D to LOS B in the a.m. peak hour at the Florence/Redondo intersection.

Table 6-1. Summary of Intersection Level of Service Analysis with 5-Minute Headways for LRT Operations at the Florence/Centinela Intersection and at the Florence/Redondo Intersection

	2009		2030 No Build		2030 w/ Potential Improvements		2030 with LRT 5-minute Headways				2030 with LRT (5-minute Headways) and Potential Mitigation			
Location	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay Change over No Build	Significant Impact?	Delay	LOS	Delay Change over No Build	Residual Impact?
A.M. Peak Hour Level of Service														
Florence/Centinela	15.2	B	22	C	22	C	78.1	E	56.1	Yes	26.5	C	4.5	No
Florence/Redondo	10	A	13.6	B	13.6	B	46.0	D	32.4	Yes [1]	14.9	B	1.4	No [2]
P.M. Peak Hour Level of Service														
Florence/Centinela	19.7	B	23.5	C	23.5	C	66.1	E	42.6	Yes [1]	25.9	C	2.4	No [2]
Florence/Redondo	5.4	A	6	A	6	A	7.9	A	1.9	No	7.6	A	1.6	No

[1] This traffic impact at Florence/Redondo intersection in the a.m. peak hour is not because of the LRT operations directly at this location, but is because of queues spilling back from the downstream Florence/Centinela intersection into the intersection at Florence/Prairie, and these queues in turn spilling back into the intersection at Florence/Redondo.

[2] As the impacts at the downstream Florence/Centinela are addressed with the proposed mitigation described in the previous Section 6.2, those queues would not spillback into the intersection at Florence/Redondo, which would then result in acceptable levels of delay with no residual impact at both Florence/Centinela and Florence/Redondo intersections.

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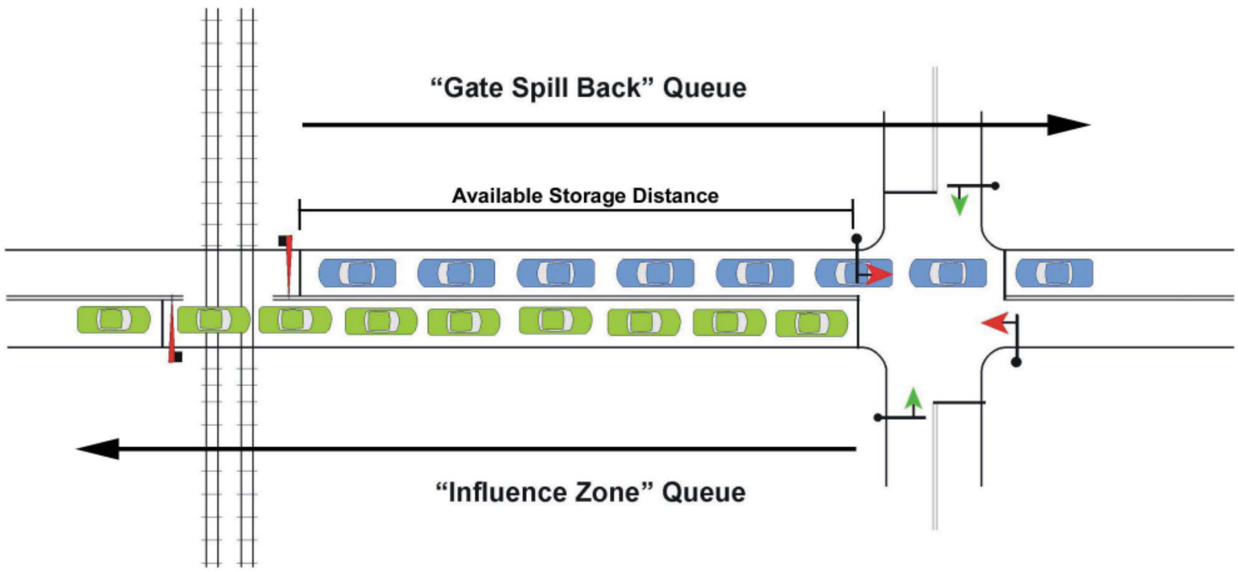
7.0 INFLUENCE ZONE QUEUE AND CROSSING SPILLBACK QUEUE ANALYSIS

This queuing analysis was completed in accordance with the Metro Grade Crossing Policy. Figure 7-1 illustrates the two types of queuing that interact with an at-grade crossing. The first queue that was calculated is the "influence zone" queue. This is a queue that forms at a signal and could back onto the crossing. Also analyzed is the "gate spillback" queue formed from the at-grade crossing and could spillback into an adjacent intersection.

Figure 7-1. Influence Zone Queues and Spillback Queues (Source: Metro Grade Crossing Policy)



For the purpose of this analysis, computation of the influence zones and the gate spillback queues were provided in two methods:

- Maximum design queue - based on the Webster Uniform Delay model Formula indicated in the Appendix A of the MTA Grade Crossing Policy (Page A-10), and
- Maximum simulated queue - reported from the traffic micro-simulation developed for the intersection level of service analysis.
- To be conservative, the greater queues from the two methods were used to compare to the existing queuing storage for the determination of the queuing impacts.
- As per the policy, the maximum design queue is calculated based on vehicle arrival rates, signal timing parameters, and average calculated delay. The following assumptions were used in estimating the maximum design queues:
- The estimated queue length was factored by a peaking factor of 1.5 to identify the maximum design queue that could occur during the peak period due to cycle-to-cycle variations in arrival rate.

- The average vehicle has a length of 22 feet.
- The Red Time was calculated from the anticipated timing plans developed for 2030 conditions.
- The Average Delay was derived from the micro-simulation that was performed at each of the crossings.

Table 7-1 through Table 7-8 presented the influence zone queues and the gate queues from the Webster Formula and the micro-simulation results. The greater value of the maximum design queue and the maximum simulated queues was compared to the available queuing storages at each location for 2030 with LRT crossing conditions. Based on the results shown in Table 7-1 through Table 7-8, significant queuing conditions because of the LRT operations are expected at the Florence/Aviation/Manchester and Florence/Centinela intersections.

7.1 Florence/Aviation/Manchester Intersection

With the proposed 10-minute headways for the LRT operations at the Florence/Aviation/Manchester intersection, both the projected influence zone queues and the gate spillback queues may potentially exceed the queuing storages on Manchester Avenue between Aviation Boulevard and Bellanca Avenue in both peak a.m. and p.m. peak hours.

Increasing the headways from 10 minutes to 5 minutes will further extend the influence zone queues and gate spillback queues beyond the available queuing storage on Manchester Avenue.

Proposed roadway improvements (Section 5.2.2) to mitigate the intersection impacts would <u>not</u> fully mitigate the influence zone queues or gate spillback queues for future plus LRT operations at 10-minute or 5-minute headways. Potential anti-queuing control could be installed, such as installation of “DO NOT BLOCK INTERSECTION” sign and “KEEP CLEAR” marking. Design option such as grade separation should also be considered.

7.2 Florence/Centinela Intersection

With proposed 10-minute headways for the LRT operations at Florence/Centinela intersection, the projected influence zone queues (northbound traffic queue extending from Warren Lane) would be sufficiently accommodated within the existing storage during both peak hours. However, the projected southbound queues would spillback from the gate into the intersection at Warren Lane/Centinela in the p.m. peak hour. Another concern is the potential influence zone queue blocking the emergency vehicle garage located at southeast corner of Centinela Avenue/Warren Lane.

This issue could be partially mitigated by the installation of signage for southbound vehicles not to block the intersection at Warren Lane and for northbound vehicles not to block the driveway to the emergency vehicle garage.

With the alternative 5-minute headways for the LRT operations, this intersection may be impacted due to the projected influence zone queue (northbound traffic) in the a.m. peak hour and the projected gate spillback queue (southbound traffic) in the p.m. peak hour. The proposed roadway improvements (Section 6.2) to mitigate the intersection impacts would not fully mitigate the queuing impacts, and, however may result in secondary impact to the northbound queuing conditions in the p.m. peak hour. Implementation of the proposed intersection improvements would increase the traffic volume served at this intersection in each signal cycle. This may result in a secondary impact of traffic increase on Centinela Avenue in the peak hour. As a result, motorists traveling northbound at Centinela and Warren may experience increase in traffic queuing. The micro-simulation for Florence/Centinela intersection indicates that the projected northbound queue extending from Warren Lane may exceed the available storage and spill back to the proposed LRT crossing at Florence/Centinela intersection.

Potential anti-queuing control could be installed, such as installation of “DO NOT BLOCK INTERSECTION” sign, “DO NOT STOP ON TRACKS”, “WAIT HERE”, and “KEEP CLEAR” markings.

7.3 Florence/Redondo Intersection

No issue related to gate spillback or influence zone queues were found with 10- or 5-minute headways for LRT operations at the Florence/Redondo intersection. Since the volumes are low and the storage space is large, no significant influence zone queues or gate spillback queues are expected for this proposed at-grade crossing.

Table 7-1. Projected Influence Zone Queues – 2030 with LRT Crossing with 10-Minute Headways (No Improvements)

Grade Crossing	Cross Street	Direction	Peak Hour	Queuing Analysis: Volume (Veh/Sec)	Red Time (Sec)	Delay (Sec)	Max Design Queue (Ft)	Max Simulated Queue (Ft)	Available Storage (ft)	Sufficient Queuing Storage?
Florence/ Aviation/ Manchester	Aviation	EB	A.M.	0.31	40	135.3	1573	>130	130	No [2]
			P.M.	0.35	32	29.3	525	>130	130	No [2]
	Bellanca	WB	A.M.	0.67	51	48.7	1646	>805	805	No [2]
			P.M.	0.38	40	9.2	367	>805	805	No [2]
Florence/ Centinela	Warren	NB	A.M.	0.49	46	9.6	524	568	575	Yes [3]
			P.M.	0.37	46	8	375	444	575	Yes
Florence/ Redondo	West	EB	A.M.	0.09	60	n/a [1]	88	n/a [1]	1390	Yes
			P.M.	0.08	60	n/a [1]	80	n/a [1]	1390	Yes

1. Florence/West intersection was not included in the simulation model, therefore average vehicle delay and simulated queue length are not provided for this location. The maximum design queue per the Webster Formula was compared to the available storage for this analysis.
2. Available queuing storage is insufficient to meet the maximum design queue and/or the maximum simulated queue.
3. Maximum Simulated Queue is within one car length of exceeding the available storage.

Table 7-2. Projected Influence Zone Queues – 2030 with LRT Crossing with 10-Minute Headways with Improvements

Grade Crossing	Cross Street	Direction	Peak Hour	Queuing Analysis: Volume (Veh/Sec)	Red Time (Sec)	Delay (Sec)	Max Design Queue (Ft)	Max Simulated Queue (Ft)	Available Storage (ft)	Sufficient Queuing Storage?
Florence/ Aviation/ Manchester	Aviation	EB	A.M.	0.31	40	135.3	1573	>130	130	No [1]
			P.M.	0.35	32	29.3	525	>130	130	No [1]
	Bellanca	WB	A.M.	0.67	51	48.7	1646	>805	805	No [1]
			P.M.	0.38	40	9.2	367	536	805	Yes

1. Available queuing storage is insufficient to meet the maximum design queue and/or the maximum simulated queue.

Table 7-3. Projected Gate Spillback Queues – 2030 with LRT Crossing with 10-Minute Headways (No Improvements)

				Queuing Analysis						
Grade Crossing	Cross Street	Direction	Peak Hour	Volume (Veh/Sec)	Red Time (Sec)	Delay (Sec)	Max Design Queue (Ft)	Max Simulated Queue (Ft)	Available Storage (ft)	Sufficient Queuing Storage?
Florence/ Aviation/ Manchester	Aviation	WB	A.M.	0.41	45	n/a [1]	306	>130	130	No [2]
			P.M.	0.34	45	n/a [1]	253	>130	130	No [2]
	Bellanca	EB	A.M.	0.35	45	n/a [1]	261	>805	805	No [2]
			P.M.	0.53	45	n/a [1]	394	>805	805	No [2]
Florence/ Centinela	Warren	SB	A.M.	0.23	45	35.8	452	337	575	Yes
			P.M.	0.37	45	73	1177	>575	575	No [2]
Florence/ Redondo	West	WB	A.M.	0.09	45	25.3	149	153	1390	Yes
			P.M.	0.07	45	22.5	107	110	1390	Yes

1. Overflow condition indicating oversaturated conditions for long periods. Average vehicle delay cannot be calculated at this gated crossing.
2. Available queuing storage is insufficient to meet the maximum design queue and/or the maximum simulated queue.

Table 7-4. Projected Gate Spillback Queues – 2030 with LRT Crossing with 10-Minute Headways with Improvements

				Queuing Analysis						
Grade Crossing	Cross Street	Direction	Peak Hour	Volume (Veh/Sec)	Red Time (Sec)	Delay (Sec)	Max Design Queue (Ft)	Max Simulated Queue (Ft)	Available Storage (ft)	Sufficient Queuing Storage?
Florence/ Aviation/ Manchester	Aviation	WB	A.M.	0.41	45	n/a [1]	306	>130	130	No [2]
			P.M.	0.34	45	n/a [1]	253	>130	130	No [2]
	Bellanca	EB	A.M.	0.35	45	n/a [1]	261	>805	805	No [2]
			P.M.	0.53	45	n/a [1]	394	>805	805	No [2]

1. Overflow condition indicating oversaturated conditions for long periods. Average vehicle delay cannot be calculated at this gated crossing.
2. Available queuing storage is insufficient to meet the maximum design queue and/or the maximum simulated queue.

Table 7-5. Projected Influence Zone Queues – 2030 with LRT Crossing with 5-minute Headways (No Improvements)

Grade Crossing	Cross Street	Direction	Peak Hour	Queuing Analysis: Volume (Veh/Sec)	Red Time (Sec)	Delay (Sec)	Max Design Queue (Ft)	Max Simulated Queue (Ft)	Available Storage (ft)	Sufficient Queuing Storage?
Florence/ Centinela	Warren	NB	A.M.	0.49	46	10	531	558	575	**Yes** [1]
			P.M.	0.37	46	16	472	553	575	**Yes** [1]
Florence/ Redondo	West	EB	A.M.	0.09	60	n/a [2]	88	n/a [2]	1390	Yes
			P.M.	0.08	60	n/a [2]	80	n/a [2]	1390	Yes

1. Maximum Simulated Queue is within one car length of exceeding available storage. As the simulation model is the stochastic model, depending on the time of the day and the length of the cars, the projected influence zone queues are expected to often exceed the available storage.
2. Florence/West intersection was not included in the simulation model, therefore average vehicle delay and simulated queue length are not provided for this location. The maximum design queue per the Webster Formula was compared to the available storage for this analysis.

Table 7-6. Projected Influence Zone Queues – 2030 with LRT Crossing with 5-minute Headways with Improvements

Grade Crossing	Cross Street	Direction	Peak Hour	Queuing Analysis: Volume (Veh/Sec)	Red Time (Sec)	Delay (Sec)	Max Design Queue (Ft)	Max Simulated Queue (Ft)	Available Storage (ft)	Sufficient Queuing Storage?
Florence/ Centinela	Warren	NB	A.M.	0.49	46	10.7	542	>575	575	**No** [2]
			P.M.	0.37	46	6.9	362	474	575	Yes
Florence/ Redondo	West	EB	A.M.	0.09	60	n/a [1]	88	n/a [1]	1390	Yes
			P.M.	0.08	60	n/a [1]	80	n/a [1]	1390	Yes

1. Florence/West intersection was not included in the simulation model, therefore average vehicle delay and simulated queue length are not provided for this location. The maximum design queue based on the Webster Formula was compared to the available storage for this analysis.
2. With the proposed improvements described in Section 6.2 at Florence/Centinela intersection, it is expected that more traffic would be served by this intersection in each signal cycle, which may result in a secondary impact of traffic increase on Centinela Avenue. Due to the increased traffic demand on Centinela Avenue, motorists traveling northbound at Centinela and Warren may experience increase in traffic queuing and travel time. The micro-simulation for Florence/Centinela intersection indicates that the projected influence queues from Warren Lane may exceed the available storage and spill back to the proposed LRT crossing at Florence/Centinela intersection.

Table 7-7. Projected Gate Spillback Queues – 2030 with LRT Crossing with 5-minute Headways (No Improvements)

Grade Crossing	Cross Street	Direction	Peak Hour	Queuing Analysis						
				Volume (Veh/Sec)	Red Time (Sec)	Delay (Sec)	Max Design Queue (Ft)	Max Simulated Queue (Ft)	Available Storage (ft)	Sufficient Queuing Storage?
Florence/ Centinela	Warren	SB	A.M.	0.23	45	49.4	557	465	575	Yes [1]
			P.M.	0.37	45	153.2	2166	680	575	No [2]
Florence/ Redondo	West	WB	A.M.	0.09	45	46.8	216	206	1390	Yes
			P.M.	0.07	45	29.3	123	145	1390	Yes

1. Maximum Simulated Queue is within one car length of exceeding available storage. As the simulation model is the stochastic model, depending on the time of the day and the length of the cars, the projected influence zone queues are expected to often exceed the available storage.
2. Available queuing storage is insufficient to meet the maximum design queue and/or the maximum simulated queue.

Table 7-8. Projected Gate Spillback Queues – 2030 with LRT Crossing with 5-minute Headways with Improvements)

Grade Crossing	Cross Street	Direction	Peak Hour	Queuing Analysis						
				Volume (Veh/Sec)	Red Time (Sec)	Delay (Sec)	Max Design Queue (Ft)	Max Simulated Queue (Ft)	Available Storage (ft)	Sufficient Queuing Storage?
Florence/ Centinela	Warren	SB	A.M.	0.23	45	41.6	497	406	575	Yes
			P.M.	0.37	45	46.1	846	>575	575	No [1]
Florence/ Redondo	West	WB	A.M.	0.09	45	31.9	170	180	1390	Yes
			P.M.	0.07	45	29.6	124	136	1390	Yes

1. Available queuing storage is insufficient to meet the maximum design queue and/or the maximum simulated queue.

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8.0 INITIAL AT-GRADE CROSSING SAFETY ASSESSMENT

As part of the Milestone 2 Analysis, the Metro Grade Crossing Policy requires that a preliminary safety review be conducted for all grade crossings as part of the design process to determine whether adverse safety conditions, in conjunction with adverse operations, would trigger the need for grade separation.

For the preliminary safety assessment, Metro requires that twelve factors and potential mitigation be reviewed related to site-specific evaluation of geometric conditions, projected usage of the crossing, and available crossing design information. Additional data such as accident history, access routes to school and site-specific assessment are required to complete the evaluation during the Preliminary Engineering (PE) Phase of the project. The review results of the initial safety screening are summarized in Table 8-1 through Table 8-3.

Table 8-1. Safety Check for Florence/Aviation/Manchester Intersection

Safety Concern	Safety Check	Potential Mitigation
Traffic Queuing	Insufficient queuing storage for both the projected gate spillback queues and influence zone queues on Manchester Boulevard between Aviation Boulevard and Bellanca Avenue under both 10-minute headway scenarios and 5-minute headway scenarios.	Proposed roadway improvements[1] to mitigate the significant intersection impacts would only partially mitigate the influence zone queue or gate spillback queue. Potential anti-queuing control include: installation of "DO NOT BLOCK INTERSECTION" sign, "DO NOT STOP ON TRACKS", "WAIT HERE", and "KEEP CLEAR" markings. Grade Separation if none feasible.
Approach and Corner Sight Distance	To be determined during the PE Phase	Not required
Visual Confusion / Sign or Signal Clutter	To be determined in the PE Phase.	If any, removal of unnecessary signs/signals
Train Speed	55 mph in the Harbor Subdivision exclusive right-of-way	Not required
Prevailing Traffic Speed	35 mph	Not required
Large Truck Percentage	Potential high percentage of large trucks because of the proximity of the Los Angeles International Airport	Improve signing or traffic signal timing to keep trucks off tracks
Heavy Pedestrian Volumes	Nominal	Four quadrant gates and consideration of pedestrian gates will be evaluated to control pedestrian crossing.
School Access Routes	Data to be obtained from LAUSD during the PE Phase.	Four quadrant gates and consideration of pedestrian gates will be evaluated to control pedestrian crossing. Education programs to be implemented as appropriate.
Accident History	Accident History data to be obtained from LADOT during the PE Phase	To be determined.
Gate Drive Around Potential	None. (Four quadrant gates and pedestrian gates will be provided to minimize potential safety hazard because of driver or pedestrian violation)	Not required
Delineation and Roadway Marking	To be determined during the PE Phase	Increase contrast at crossing or improve Delineation
Traffic Control Observance	Accident History data to be obtained from LADOT during the PE Phase.	Install Active Signs. Increase Enforcement. Consider photo enforcement system.

[1] Proposed mitigation measures to mitigate the impact at the Florence/Aviation/Manchester Avenue intersection are described in Section 5.2, including (1) Extension of southbound right-turn pocket to 415 feet, (2) Addition of new southbound right-turn overlap phase, and(3) Addition of new westbound left-turn protected phase.

Table 8-2. Safety Check for Florence/Centinela Intersection

Safety Concern	Safety Check	Potential Mitigation
Traffic Queuing	Insufficient queuing storage on Centinela Avenue between the rail tracks and Warren Lane for the projected southbound movement during the p.m. peak hour with proposed 10-minute headway for the LRT operations. Insufficient queue storage for the northbound movement at Centinela Avenue and Warren Lane with proposed 5-minute headway for the LRT operations. Potential queue blocking the emergency vehicle garage located at south east of the adjacent Centinela Avenue/Warren Lane intersection.	Potential anti-queuing controls include: installation of "DO NOT BLOCK INTERSECTION" sign and "KEEP CLEAR" marking.
Approach and Corner Sight Distance	Potential visual obstruction because of the mature plants on Centinela. To be determined in the PE Phase.	Remove the obstruction; Supplemental Active Warning Devices
Visual Confusion/Sign or Signal Clutter	To be Determined during the PE Phase.	Removal of unnecessary signs/signals
Train Speed	55 mph on the Harbor Subdivision exclusive right-of-way	Not required
Prevailing Traffic Speed	40 mph	Not required
Large Truck Percentage	Nominal	Not required
Heavy Pedestrian Volumes	Potential heavy pedestrian crossing volumes during major events in the adjacent Centinela Park or the Inglewood Park Cemetery.	Four quadrant gates and consideration of pedestrian gates will be evaluated to control pedestrian crossing. Education programs to be implemented as appropriate.
School Access Routes	Data to be obtained from LAUSD and appropriate private school operators during the PE Phase.	Four quadrant gates and consideration of pedestrian gates will be evaluated to control pedestrian crossing. Education programs to be implemented as appropriate.
Accident History	Accident history data to be obtained from LADOT during the PE Phase.	To be determined.
Gate Drive Around Potential	None. (Four quadrant gates and pedestrian gates will be provided to minimize potential safety hazard because of driver or pedestrian violation)	Not Required.
Delineation and Roadway Marking	To be determined during the PE Phase.	Increase Contrast at Crossing or Improve Delineation
Traffic Control Observance	Accident history data to be obtained from LADOT during the PE Phase.	Install Active Signs. Increase Enforcement. Consider photo enforcement system.

Table 8-3. Safety Check for Florence/Redondo Intersection

Safety Concern	Safety Check	Potential Mitigation
Traffic Queuing	No issue related to gate spillback or influence zone queues with 10- or 5-minute headway operations.	Not Required.
Approach and Corner Sight Distance	To be determined during the PE Phase.	Remove the obstruction; Supplemental Active Warning Devices; Reduce Allowable Train Speed
Visual Confusion / Sign or Signal Clutter	To be determined during the PE Phase.	Removal of unnecessary signs/signals
Train Speed	55 mph in the Harbor Subdivision exclusive right-of-way	Not required.
Prevailing Traffic Speed	35 mph	Not required
Large Truck Percentage	Nominal	Not required.
Heavy Pedestrian Volumes	Nominal	Four quadrant gates and consideration of pedestrian gates will be evaluated to control pedestrian crossing.
School Access Routes	Data to be obtained from LAUSD during the PE Phase.	Four quadrant gates and consideration of pedestrian gates will be evaluated to control pedestrian crossing. Education programs to be implemented as appropriate.
Accident History	Accident history data to be obtained from LADOT during the PE Phase.	To be determined.
Gate Drive Around Potential	None. (Four quadrant gates and pedestrian gates will be provided to minimize potential safety hazard because of driver or pedestrian violation)	Not Required.
Delineation and Roadway Marking	To be determined during the PE Phase.	Increase Contrast at Crossing or Improve Delineation
Traffic Control Observance	Accident history data to be obtained from LADOT during the PE Phase.	Install Active Signs. Increase Enforcement. Consider photo enforcement system.

9.0 CONCLUSIONS

This study resulted in the following findings:

- Potential significant project intersection impact was identified at the Florence/Manchester/Aviation intersection during both a.m. and p.m. peak hours. Potential mitigations include:
  - Lengthen the southbound right-turn pocket to 415 feet. This improvement would require roadway widening and may involve property acquisition.
  - Add a southbound right-turn overlap phase.
  - Add a westbound left-turn protected phase.

  These mitigation measures are sufficient to allow the future 2030 with LRT scenario to operate at approximately the same level of delay as the future 2030 no build scenario at the Florence/Manchester/Aviation intersection. However, this intersection would remain operating at LOS F during the a.m. peak hour.

  Increasing the LRT train frequency from 10-minute headways to 5-minute headway at this intersection would cause even greater vehicle delay and significant queuing on the cross streets interrupted by the LRT train operations. Previously proposed mitigation for the proposed 10-minute headway would not fully mitigate the project's significant intersection impact resulting from the LRT operations at 5-minute headways.

  To improve the LOS under future with the project's 10-minute headways scenario or to fully mitigate the intersection impact with the 5-minute headways scenario, significant roadway widening of Manchester Avenue to allow a third through traffic lane would be required in each direction. As the impact of the right-of-way acquisition would be difficult to estimate at this planning stage of the project, the feasibility of widening Manchester Avenue would require further consultation with both the City of Los Angeles and the City of Inglewood.

- Potential significant project intersection impact was identified at the Florence/Centinela intersection during the a.m. and p.m. peak hours, with the proposed 10-minute headways for the LRT operations. However, because this intersection is projected to operate at an acceptable LOS D with the LRT operations, mitigation measures are not recommended, unless requested by the City of Inglewood.

- Increasing the train frequency from 10-minute headways to 5-minute headway at this intersection would cause even greater vehicle delay that may require roadway improvements to accommodate the increased train operations. Potential mitigation measures to mitigate the project's intersection under this alternative scenario include:
  - Convert the current eastbound left-turn lane to dual left-turn lanes with protected only left-turn phasing. This improvement would be necessary for the p.m. peak hour.

- ► Convert the westbound right-turn lane from one exclusive right-turn lane and a shared right/through lane to two exclusive right-turn lanes with phasing that provides for overlapping with the southbound left turn movement. This would require an arrow signal to the westbound right turn lane.
- ► Add an arrow signal to the southbound right-turn movement so that it can be overlapped with the eastbound left-turn movement.

- Implementation of these measures would mitigate the project significant intersection impact related to the alternative LRT operation scenario at 5-minute headways, and would improve the operating conditions from LOS E to LOS C during both a.m. and p.m. peak hour.
- In addition, additional ROW would be needed at this intersection for placement of crossing gates, which may require slight encroachment into La Colina Drive or Florence Avenue. With the anticipated traffic queuing on Centinela Avenue southbound lanes due to the gate operations, it is recommended that La Colina Drive remain unsignalized and left-turn movements from La Colina Drive to northbound Centinela Avenue be restricted during the peak periods. In the event that that La Colina Drive is determined to be signalized in the later Advanced Conceptual/Preliminary Engineering design phases, realignment of La Colina Drive or modification to the stop bar locations at this location may be required. However, inclusion of La Colina Drive in the signal phasing and operation may potentially result in additional vehicle delay and queuing at this intersection and may require physical or operational improvements to ensure acceptable operating conditions at this location.
- No significant traffic impact or queuing impact was identified at the Florence/Redondo intersection with 10- or 5-minute headways for LRT operations at the Florence/Redondo intersection.
- A queuing analysis was completed to identify if sufficient queuing storage is provided to accommodate both the "influence zone" queue that forms at a signal and the "gate spillback" queue formed from the at-grade crossing. The analysis indicates that significant queuing conditions because of the LRT operations are expected at the Florence/Aviation/Manchester and Florence/Centinela intersections. Potential anti-queuing control could be installed, such as installation of "DO NOT BLOCK INTERSECTION" sign and "KEEP CLEAR" marking. If such techniques are deemed to be insufficient by CPUC, design options such as grade separations may need to be considered.
- A preliminary safety review was conducted for all grade crossings as part of the design process to determine whether adverse safety conditions, in conjunction with adverse operations, would potentially trigger the need for grade separation. Additional data such as accident history, access routes to school and site-specific assessment are required to complete the evaluation during the Preliminary Engineering Phase of the project.