ATTACHMENT A
Item 2017-0413

iteris®

Metro Orange Line Grade Separation Analysis and Operational Improvements Technical Study

Task 10.0 Executive Summary

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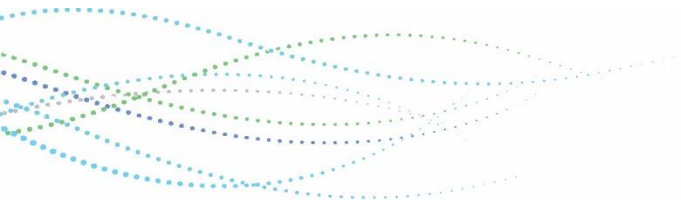


TABLE OF CONTENTS

TABLES

FIGURES

1.0 INTRODUCTION

The Metro Orange Line Grade Separation Analysis and Operational Improvements Technical Study evaluated the feasibility of grade separation improvements at key intersections and other improvements that would enhance existing bus service, performance, and ridership. Other improvements considered included minor street closures, better transit signal priority technology, improved bus signal communication, and a four quadrant gating system. This study covers approximately 12.7 miles of the MOL from the North Hollywood station to the Canoga station, and it does not include the Warner Center or the Chatsworth extensions.

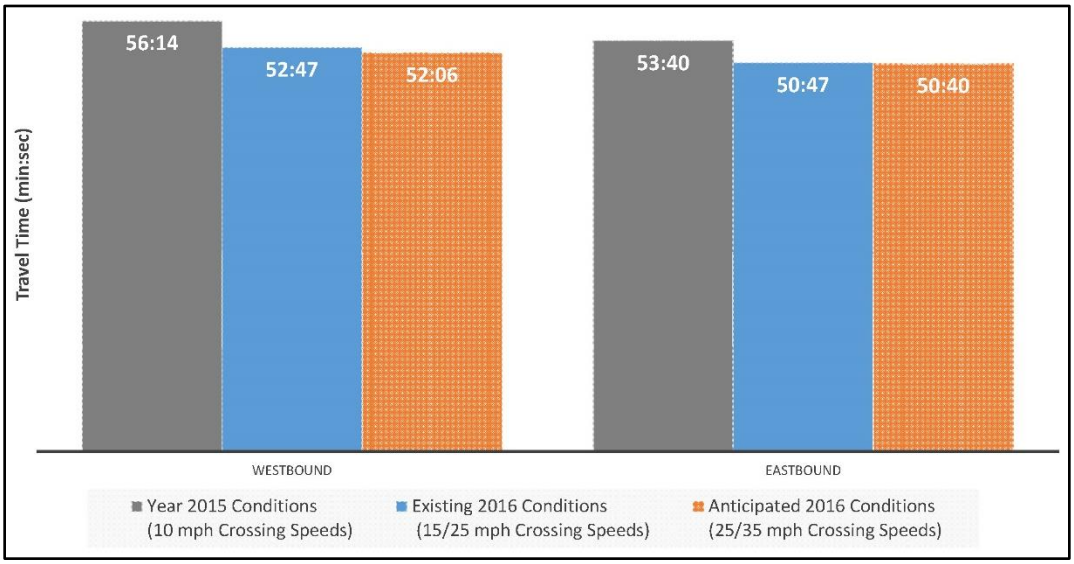
At the conclusion of the feasibility study, several packages of improvements were identified to be brought to the Metro Board. Among the packages of improvements, a single recommended option was developed for the Board's consideration. This alternative would address the operational needs of Orange Line buses and passengers, and improve safety at all the intersections while also falling within the budget allocated in the Measure M Expenditure Plan for Orange Line Bus Rapid Transit (BRT) improvements. This document further details the technical analysis and ultimate recommendation.

2.0 PROJECT PURPOSE AND NEED

To improve operations, address safety concerns, minimize environmental and community impacts, and ensure cost effectiveness, several types of improvements were evaluated throughout this technical study. The purpose of the project is to identify the optimal improvements to address specific goals, as described further below:

- **Improve Operating Speeds** - Improving operating speeds addresses current public complaints of excessive cross-Valley travel times and delays at intersections. Year 2015 intersection crossing speed for MOL buses was 10 miles per hour (mph). In 2016, intersection crossing speeds were increased to 15/25 mph. When the MOL is modeled with improved intersection crossing speeds of 25 mph (crossings adjacent to stations) and 35 mph (at all other crossings) and at the posted speed limit between stations, travel time savings of nearly four minutes may be achieved. **Figure 1** shows the MOL modeled travel time savings with the implementation of higher intersection crossing speeds. Travel time savings may likely be higher with additional enhancements such as grade separations or gate systems, to reduce the potential for unsafe behaviors by cross street traffic (vehicles, pedestrians, and bicycles) crossing the busway.

Figure 1 – MOL Travel Time Comparison (North Hollywood to Chatsworth)



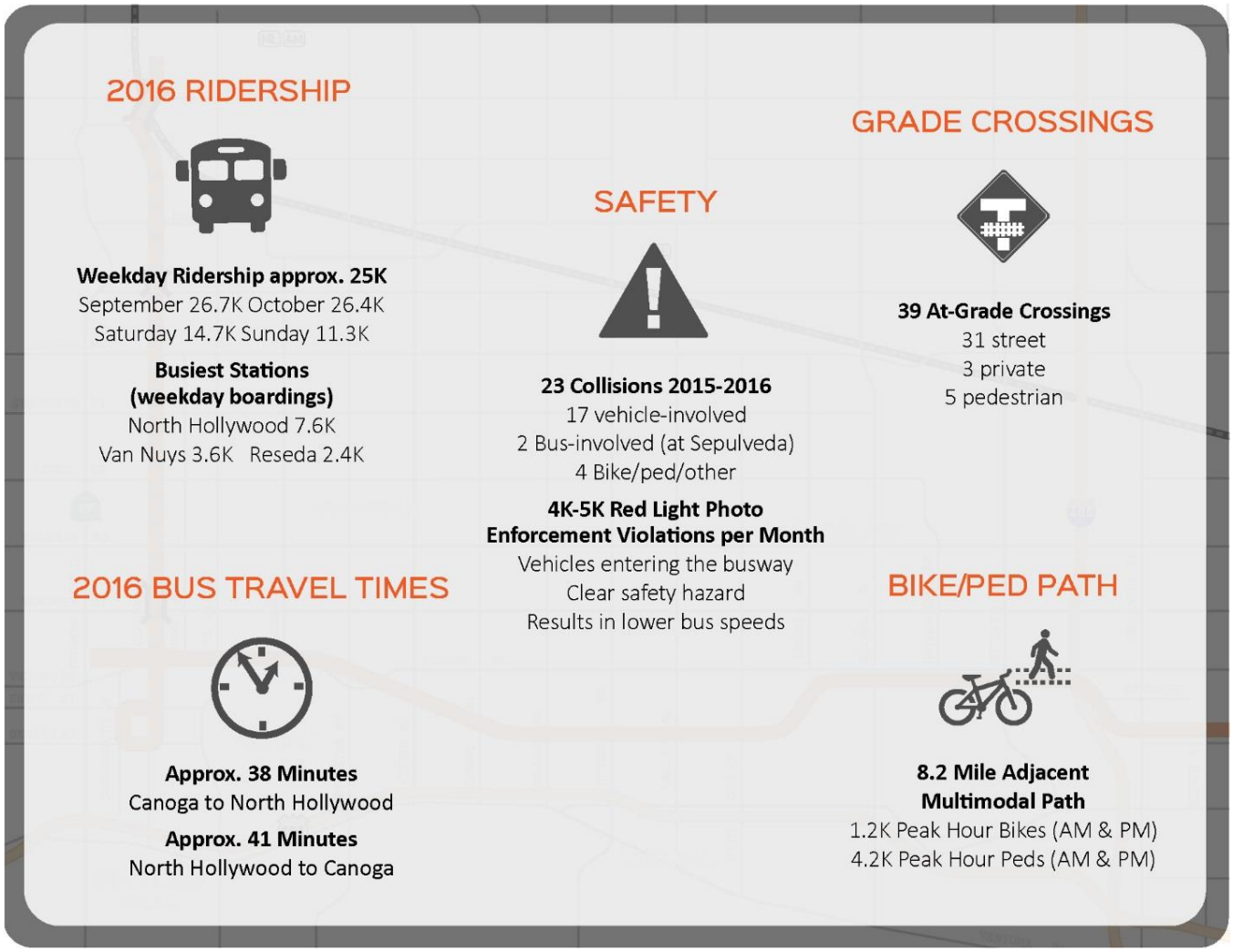
- **Address Safety Concerns** - Given current incident data, there are key locations that would benefit from improvements along the MOL corridor to reduce conflicts between MOL buses, vehicles, bicyclists, and pedestrians. In particular, grade separations at key intersections can minimize conflicts and prevent incidents by physically separating the MOL corridor, potentially including the adjacent bike path, from the crossing roadways. Controlled crossings (e.g., gate controls) would address safety concerns by managing and restricting vehicle and bicycle/pedestrian interactions with MOL operations. Overall, the MOL corridor experienced 23 bus-involved collisions between 2015 and 2016, and these collisions would likely be reduced by additional crossing improvements analyzed as a part of this project.

- **Benefit the Surrounding Community** – Improvements to the MOL corridor can increase bus speeds, decrease end-to-end travel times, increase ridership, improve safety conditions, and provide better overall mobility options for the San Fernando Valley. However, any improvements along the MOL corridor will need to consider impacts during construction and on existing and planned transportation facilities during operation. This includes effects and potential impacts to existing circulation (vehicular, bicycle and pedestrians), land use impacts, effects to transit connectivity, changes to roadway and intersection configurations, effects to parking supply, minimizing pedestrian and bicycle impacts, and any degradation to traffic operations on adjacent streets. It would not be desirable to significantly delay existing MOL riders during construction, as this could reduce ridership by creating lengthy off-corridor detours for the MOL buses. The 2012 Orange Line BRT Sustainable Corridor Implementation Plan (Implementation Plan) called for substantial investment in the corridor including additional housing in station areas and improved active transportation access to/from stations. The Implementation Plan also described the need for short- and long-term operational improvements along the corridor, such as better signal timing, crossing gates, and grade separation at specific intersections. It is important that improvements to the MOL corridor incorporate and reflect these plans and programs, and consider any impacts/effects to San Fernando Valley neighborhoods and communities.

- **Ensure Cost Effectiveness** - The MOL is a successful system as it has an estimated ridership of 25,090 weekday daily boardings (2016 year to date) through the San Fernando Valley. As a Bus Rapid Transit (BRT) facility, the MOL has delivered cost-effective service with an estimated $10 cost per new daily transit trip compared to a light rail service of around $25 per new rider. Improvements to the MOL corridor must ensure costs are commensurate with benefits to continue the overall cost effectiveness of the system. This goal is to ensure financial feasibility in order for the project to achieve reasonable benefits today and in the long term. Short-term improvements must be designed to not preclude conversion to LRT in the future.

Key operational highlights of the existing busway are as shown in **Figure 2**

Figure 2 – Key Operational Highlights



The project study area is shown in **Figure 3**.

Figure 3 – Study Area

Since the project began in September 2016, the project team has conducted the following tasks: Developed a clear purpose and need statement, conducted a review of existing conditions, developed screening criteria to identify improvements and alternatives for further evaluation, conducted detailed technical analyses of a variety of improvements, prepared a preliminary environmental checklist, performed travel demand modeling, developed a matrix of recommended solutions, identified a series of improvement packages for consideration as a part of an identified Measure M expenditure, and identified a recommended base alternative with other options as alternatives for further consideration and study. All these tasks were conducted in order to further document and evaluate the criteria specified in the project's **purpose and need statement**, as shown below:

The Metro Orange Line Grade Separation and Operational Improvements Technical Study seeks to provide safe and cost-effective strategies to improve operating speeds, capacity, and safety, while addressing passenger needs and minimizing disruption to the San Fernando Valley residents.

3.0 EVALUATION, SCREENING, AND RECOMMENDED IMPROVEMENTS

Based on the factors described in the purpose and need statement, the project team identified the following goals, criteria, and performance metrics:

Table 1 – Evaluation Criteria and Performance Measures

GOAL	CRITERIA	PERFORMANCE MEASURE
Improve Operating Speeds	• Reduce bus delays from red lights • Reduce overall person-delay • Improve consistency of bus speeds across the corridor	• Average bus speed at crossing • Red light delay for buses at crossing • Total rider delay • Average bus speed per segment • Stop-to-stop travel time
Address Safety Concerns	• Decrease modal conflicts at crossings • Improve pedestrian and bicyclist safety	• Collisions with buses • Collisions from right-turn-on-red violations • Visibility restrictions • Near-miss collisions • Bicycle/pedestrian collisions
Benefit the Surrounding Community	• Serve surrounding community • Preserve/enhance pedestrian and bicycle connections • Reduce delays for cross-traffic	• Population & employment density • Traffic volumes of cross-streets • Level-of-service of cross-streets • Per-lane volumes of cross-streets
Ensure Cost Effectiveness	• Maximize cost-effectiveness	• Capital costs • Operations and maintenance costs • Annual cost/ridership added

The evaluation criteria and performance metrics were used to screen all crossings to identify the need for potential improvements, as shown in **Table 2** below. The specific improvements for each crossing, as identified via the needs analysis summarized in **Table 2**, are shown on **Figure 6**.

Table 2 – Needs Analysis Matrix: Initial Improvement Based on Needs Analysis Findings

Crossing	Need for Improvement			Key Issues	Initial Proposed Improvement
	Improve Operating Speeds	Address Safety Concerns	Benefit Surrounding Community		
Laurel Canyon Blvd	HIGH	MED	HIGH	- High impacts on average bus speeds - High numbers of collisions - Visibility restrictions - High cross-traffic volumes	Grade Separation
Woodman Ave	HIGH	HIGH	HIGH		
Sepulveda Blvd	HIGH	HIGH	HIGH		
Balboa Blvd	HIGH	HIGH	MED		
Reseda Blvd	HIGH	HIGH	HIGH		
Tujunga Ave	HIGH	LOW	LOW	- Impacts on average bus speeds - Red light delay - Presence of current collisions or near misses - Varying levels of cross-traffic volumes	Other Improvements (Minor Capital, Operational, and/or Closure)
Colfax Ave	HIGH	LOW	LOW		
Corteen Pl	MED	LOW	MED		
Whitsett Ave	MED	LOW	MED		
Coldwater Canyon Ave	HIGH	LOW	MED		
Chandler Blvd	HIGH	LOW	LOW		
Fulton Ave/Burbank Blvd	HIGH	LOW	MED		
Oxnard St	HIGH	LOW	MED		
Hazeltine Ave	MED	LOW	MED		
Tyrone Ave	LOW	MED	MED		
Van Nuys Blvd	MED	MED	HIGH		
Kester Ave	MED	HIGH	MED		
Sepulveda Station (ped Xing)	MED	LOW	MED		
Woodley Ave	HIGH	MED	MED		
White Oak Ave	MED	LOW	MED		

Table 2 – Needs Analysis Matrix: Initial Improvement Based on Needs Analysis Findings (continued)

Crossing	Need for Improvement			Key Issues	Initial Proposed Improvement
	Improve Operating Speeds	Address Safety Concerns	Benefit Surrounding Community		
Lindley Ave	LOW	MED	MED	- Impacts on average bus speeds - Red light delay - Presence of current collisions or near misses - Varying levels of cross-traffic volumes	Other Improvements (Minor Capital, Operational, and/or Closure)
Wilbur Ave	HIGH	LOW	LOW		
Tampa Ave	MED	MED	MED		
Corbin Ave	MED	MED	LOW		
Victory Blvd	HIGH	LOW	MED		
Winnetka Ave	MED	LOW	MED	- Impacts on average bus speeds - Red light delay - Presence of current collisions or near misses - Varying levels of cross-traffic volumes	Other Improvements (Minor Capital, Operational, and/or Closure)
Mason Ave	LOW	HIGH	LOW		
De Soto Ave	LOW	MED	HIGH		
Agnes Ave (ped Xing)	MED	LOW	LOW	- Limited impacts on average bus speeds - Limited red light delay - Low numbers of collisions - Low levels of visibility restrictions - Low volumes of cross-traffic - High level of service (LOS) performance for cross-streets	No Change
Bellaire Ave	LOW	LOW	MED		
Goodland Ave (ped Xing)	LOW	LOW	MED		
Ethel Ave	MED	LOW	LOW		
Vesper Ave	LOW	LOW	MED		
City of LA (private Xing)	LOW	LOW	LOW		
Densmore Ave (gated driveway)	LOW	LOW	LOW		
Driveway (private)	LOW	LOW	LOW		
Hayvenhurst Ave (ped Xing)	LOW	LOW	LOW		
Zelzah Ave (ped Xing)	LOW	LOW	LOW		

Note: Crossings listed in **bold** indicate the presence of a MOL station.

Detailed technical analyses were completed for the following aspects of each identified improvement alternative, for each selected location:

- Potential minor street closures
- Conceptual design and cost estimates
- Operating plans
- Traffic impacts
- Traffic management and construction staging plans
- Parking impacts
- Right-of-way survey and maps
- Conceptual geotechnical investigation
- Utility investigation
- Conceptual hydraulics and hydrology study
- Four quadrant gate system feasibility

A number of detailed technical studies were prepared to address specific aspects and improvements. The results of these technical studies are documented in independent technical memoranda. A summary of the technical analyses is presented in **Table 3** and shown in **Figure 4**.

Additional improvements are currently planned for the MOL, and include the following:

- **Canoga shortline operations** – In order to provide improved service for the portions of the MOL experiencing the highest passenger loads, Metro conducted public outreach for potential implementation of a new shortline service at Canoga. This new service will provide a shortline turnaround loop for buses and operate between the North Hollywood and Canoga and /or other stations, adding additional capacity.
- **Electric buses** – Metro is planning on operating 100% electric buses on the MOL in the near future, following Board approval of new electric buses for the MOL corridor in July 2017. These buses will be significantly quieter than existing buses, which should improve adverse noise levels along the corridor. It is anticipated that the new buses will be delivered and in operation along the MOL corridor by 2020.
- **On-board WiFi** – Metro is currently exploring means for providing on-board WiFi service on MOL buses. This service would improve the quality of a rider's experience, and could potentially increase ridership.
- **Canoga Transit Hub** – Metro is considering a new Transit Hub at the Canoga Station to better coordinate with other local services and possibly a new Warner Center shuttle service that would provide more stops along the way to the Transit Center at Owensmouth Avenue.

Table 3 – Summary of Potential Improvements and Associated Technical Analysis Findings

Improvement	Bus Travel Time Change	Change in Cross-Street Traffic Delays	Safety Benefit	Cost[1]	Other Issues
Grade Separation	• **Reduction** of approx. 1 min per bus per grade separation	• **Reduction** in average peak hour delay of approximately 5 seconds per vehicle per grade separation • Note that the reduction in delay is directly related to adjacent traffic signals, and is greatest in those locations where the existing MOL crossing is adjacent to other traffic signal controlled intersections	• Removes potential for bus/vehicle/bike/ped conflicts for buses within the MOL corridor	• $50 M -$100 M per grade separation	• Potential interruption of existing bus/bike path operations • Potential reduction of Metro-owned parking • Potential utility conflicts
Improved Transit Signal Priority (TSP)	• **Reduction** of less than 1 min per bus for the entire corridor	• **Increase** in average peak hour delay of approximately 1-2 seconds per vehicle per crossing	• Reduced potential for short stops by bus vehicles	• $50 K per crossing • Note that costs could increase if additional communication links are required	• Maintenance/deployment challenges with in-vehicle transponders
Improved Bus-Signal Communication[2]	• **Reduction** of less than 1 min per bus for the entire corridor	• **Increase** in average peak hour delay of approximately 1-2 seconds per vehicle per crossing	• Reduced potential for short stops by bus vehicles	• $50 K per crossing	• Accuracy of real-time traffic signal information
Minor Street Closures	• **Reduction** of approx. 40 sec per bus per closure	• N/A (no cross traffic movements)	• Removes potential for bus/vehicle/bike/ped conflicts for buses within the MOL corridor	• $25 K - $100 K per closure (or higher)	• Interruption of direct walking/bicycling paths in residential neighborhoods • Reduced access for public safety vehicles
Four Quadrant Gate Systems	• **Reduction** of approx. 48 sec per bus per gate system	• **Increase** in average peak hour delay of approximately 7-8 seconds per vehicle per gate system location • Note that gates would only operate when a bus is present, and changes in bus operations – such as platooning vehicles or operating at increased headways – could reduce the overall average delay experienced	• Virtually removes potential for bus/vehicle/bike/ped conflicts for buses within the MOL corridor	• $1.3 M per gate system (or higher)	• May require further coordination with regulatory agencies, as the application of gates for a BRT system is unique • Implementation challenges for fail-safe operation

Notes:
1. Costs do not include ongoing operations and maintenance costs. Capital costs only
2. This improvement is being pursued as a separate initiative from the Office of Extraordinary Innovation.

Figure 4 – Potential Improvement at Each Crossing

4.0 POTENTIAL FOUR QUADRANT GATE SYSTEMS

As a part of the study, an additional analysis was conducted to evaluate the potential application of railroad-type gate systems as an additional traffic control and safety feature at MOL busway crossing intersections. This improvement would consist of the deployment of railroad-style four quadrant gate systems at at-grade intersection crossings along the MOL corridor. This improvement is considered technically feasible, and would require clear policy direction from Metro in regards to corridor access for non-bus vehicles. This improvement would result in the replacement of existing traffic signals controlling the buses at MOL intersection crossings with four-quadrant gate systems. The gate systems would require additional warning time, which would increase delays for cross-street traffic; however, the gates would only be activated when a bus is present, so the overall number of activations would potentially offset any travel delays over the course of a day. The analysis has identified the following factors that will determine the potential feasibility of such a system:

- A four quadrant gate system is technically feasible, utilizing existing technologies.
- Application of a four quadrant gate system on a BRT corridor would be unique, and it is recommended that Metro pursue formal discussions with the California Traffic Control Devices Committee (CTCDC) during development. It is unclear if the CTCDC would require formal approval of a gate system deployment for BRT.
- It is recommended that the gate system conform with existing guidelines, including and not limited to the California Manual on Uniform Traffic Control Devices (CA MUTCD), to the greatest extent possible.
- In order to comply with the CA MUTCD, application of a gate system at MOL crossings would require the removal of existing traffic signals currently controlling the bus movements at each crossing; traffic signals controlling vehicular movements on crossing streets would be modified or remain, consistent with traffic signal installations adjacent to other Metro rail crossings.
- With the removal of existing traffic signals controlling the buses and replacement with gate systems, it is recommended that Metro restrict access to the MOL busway to only authorized bus vehicles; any other vehicles would be subject to the right-of-way restrictions currently in-place on other Metro rail facilities throughout Los Angeles County.

Any gate system would require fail-safe operations, consistent with current rail systems. For the MOL corridor, fail-safe operations would be ensured by the following key principles:

1. Only Metro buses would be allowed to operate along the MOL corridor, consistent with current rail operations. All other vehicles (e.g., maintenance, public safety) would be required to adhere to Metro policies regarding access to Metro-owned rights-of-way.
2. Existing traffic signals controlling bus movements at street crossings would be removed and replaced with gate systems, in accordance with CA MUTCD requirements for light rail transit (LRT) signals. The gate systems would employ train signals to notify approaching buses of gate status – displaying a solid light when the gate system is activated and displaying a flashing light when the gate arms are down and the crossing is secured.
3. A combination of redundant vehicle detection systems would be required, to both activate the gate system when a bus was approaching, and to provide the required “check-in/check-out” functionality to ensure a bus has crossed the intersection. Additional features may be required at certain

locations, such as in-vehicle mounted equipment or a secured external control mechanism (similar to a "police key" on a traffic signal controller cabinet), to ensure that bus operators could trigger gate operations in the event of detector failure and/or extended loading/unloading time at adjacent station platforms.

In order to operate in a manner least impactful to cross-street traffic, it is recommended that the four quadrant gate systems fail in the upright position. Should a gate system fail to detect an approaching bus and not activate or if a vehicle were to stall on the crossing, the gate status signal would notify the bus operator that the gates were in the upright position, and the bus operator would then be required to stop before proceeding through the crossing. Approaches described under item 3 above could be used as an alternate gate activation technique.

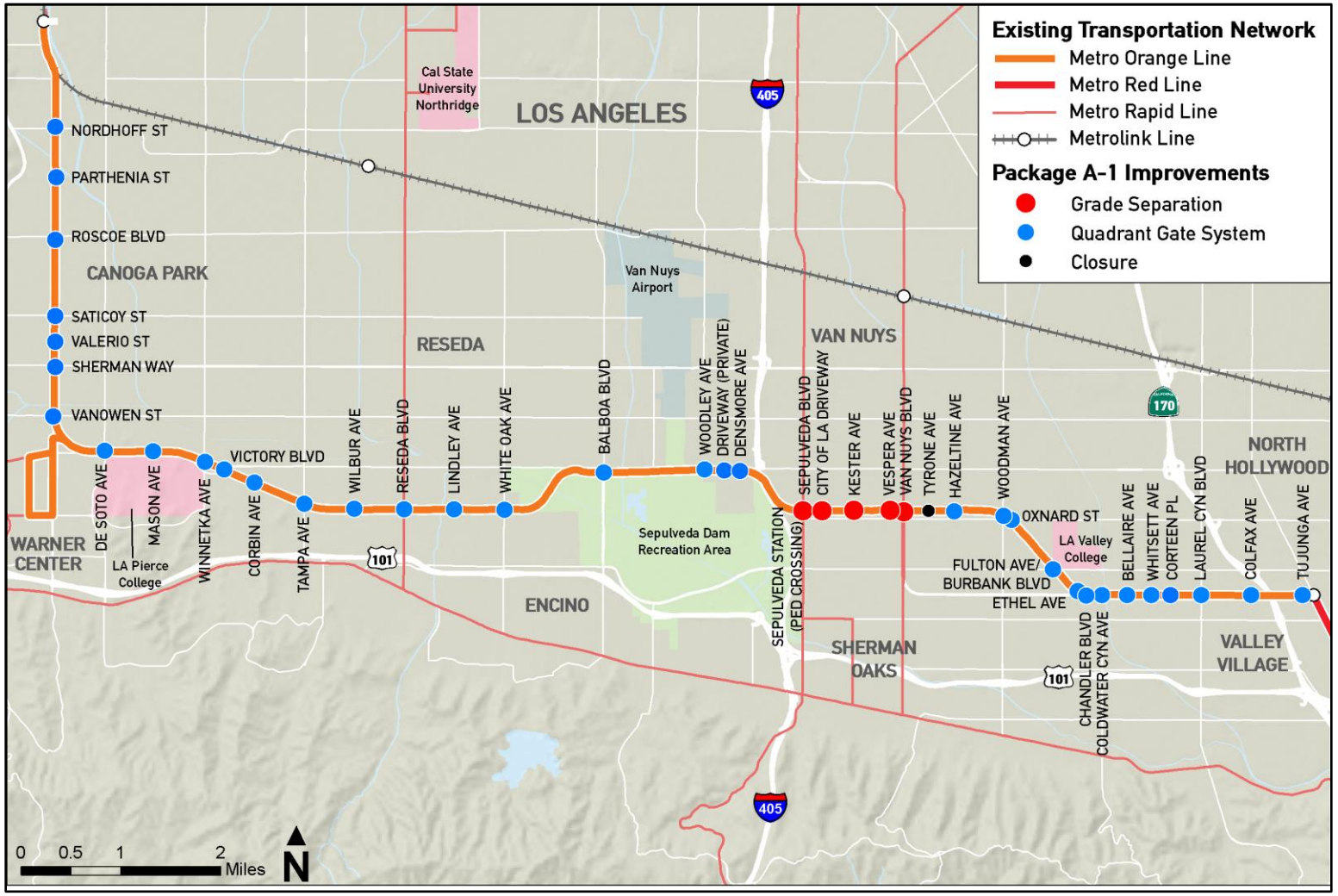
5.0 RECOMMENDED BASE ALTERNATIVE

Initially four packages of improvements were developed for consideration, reflecting different combinations of grade separations and other operational improvements. An additional package was added, in order to consider the deployment of gate systems at all crossings. When these five packages were discussed with Metro staff during the course of recurring project meetings, it was ultimately determined that a hybrid package combining a variety of improvement measures would provide the maximum benefit and address the stated purpose and need to the greatest extent. Therefore, Package A-1 was developed as presented below.

Package A-1: Hybrid Solution (Grade Separations + Gate Systems)

Package A-1 (shown in **Figure 5**) proposes aerial grade separations at the Van Nuys and Sepulveda stations. The busway would be elevated the entire length from Van Nuys Station to Sepulveda Station, including the pedestrian crossing at Sepulveda Station and the station would be relocated over Sepulveda Boulevard. All roadway crossings between the Van Nuys and Sepulveda stations would remain open. Tyrone Avenue is the only roadway proposed to be closed. No changes are proposed to the other four pedestrian-only crossings located along the study segment, and the remaining 27 crossings would have gate systems installed.

Figure 5 – Recommended Base Alternative (Package A-1)



The recommended base alternative, Package A-1, assumes that the majority of busway crossings along the 12.7-mile study segment would be protected by gate systems, as described previously in **Section 4**. As the gate systems require additional advance warning time, the recommended base alternative also assumes changes to busway operations to minimize cross-traffic delays. The recommended base alternative assumes that during peak periods, buses would operate in two-vehicle platoons at eight-minute headways. This operation would allow the busway to carry the same amount of peak period riders at increased headways, thereby reducing the frequency of gate activation and reducing associated potential cross traffic delays. It should be noted that the eight-minute headway needs to be further evaluated and approved by Metro Operations department. The recommended base alternative also assumes that bus vehicles would operate at the maximum civil speed allowed by Metro operations, when traveling within the busway. With the increased protection of the crossings provided by the gate systems and grade separations, bus operators will be able to operate at higher speeds at the crossings, and will therefore be able to operate at higher speeds on busway segments between crossings.

Under Package A-1, bus travel times would decrease by approximately 12.6 minutes (average for both directions), and average cross street traffic delays due to gate activations during peak periods would reduce by approximately 1.6 seconds per vehicle. Daily vehicle miles travelled (VMT) would decrease by about 81756, and the change in O&M costs would decrease by approximately 6.4 percent. The recommended base alternative assumes that the adjacent bike path would remain operational, and associated traffic signal controls for bike path crossings would be maintained. The signals controlling the bike path crossings would be connected to the busway crossings and gate systems, so that bikes could operate a push button to receive a signal to cross the intersecting streets, independent of gate system activation by MOL buses. This means that cross traffic would potentially face red lights due to bike crossings, assumed to be consistent with current levels of activation.

In terms of overall safety benefits, the hybrid package A-1 would provide the maximum potential improvement for the entire MOL corridor, as it allows for additional features that restrict and limit potential conflicting vehicular, pedestrian, and bicycle movements across the busway at the highest number of crossings. The combination of grade separations and gate systems would significantly impede the ability of cross-street traffic and pedestrians to illegally cross the busway while a bus was approaching or within the crossing, which would result in a significant reduction of bus-involved collisions.

It is important to note that although the focus of this feasibility study is the 12.7-mile east-west segment (from North Hollywood to Canoga), Metro seeks to provide improvements for the entire 18-mile MOL corridor, (from North Hollywood to Chatsworth). Recognizing this, **Table 4** below presents a summary of the recommended improvements and associated performance metrics for all segments of the MOL corridor. As noted on the table, performance metrics and costs for improvements for the segments not included in this current feasibility study were developed using information provided by Metro. Additional evaluations and refinements will likely occur during subsequent environmental clearance and design phases.

From a cost/benefit standpoint, the recommended base alternative would provide improvements at 33 MOL crossings at an average cost of $8.5 M per crossing. By increasing protections at 33 crossings, Package A-1 provides the maximum potential reduction for the 23 bus-involved collisions that occurred along the MOL corridor between 2015 and 2016. Compared to the other alternative packages described in the next section, the recommended base alternative provides greater improvements at more crossings, at nearly half the cost

per crossings.

Table 4 – Recommended MOL Corridor Improvements

Segment	Recommended Improvements & Performance Metrics
East-West Segment (North Hollywood to Canoga)	• Hybrid Solution ○ 5 Grade separated crossings ○ 27 Gated crossings ○ 1 roadway crossing closures ○ $273 M (2017 $)[1] ○ Average 12.6-minute travel time decrease • Maintain existing bike path
North-South Segment (Canoga to Chatsworth)	• Gates only (Not included in current study) ○ 7 Gated crossings ○ $10 M[2] (2017 $) ○ Average 3.4-minute travel time decrease[2] • Maintain existing bike path
Entire Corridor (North Hollywood to Chatsworth)	• Hybrid Solution (Not included in current study) ○ 5 Grade separated crossings ○ 34 Gated crossings ○ 1 roadway crossing closure ○ Bike path grade separation ○ $283 M[2] (2017 $) ○ Average 16-minute travel time decrease[2] • Maintain existing bike path

Note:

1. Cost estimates include elevated bike path (described below) as well as side platform station configurations.
2. Cost estimates and performance metrics presented are rough estimates, due to the preliminary nature of the feasibility analysis. Subsequent environmental clearance and design phases will require further evaluation and analysis.

As an optional component of the recommended base alternative, a preliminary feasibility analysis of potential grade separations for the adjacent bike path was conducted, so that bike path users could cross over the busiest cross streets – Sepulveda and Van Nuys. The results of the preliminary feasibility analysis are presented below in **Table 5**. It is important to note that these results address only the engineering and operational feasibility, with a goal of identifying improvements that could be incorporated into the recommended base alternative to provide improved facilities for additional modes besides only buses and vehicles. There are many conceptual benefits of providing grade separations for the adjacent bike path over two of the most congested crossings along the MOL corridor, including safety and travel time benefits. There are also concerns regarding the feasibility of constructing, maintaining, and ensuring ongoing safety and security for separate grade separated bike path crossings. Therefore, additional evaluations and refinements will likely occur during subsequent environmental clearance and design phases.

Table 5 – Bike Path Grade Separation Alternatives

Alternative	Cost (2017 $)
Grade Separated bike path from Sepulveda to Van Nuys (No local access between these crossings) – Long Bike Path option	$22.7M
Grade separated bike path at Sepulveda crossing and Van Nuys crossing only – Short Bike Path option	$12.8M

6.0 ALTERNATIVE OPTIONS

Using the findings of the detailed technical analyses, the project team identified feasible improvements for further consideration. The improvements were then compared to the preliminary environmental checklist and travel demand modeling results, in order to arrive at a group of recommended improvements. These recommended improvements were then grouped together into potential packages for further study and potential implementation. The improvement packages for the east-west segment portion of the MOL are summarized in **Table 6** and described further below, and shown in **Appendix A**.

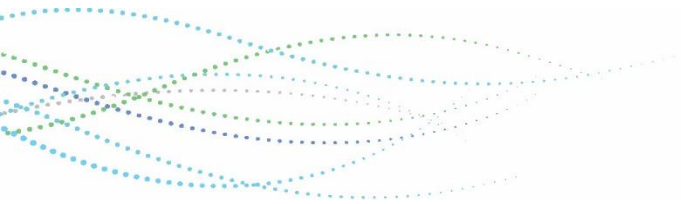


Table 6 – Summary of Potential Alternative Options (MOL North Hollywood to Canoga Segment)

Improvement / Benefit	Package A: Van Nuys & Sepulveda + Reseda	Package B: Valley College & Woodman + Reseda	Package C: Woodman + Sepulveda + Reseda	Package D: Valley College & Woodman + Van Nuys & Sepulveda + Reseda (Fiscally Unconstrained)	Package E: Gate Systems (Current operating speeds)	Package A- 1 (Hybrid) Van Nuys + Sepulveda + Gates Systems (with platooning & higher speeds & increased headways)[6]
# of Grade Separated Crossings	6	4	4	9	0	5
# of Permanent Closures	1	1	1	1	0	1
LA City Council Districts with Grade Separations	CD 3; CD 6	CD 2 & CD 4; CD 3	CD 2; CD 3; CD 6	CD 2; CD 3; CD 4; CD 6	-	CD 6
Existing Bus Travel Time (Average)[2]	Eastbound (EB - Canoga to North Hollywood): 40.3 mins Westbound (WB - North Hollywood to Canoga): 42.7 mins					
Change in Bus Travel Time (Between Canoga and North Hollywood)[2]	EB: -4.2 mins WB: -3.8 mins	EB: -2.5 mins WB: -2.3 mins	EB: -2.7 mins WB: -2.4 mins	EB: -6.3 mins WB: -4.2 mins	EB: -12.1 mins WB: -12.7 mins	EB: -12.3 mins WB: -12.9 mins
Existing Cross Street Traffic Delay[3] (PM Peak Hour, Average per Vehicle)	Northbound: 24.4 sec/veh Southbound: 22.2 sec/veh Average: 23.3 sec/veh					
Change in Cross Street Traffic Delay[3] (PM Peak Hour, Average per Vehicle)	NB: -0.3 sec/veh SB: -0.4 sec/veh AVG: -0.4 sec/veh	NB: -0.7 sec/veh SB: -0.9 sec/veh AVG: -0.8 sec/veh	NB: -0.6 sec/veh SB: -0.8 sec/veh AVG: -0.7 sec/veh	NB: -0.7 sec/veh SB: -1.6 sec/veh AVG: -1.1 sec/veh	NB: +9.6 sec/veh SB: +4.9 sec/veh AVG: +7.3 sec/veh	NB: -1.7 sec/veh SB: -1.4 sec/veh AVG: -1.6 sec/veh
Existing Ridership[4] (Weekday daily passengers)	24,500					
Change in Ridership, Year 2025 (Weekday daily passengers)	+1,000 (+4%)	+1,400 (+5%)	+900 (+3%)	+3,400 (+13%)	+10,100 (+39%)	+10,100* (+39%)
Change in VMT, Year 2025 (Daily)	-11,120	-13,202	-8,765	-29,159	-81,756	-81,756*
% Change in O&M Costs[5]	-2.5%	-1.4%	-1.4%	-1.9%	-6.4%	-6.4%*
Estimated Capital Cost of Grade Separations	$259M	$262M	$223M	$453M	-	$191M
Estimated Capital Cost of Permanent Closures	$0.08M	$0.08M	$0.08M	$0.08M	-	$0.08M
Estimated Capital Cost of Improved Bus-Signal Communications	$0.2M	$0.4M	$0.4M	$0.2M	-	-
Estimated Capital Cost of Signal Improvements	$1.3M	$1.4M	$1.4M	$1.2M	-	-
Estimated Capital Cost of Gate Systems	-	-	-	-	$40.3M	$35.1M
Estimated Capital Cost of Side Platform Locations	$15M	$10M	$10M	$20M	-	10M
Estimated Capital Cost of Elevated Bike Path (Van Nuys to Sepulveda)	$23M	$13M	$13M	$23M	-	$23M
Additional Overall Contingency (5.5%)[7]	$16.4M	$15.8M	$13.6M	$27.4M	$2.2M	$14.3
Estimated Total Capital Costs (2017 $)	**$315M**	**$303M**	**$261M**	**$525M**	**$43M**	**$273M**

Notes:

1. *Grade separations at certain locations will require additional grade separations for adjacent crossings due to the proximity of roadways and design requirements for grade separations.*
2. *Does not include station dwell time, as dwell time is highly variable per station and time of day.*
3. *Average for all signalized crossings between North Hollywood and Canoga, and not indicative of specific crossings.*
4. *Travel demand model derived ridership; actual existing (Year 2016) ridership averages 25,090 daily passengers on weekdays.*
5. *O&M costs are rough estimates; see Appendix B for additional details.*
6. *Under Package A-1, buses are assumed to travel at the maximum civil speed authorized by Metro within the corridor, further reducing end-to-end travel times. Buses are also assumed to operate in two-vehicle platoons at increased headways (8-minute headways assumed for purposes of analysis). Last, gate systems would only operate when a bus is present, which would result in on overall decrease in gate activations throughout the course of a typical day.*
7. *A 5.5% contingency was added to all cost estimates, on top of individual contingencies for specific elements, to account for the preliminary nature of this technical study.*

** Travel Demand Model results are preliminary in nature, due to the preliminary nature of this technical study. Since changes in ridership and VMT are related to increased bus travel speeds, it is assumed that the estimates of Ridership and VMT change would change slightly from what is currently shown with further refinements to the proposed alternatives. Similarly, O&M costs for Package A-1 were not provided. These items would be refined in subsequent environmental clearance and design phases.*

Package A: Van Nuys & Sepulveda + Reseda
Package A (shown in **Figure 6a**) proposes aerial grade separations at the Van Nuys, Sepulveda, and Reseda stations. The busway would be elevated the entire length from Van Nuys Station to Sepulveda Station, which is proposed to be relocated over Sepulveda Boulevard. All roadway crossings between the Van Nuys and Sepulveda stations would remain open. Tyrone Avenue is proposed to be closed as it required for the grade separation ramp structure. The package also includes bus-signal communication systems at pedestrian crossings (Agnes Avenue, Goodland Avenue, Hayvenhurst Avenue, and Zelzah Avenue). These crossings do no significant impact bus operations and could be good opportunities to pursue a bus-signal communications pilot program. The remaining crossings in the corridor would receive TSP improvements.

Under Package A, bus travel times would decrease by approximately six minutes (combined in both directions), and cross street traffic delays would decrease by an average of 0.4 seconds per vehicle. Daily VMT would decrease by about 11,100, and the change in O&M costs would decrease by approximately 2.5 percent.

Package B: Valley College & Woodman + Reseda
Package B (shown in **Figure 6b**) proposes two undercrossing grade separations at the Valley College and Woodman stations, and an aerial grade separation at Reseda Station. The Valley College and Woodman stations are proposed to be below-grade stations, and the busway would be lowered from at-grade to travel below-grade between the stations, crossing under Oxnard Avenue as well. Tyrone Avenue is proposed to be closed. The remaining crossings would receive the same bus-signal communication systems and signal improvements as recommended in Package A. In addition, the City of Los Angeles Bureau of Street Maintenance, Van Nuys District Yard driveway (referred in this document as City of Los Angeles driveway), located just east of the Sepulveda Boulevard crossing, would receive bus-signal communication system improvement.

Under Package B, bus travel times would decrease by approximately four minutes (combined in both directions), and cross street traffic delays would decrease by an average of 0.8 seconds per vehicle. Daily VMT would decrease by about 13,200, and the change in O&M costs would decrease by approximately 1.4 percent.

Package C: Woodman + Sepulveda + Reseda
Package C (shown in **Figure 6c**) proposes an undercrossing grade separation at Woodman Station and aerial grade separations at the Sepulveda and Reseda Stations. The Woodman Station is proposed to be a below-grade, station and the busway would be lowered from at-grade to travel below-grade in this area, crossing under Oxnard Street as well. Similar to Package A, the existing Sepulveda Station would be relocated to be over Sepulveda Boulevard. Tyrone Avenue is proposed to be closed. The remaining crossings would receive the same bus-signal communication systems and signal improvements as recommended in Package B.

Under Package C, bus travel times would decrease by approximately four minutes (combined in both directions), and cross street traffic delays would decrease by an average of 0.7 seconds per vehicle. Daily VMT would decrease by about 8,800, and the change in O&M costs would decrease by approximately 1.4 percent.

Package D: Fiscally Unconstrained (All Priority Grade Separations)
Package D (shown in **Figure 6d**) is fiscally unconstrained, and would grade separate all five priority grade

separations identified in Measure M. Tyrone Avenue is proposed to be closed. The remaining crossings would receive the same bus-signal communication systems and signal improvements as recommended in Package A.

Under Package D, bus travel times would decrease by approximately six minutes (combined in both directions), and cross street traffic delays would decrease by an average of 1.1 seconds per vehicle. Daily VMT would decrease by about 29,100, and the change in O&M costs would decrease by approximately 1.9 percent.

Package E: Gate Systems
This alternative (shown in **Figure 6e**) proposes deploying railroad-style four quadrant gated systems at all crossings along the corridor, except for the City of Los Angeles driveway and pedestrian crossings, which would receive bus signal improvements. No crossings are proposed to be closed.

Under this alternative, bus travel times would decrease by 12 minutes (per direction), and cross street traffic delays would increase by an average of 7.3 seconds per vehicle. Daily VMT would decrease by about 82,000, and the change in O&M costs would decrease by approximately 6.4 percent.

Detour Routing
The technical evaluation also included an analysis of potential detour routes for buses, bicycles, and pedestrians during construction of any of the grade separation alternatives. For bicycle and pedestrian routes, including the adjacent multi-modal bike path, the detours would route users to adjacent surface streets and signalized intersections. The goals for potential bus detours include:

- Maintain bus service during the construction period
- Maintain convenient passenger access to MOL service and connecting bus routes
- Avoid bus operations in construction zones
- Keep MOL service as close to the current ROW as possible
- Provide safe and efficient bus service operation during construction

7.0 TRAVEL DEMAND FORECASTING MODEL SUMMARY

Preliminary travel demand model forecasts were developed to determine potential ridership and VMT changes that would result from potential grade separations. Metro's travel demand model was used to develop forecasts for the opening year of potential grade separations, anticipated as the year 2025 (based on the most recent Measure M funding plan). The project team reviewed detailed model inputs for accuracy and correctness, running the model stream and comparing the results to existing conditions for the modeling area. Changes were made in the model code to reflect current conditions and the 2025 horizon year, including modifications to socioeconomic data and updated transit information. Ridership forecasts were prepared for potential combinations of grade separations, and the results are presented on **Table 7**. The majority of the growth is forecast to occur during peak periods, with additional growth forecast in the off-peak periods. Maximum passenger loads are forecast for the Sepulveda station, consistent with current ridership.

Table 7 – Summary of Ridership Forecasts

Forecast Scenario	Ridership			Change			Growth		
	Peak	Off-Peak	Total	Peak	Off-Peak	Total	Peak	Off Peak	Total
Base Year 2012	16,200	8,300	24,500	-	-	-	-	-	-
Year 2025 (No Build)	18,200	7,700	25,900	-	-	-	12%	-7%	6%
Year 2025 Package A	18,900	8,000	26,900	700	300	1,000	4%	4%	4%
Year 2025 Package B	19,200	8,100	27,300	1,000	400	1,400	5%	5%	5%
Year 2025 Package C	18,900	7,900	26,800	700	200	900	4%	3%	3%
Year 2025 Package D	20,900	8,400	29,300	2,700	700	3,400	15%	9%	13%
Year 2025 Gate Systems	26,100	9,900	36,000	7,900	2,200	10,100	43%	29%	39%

8.0 FUTURE LRT CONVERSION CONSIDERATIONS

As the Measure M Expenditure Plan identifies future conversion of the MOL corridor to rail, stations at the proposed grade crossing locations would be designed to be convertible to future light rail transit (LRT) requirements. A feasibility study was conducted to evaluate the potential for temporarily raising the busway during BRT operations, and then lowering the guideway for future LRT operations, and this was determined to be infeasible. Other considerations regarding conversion of stations to LRT requirements include:

- Center platform design implemented for BRT operation (requires cross-over, similar to El Monte Busway)
- Platforms would be extended to three-car LRT length
- Platforms would be raised
- Canopies would be adjusted
- Escalators would be modified

9.0 PARKING IMPACTS

Existing Metro-owned parking facilities adjacent to proposed grade separations would be impacted both during construction and after, with the addition of new structures. Currently there are approximately 1,500 spaces available in Metro-owned parking facilities within the study area, and a total of 1,073 would potentially be lost if all proposed grade separations were constructed simultaneously. A summary of temporary parking losses by grade separation location is shown on **Table 8**.

Table 8 – Summary of Temporary Parking Loss

Location	Inventory	Temporary Loss
Reseda	401	371
Sepulveda	531	249
Van Nuys	594	431
Woodman	22	22
TOTAL	**1,548**	**1,073**

10.0 FUNDING SUMMARY

Potential grade separations are included in the Measure M Expenditure Plan, as well as ultimate conversion of the MOL corridor to LRT. Funding is summarized in **Table 9**.

Table 9 – MOL Measure M Expenditure Plan

Project (Final Project to be Defined by the Environmental Process)	Notes	Schedule of Funds Available		Subregion*	2016 - 2067 Local, State, Federal, Other Funding 2015$ ('000s)	Measure M Funding 2015$ ('000s)	Most Recent Cost Estimate 2015$** ('000s)	Modal Code
		Ground-breaking Start Date	Expected Opening Date (3 year range)					
Expenditure Plan Major Projects			1st yr of Range					
Orange Line BRT Improvements	n	FY 2019	FY 2025	sf	$0	$286,000	$286,000	T
Orange Line Conversion to Light Rail		FY 2051	FY 2057	sf	$1,067,000	$362,000	$1,429,000	T

Notes:
n. Critical grade separation(s) will be implemented early through Operation Shovel Ready.
* Subregion Abbreviations: sf = San Fernando Valley
** The most recent cost estimate equals the accelerated cost. Prior year expenses included in all project costs.
Source:
Los Angeles County Transportation Expenditure Plan – Fiscal Year 2018-2057
(http://theplan.metro.net/wp-content/uploads/2016/09/measurem_ordinance_16-01.pdf)

11.0 NEXT STEPS

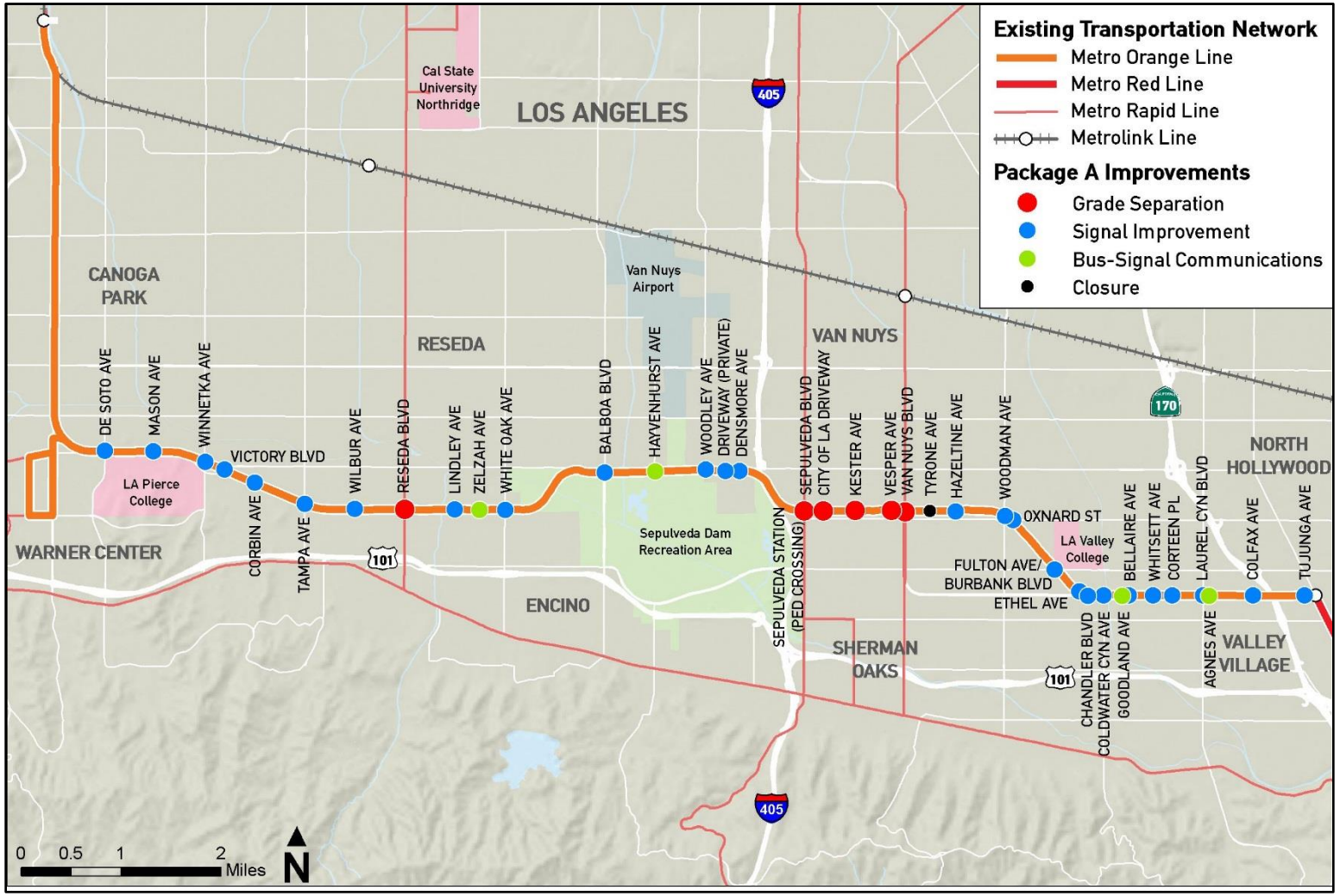
Following completion of this technical study, Metro staff will initiate an environmental process and preliminary engineering design. Concurrently, Metro is pursuing a pilot study of potential gate systems to reduce the frequency of right-turn on red (RTOR) violations and collisions, and will be deploying new equipment at four intersections along the north-south segment between Canoga and Chatsworth to test the efficacy of gates to deter motorists from making illegal right hand turns across the busway.

A number of key issues will require further attention and analysis during subsequent project phases. The issues include:

- **Project-specific transportation and parking impacts** –Refined transportation and parking analyses should be conducted for the recommended base alternative, as a part of subsequent environmental clearance and design efforts.
- **Real estate/Right-of-way impacts** - Metro may need to initiate negotiations for right-of-way acquisitions included as a part of the recommended base alternative.
- **Utility impacts** - Further utility investigations should be conducted to confirm potential conflicts for the recommended base alternative, as a part of subsequent environmental clearance and design efforts.
- **Ridership impacts** – Forecast ridership increases indicate continued crowding of buses during peak periods, particularly for stations between Sepulveda and North Hollywood. The Reseda (or Canoga) Shortline operation may address these issues, and Metro should continue to monitor peak bus loads to ensure bus capacity can meet ridership demand.
- **Ongoing operations** – Metro will continue to monitor and adjust bus operations to address issues related to bus speeds and safety.
- **Multi-agency coordination** – Metro will continue to coordinate with LADOT and other stakeholder agencies to ensure potential improvements along the corridor are integrated into other concurrent projects.
- **Public outreach** – Metro will continue to reach out to community stakeholders, to ensure this vital transportation link continues to meet the mobility needs of the San Fernando Valley.

Appendix A

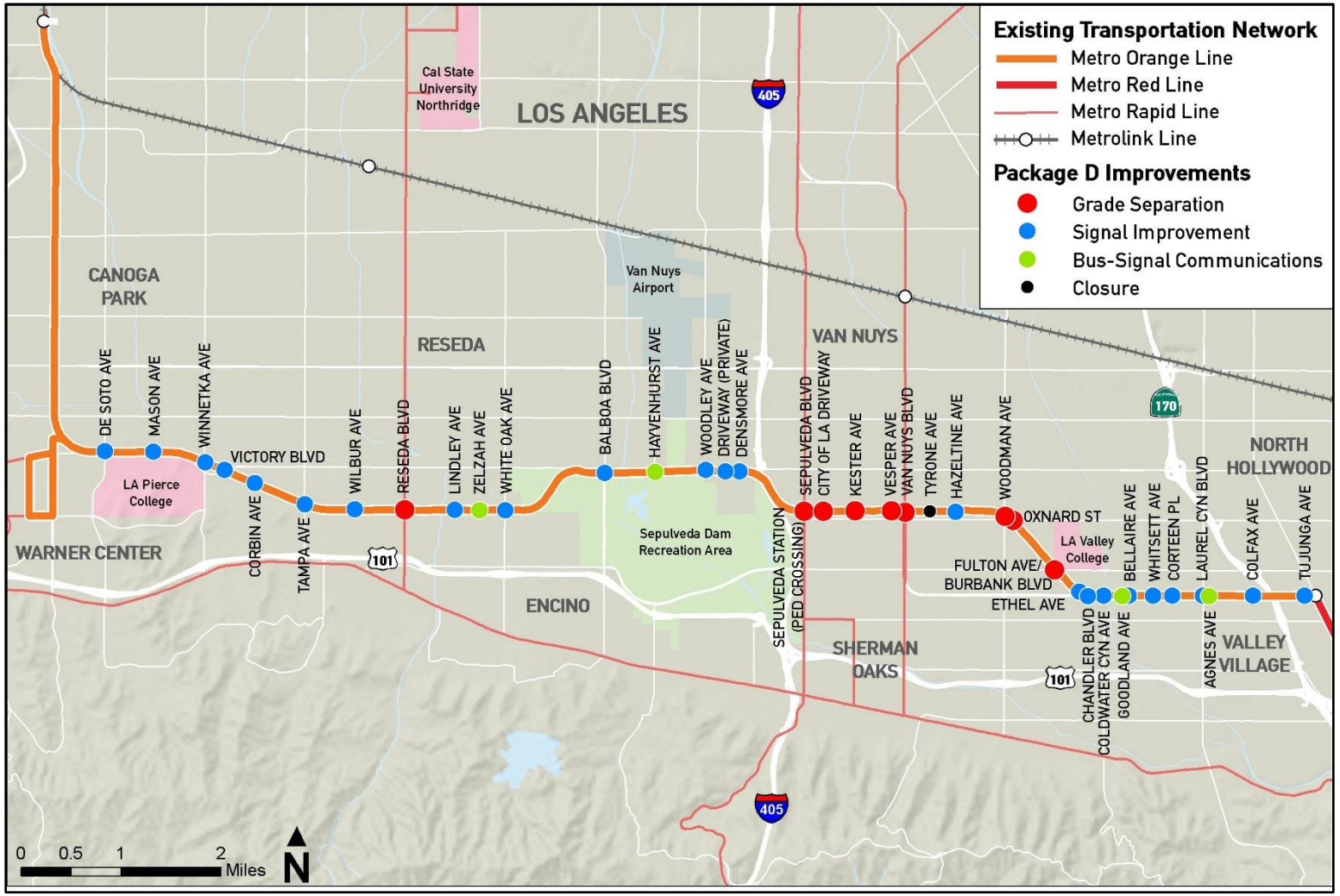
Potential Improvement Package A



Potential Improvement Package B

Potential Improvement Package C

Potential Improvement Package D



Potential Improvement Package E - Gate Systems