Investigating Cost-Effective and Time-Efficient Ways to Speed Up Transit

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I want to acknowledge Professor Cornelius Nuworsoo for his help in guiding me to complete such a large research-based project. Thank you.

I also want to thank my parents and grandparents, who have guided me to where I am today.

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1.0 Introduction

Traffic congestion on surface streets frequently delays transit service, which usually operates with general automobile traffic. Transit stuck in traffic negatively affects reliability and makes people wait longer than necessary, increasing travel times and discouraging ridership. The typical street design does not prioritize transit, which transports several more people per vehicle than automobiles, which average 1.2 people per car. Studies, including *When Are Bus Lanes Warranted?* by Todd Litman of the Victoria Transport Policy Institute*,* provide multiple ways to improve transit reliability that are easy to implement in the field, cost-effective, and achieve significant results. Queue jumps at intersections, transit signal priority, bus lanes, and vehicle turn restrictions are possible implementation strategies as part of an integrated effort to increase average bus travel speeds, decrease the variance of travel times, and advance equity to ensure that transit-dependent populations receive service that is reliable, frequent, and able to get to economic opportunities, recreation, and other desired activities. Other methods of decreasing the time needed to arrive at and leave from bus stops, such as bus stop curb outs, yield-to-bus laws, and modifying stop locations to decrease travel times and improve performance, are also options to increase transit reliability.

1.1 Study Purpose

With the emphasis on cities worldwide prioritizing more environmentally friendly forms of transportation, along with a new focus on equity to ensure that underserved and disadvantaged communities are served equitably and receive services that enable economic opportunity, access to recreation opportunities, and social services, equitable and sustainable forms of transportation are required. This study explores potential methods for enhancing and strengthening transit as a reliable and sustainable means of transportation.

1.2 Study Scope

This study evaluates cost-effective methods for achieving significant gains in improving transit reliability and speed. There are multiple methods to enhance transit speeds. For instance, bus rapid transit infrastructure, with center running lanes and dedicated boarding islands, requires extensive construction work, approval procedures, planning, design, and environmental impact processes. While this method is highly effective in improving transit reliability and travel times, it is a time-consuming and costly way of addressing the problem. There are also “quick build” strategies that address these issues with transit reliability. For instance, the New York City MTA implemented dedicated and well-marked bus lanes and signal priority as part of its Select Bus Service scheme to move buses much faster than in the past. Limiting the scope to more efficiently and rapidly implementable “quick build” methods enables the vast improvement possible with permanent infrastructure improvements but with less complication and construction cost.

Rededicating road space towards transit service to address the challenges of the environmental and equity impacts of our transportation along with the low attractiveness of public transit is imperative to ensure that our streets serve the most people, which can help reduce greenhouse gas emissions and particulate emissions and ensure that our communities are equitably connected with rapid transit and streets that genuinely serve them. This study explores “quick build” strategies and rededicating road space towards transit service.

1.3 Case Study Corridor

We propose illustrating the advocated solutions by studying a case study corridor in Los Angeles. The study corridor is along Olympic Blvd from Century Park Ave in Century City to Flower St in Downtown Los Angeles. This corridor connects the major employment centers of Downtown Los Angeles and Century City, which is essential for commuters to access these two employment centers. While this corridor is heavily used by transit vehicles, they are often stuck in general auto traffic, discouraging transit ridership, effectiveness, and reliability. Commuter Express 534 of LADOT Transit and LA Metro Route 28 operate within the study corridor. Commuter Express Route 534 is a rush-hour commuter service operating during the AM and PM peak periods. It acts as an express service between Downtown Los Angeles and Century City, with few stops in between. Several stops are also closed-door, meaning stops only allow boarding or deboarding, but not both. LA Metro Route 28 is an all-day route, running local service within the study area.

2.0 Literature Review

This section reviews literature and technical guidance regarding the various aspects of and considerations required to conduct a complete analysis of quick-build bus rapid transit infrastructure. These include strategies for community outreach and for municipalities and transit agencies to implement the quick-build infrastructure. The associated costs and design decisions when planning a quick-build bus rapid transit project are also analyzed. The warrants required for the implementation of a bus rapid transit project, along with the various arguments and methods to quantify the metrics for a specific corridor to fulfill these requirements for a bus rapid transit corridor, are also covered in the review. The review also covers the equity aspect of bus rapid transit. It explains the less quantifiable aspects of the benefits that bus rapid transit can bring to a community, including better and more equitable quality of life for the residents served by bus rapid transit.

2.1 Outreach and Quick-Build Strategies

Quick-Build Guide: How to Build Safer Streets Quickly and Affordably (Alta Planning + Design, 2020) covers examples of street improvements that enable cities to build safer streets, and solutions are specially tailored for California conditions. Covering case studies from across the state and country and providing specific advice in the planning, design, outreach, and implementation stages, the guide provides essential knowledge for municipalities looking to implement street safety improvements, especially for those who may only be looking at street improvements recently. It offers ways to improve transit boarding accessibility and safety, such as modular transit stops, which prevent conflict between cyclists and transit boarding, and ways to reduce conflict between transit vehicles merging into general traffic. This study illustrates the innovative, lower-cost, and adaptive improvements that municipalities can take quickly to improve pedestrian, cyclist, and transit user safety while improving transit accessibility, reliability, and equity through improvements in safety, accessibility, and transit service.

2.2 Cost and design analysis

Evaluation of Cost-Effective Planning and Design Options for Bus Rapid Transit in Dedicated Bus Lanes (Li, et al., 2009) provides a deep dive into the costs and design options, along with the technical figures and considerations when evaluating efforts to improve bus transit reliability and performance. The study includes potential improvement metrics and provides figures on whether dedicated bus lanes for transit service are warranted.

The study indicates that double-lane BRT systems enable improved average trip time, decreased intersection delay, and increased schedule adherence compared to before the addition of bus lanes (Li, et al., p. 36, 2009). With a double-lane system, average bus trip time is reduced by 6 percent compared to the original scenario before improvements. In this scenario presented by the authors, the BRT treatments included one dedicated curbside bus lane in each direction and signal synchronization along the corridor based on the schedules for each route to ensure that buses are given the green light as the buses are scheduled to approach a specific intersection.

2.3 Explanation of costs

The study (Li, et al., 2009) also provides examples of construction costs for a single lane mile, including in California, where the authors projected a $2,213,519 cost per mile (in 2002 dollars), while also providing potential variabilities in cost depending on reasons including right of way issues, environmental documentation, and mitigation costs, along with prevailing wage laws that also impact costs (Li et al., 2009, p. 38). This cost figure was derived from a Washington

State Department of Transportation study in 2002, which surveyed 25 states which are members of the AASHTO Subcommittee on Design. These states provided a unit cost based on bid items for Bus Rapid Transit projects, along with related percentages of project costs budgeted for mobilization, preliminary engineering, and construction engineering. The states also provided ranges in project costs for right of way, environmental documentation, environmental compliance, and mitigation costs, as costs for each project vary depending on the conditions within which these projects were completed. Ranges in terms of variability costs were asked for due to the wide range of variability possible compared to contract bid items, as project location plays a significant role in these types of expenses. As provided by the states, variability rates for the right of way range from less than 10 percent to over 30 percent, while rates for environmental documentation, which includes NEPA documentation, range from less than 10 percent to 20 percent of project costs. Costs for environmental compliance and mitigation range from less than 10 percent to nearly 20 percent. Across the 25 states surveyed, costs ranged from $1 million to $8.5 million in 2002 dollars, with an average of $2.3 million across the states observed. These costs were limited to contract bid items. Engineering costs ranged from 4 to 20 percent for preliminary and construction engineering costs, and the average percentage of project costs for preliminary engineering costs is 10.3 percent and 11.2 percent for construction engineering costs (Li et al., 2009, p. 38-39).

2.4 Rationale for Bus Lane Investment

When Are Bus Lanes Warranted? (Litman, 2016) provides another perspective for what bus lanes can bring to the table, especially in terms of the increase in average travel speeds for buses using the lanes, along with transit passenger gains when bus lanes are implemented, as transit gains a speed and reliability advantage compared to car travel. The study provides a set of pro-transit policies that can be implemented with bus lanes to encourage public transit ridership and improve the efficiency of transit operations by increasing the number of passenger-kilometers per bus hour (Litman, 2016, p. 5). These strategies include the conversion of existing traffic lanes to bus lanes, queue jumps, signal priority, and bus bays. The article also mentions that the reallocation of general traffic lanes to bus lanes is also an advancement toward social equity and consumer sovereignty (Litman, 2016, p. 13). The article concludes that effective and sensible communication and outreach to populations regarding the effectiveness of allocating general traffic lanes for bus travel in conjunction with other strategies, including bus bays, queue jumps, along with signal priority, creates positive benefits in terms of reducing bus travel times, advancing social equity, and reducing traffic and parking congestion for the non-transit using public.

Regarding technical figures, such as ridership and frequency figures required for a bus lane to be implemented on a specific corridor, *When Are Bus Lanes Warranted?* from Todd Litman of the Victoria Transport Policy Institute provides multiple figures to reference when evaluating whether a bus lane is warranted on a corridor. The study cited a 2012 AECOM analysis of individual bus lane warrants (as opposed to BRT systems) completed for the Australian Capital Territory (ACT), which cited ridership, traffic conditions, and bus frequencies on a corridor necessary for implementing bus lanes. Figure 2.1 is a summary of warrants in the AECOM study.

Figure 2.1: ACT Bus and HOV Facility Warrants

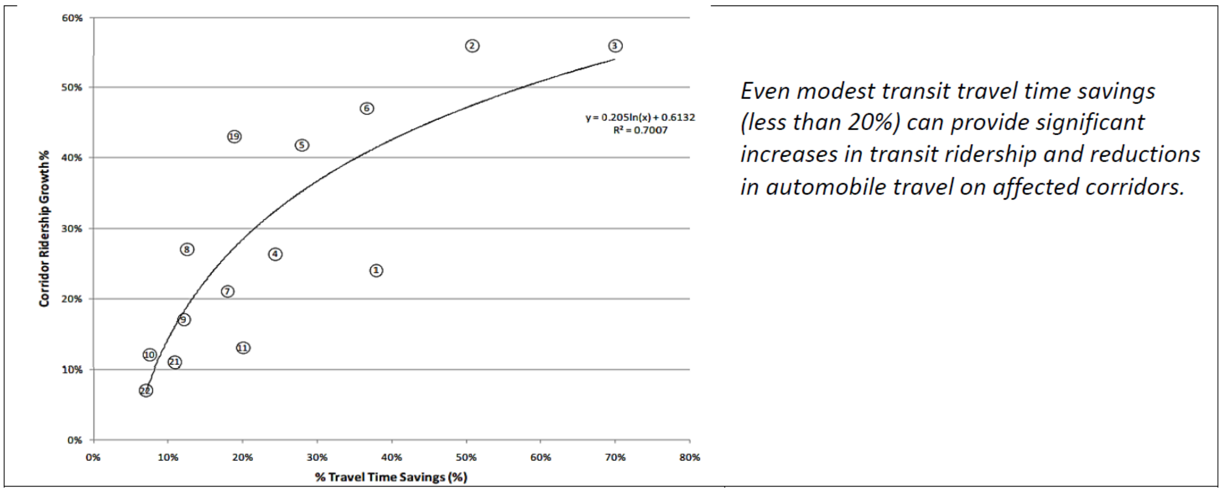
Project Type	Warrants
Segregated Busway. When warrants are met a busway should be investigated for the corridor	All of the following conditions met: • > 75 buses per one hour peak direction at time of commissioning. • Without bus lanes, congestion increases bus travel times > 80%. • Without bus lanes, < 85% of buses arrive on time.
Conversion of traffic lane. Conversion of an existing general traffic lane to an exclusive bus lane is preferred. Dependent upon the location (such as physical, environmental financial considerations) conversion to transit / HOV lane may be acceptable, if similar outcomes with exclusive bus lane	*Bus lane* if, without bus lanes three or more of the following are met: • Buses carry 65% - 80% of passengers in adjacent traffic lanes. • > 12 buses per hour. • Without bus lanes, bus travel times increase 35% - 65% under congested condition. • Without bus lanes, < 75% of buses arrive on time. *HOV lane* if the following exist: • Buses carry 40% - 65% of passenger volumes carried in adjacent general traffic lanes. • > 10 buses per hour. • Without bus lanes, bus travel times increase < 40% under congested conditions.
Road widening. When an additional traffic lane is being provided (i.e., road widening) the preference is for this additional lane to be converted to an exclusive bus lane. If warrants are not met then a transit lane should be considered in the additional lane being provided.	Bus lanes if the following is met • Buses carry more than 50% of passengers carried in adjacent lanes. • 10 buses per hour. There should be a plan for the corridor to move public transport towards a medium level of warrant (> 80% of people being carried in adjacent general traffic lane and > 15 buses / hour)
Queue Jump. Should be provided when travel times or service reliability improvements can be achieved	Queue jumps are warranted where: • > 50% of people being carried in the adjacent traffic lane. • > 10% increase in travel time when congestion is present.
Signal Priority. Should be provided when travel times or service reliability can be improved	Signal Priority is warranted where: • Queue jumps are already in place. • > 10% increase in travel time when congestion is present.
Bus bays. To be provided on corridors with bus or transit lanes where they improve the efficiency of bus operations or the safety of buses, general traffic cyclists or passengers	• If the service headway is less or close to the average dwell time, bus bays are warranted. • If a road safety audit identifies the need for a bus bay. • Where parking consistently hinders access to bus stops.

The Australian Capital Territory (ACT) developed these bus and HOV lane warrants. Other Australian transportation organizations have developed similar criteria.

Source: AECOM, 2012. Table 4

The VTPI study also illustrates how decreasing transit travel time can increase ridership. Litman provides figures from a 2012 study, proving that modest transit travel time savings, even in the less than 20 percent range, can significantly increase transit ridership and reduce automobile traffic (Litman, 2016, p. 4). The study proposes the use of an equation (Currie and Sarvi, 2012) for estimating ridership increases when travel time decreases, which states: $y=0.205\ln(x) + 0.6132$, where x is the percentage of travel time saved, and y is the corridor ridership growth. The relationship between reduced travel times and the increase in ridership is strong. The “coefficient of determination” (R^2) is 0.7, meaning that the travel time savings explain 70 percent of the variation in ridership gains. Figure 2.2 has details of the scatter plot of data points and the equation.

Figure 2.2: Transit Ridership Gains from Transit Travel Time Savings.



Source: Currie and Sarvi, 2012.

2.5 Bus Lanes

Bus lanes are travel lanes dedicated to buses, enabling them to bypass regular vehicle traffic and maintain rapid service unaffected by other vehicles, even during peak traffic hours, when traffic may be at a standstill. There are varied ways to implement bus lanes on a corridor. Center-running bus lanes run in the center of the road and require bus stops in the middle of the street. Curb-running bus lanes run along the curb of a roadway and enable the use of preexisting bus bays, stops, and other infrastructure. While bus lanes can effectively reduce bus travel time and improve reliability to a certain level, they should be coordinated with complementary infrastructure improvements, including signal priority.

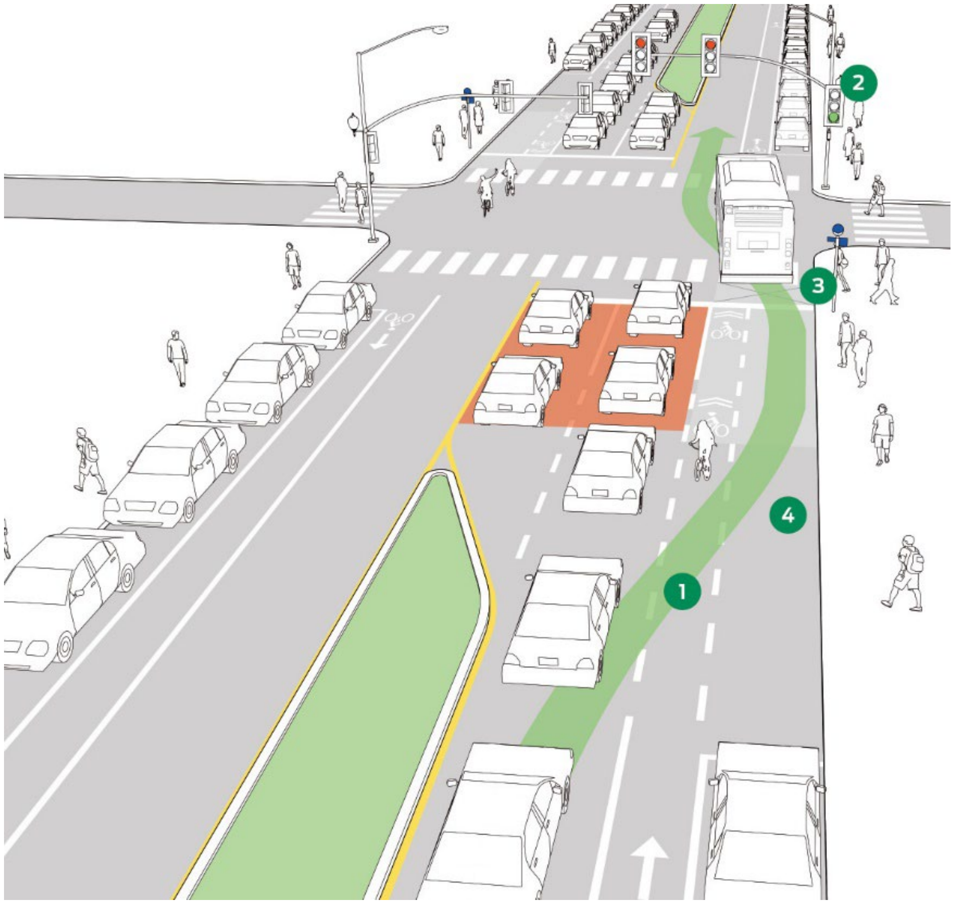
2.5.1 Making sure bus lanes are effective

The effectiveness of bus lanes is optimized using signal priority, which lengthens green phases or shortens red phases to reduce traffic signal delay for buses, along with bus bays which allow stopping buses to not interfere with buses continuing travel on a bus lane. Bus lanes are most effective when they serve bus routes that are frequently stuck in traffic, already have high ridership, or have the potential for significant increases in ridership after transit reliability and travel times are improved by the installation of bus lanes.

2.6 Queue Jumps

Queue jumps are targeted towards intersections with traffic signals, allowing buses to be at the front of the queue when waiting for a green phase to proceed and enabling the bus to be the first vehicle to enter congested intersections, skipping ahead of general traffic waiting at the same intersection. To do that, a transit-only green phase is reserved for transit vehicles to pass the intersection before general traffic. For queue jumps to be effective, buses must be able to reach the front of the queue, even with peak traffic. There must be sufficient transit-only lane length allocated to allow buses to enter the queue jump and reach the front of the queue at the intersection, or the queue jump is rendered ineffective, relegating buses to be subject to general traffic flow. Therefore, the queue jump is best used with the presence of a robust signal priority system, which detects buses and enables buses to travel first through the intersection, along with a comprehensive and complete bus lane system on a corridor that can ensure that the bus can reach the front of an intersection before the signal turns green to ensure that the bus can take full advantage of signal priority and the queue jump. Figure 2.3 illustrates the setup for a queue jump treatment.

Figure 2.3: Queue jump.



CRITICAL

1 Buses must have access to a lane and the ability to reach the front of the queue at the beginning of the signal cycle. Buses receive a head start with an advance green.

2 Separate signals must be used to indicate when transit proceeds and when general traffic proceeds. Transit signals can be either be a transit specific signal head or a louvered or visibility-limited green indication, making it visible only to the right-most lane.

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Where stops are located far-side, a signal phase progresses right-turning vehicles together with through-traveling buses. The queue jump lane must be long enough so buses can effectively bypass the expected length of congestion at the intersection at peak.

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3 Where stops are located near-side, right turns are prohibited from happening curbside. The bus pulls into the stop, completes boarding, and then pulls forward onto a loop detector to receive the advance green.

RECOMMENDED

Bus head starts may be made from a shared transit/turn lane or a short exclusive transit lane.

4 The length of a shared head start/right-turn pocket should be long enough to allow storage of right-turning vehicles and allow buses to reach the queue jump during each signal cycle.

If provided as a shared right-turn/queue jump, a protected right-turn signal may be used (MUTCD 4D-19), with a sign indicating RIGHT TURN SIGNAL (MUTCD R10-10) and EXCEPT BUSES.

Source: NACTO, 2016.

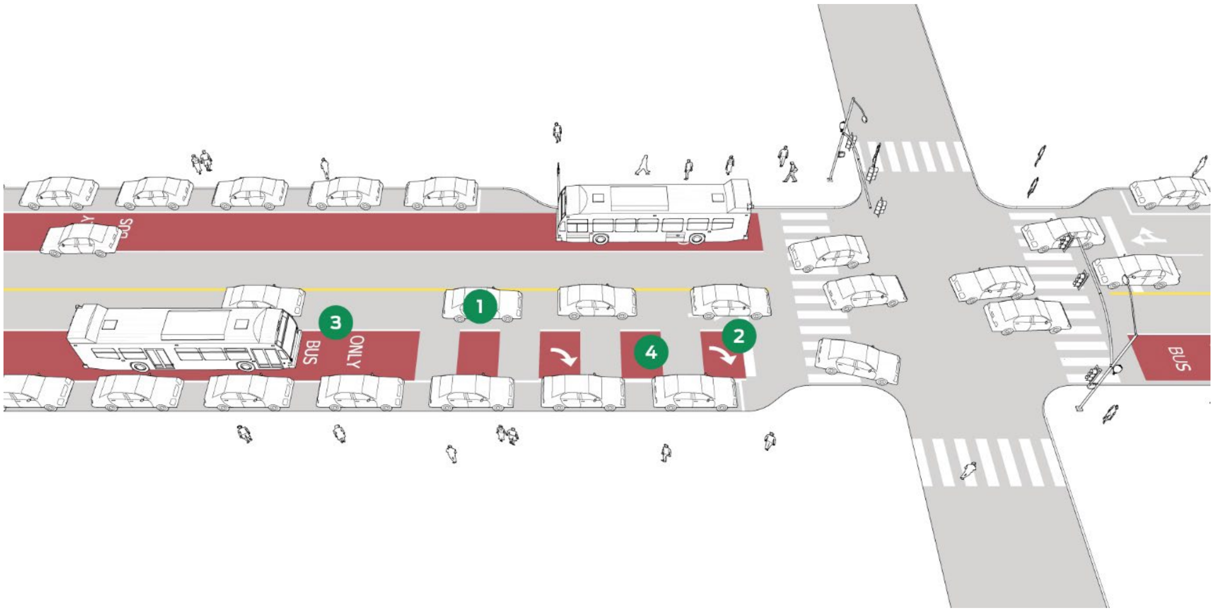
2.7 Signal Priority

Signal priority is where traffic signal systems detect the presence of approaching buses and enable them to traverse the intersection promptly. While signal priority works without other infrastructure improvements, including bus lanes and queue jumps, the full benefits of signal priority implementation are only possible with the proper implementation of bus lanes and queue jumps in accordance with the actual conditions of an implementation corridor. Even with signal priority, a transit vehicle must be able to take advantage of lengthened green phases or shortened red phases, which cannot happen if the vehicle is stuck behind general traffic and must wait for multiple signal cycles to cross an intersection. This can be done either through the active detection of buses traveling near an intersection to either shorten a red phase or lengthen a green phase, or traffic signal timing can be adjusted to coordinate with the scheduled bus arrival times at an intersection, enabling the bus to receive a green signal if it is traveling on schedule or close to its scheduled time.

2.8 Managing right turning traffic

As curb bus lanes run adjacent to right-turning traffic, these movements must be accommodated, with many methods to do so, as explained by the Transit Street Design Guide published by the National Association of City Transportation Officials. One solution is to merge right-turning traffic with the bus lane, allowing vehicles to enter the bus lane near the intersection to make right turns. While this treatment enables right-turning traffic to proceed without complicated signaling, this also means that straight-heading bus traffic may be impeded by traffic turning right in the bus lane, introducing delays to buses. Figure 2.4 illustrates the treatment of a shared transit and right-turn lane.

Figure 2.4: Shared transit and right-turn lane.



CRITICAL

1 The left-side line of the transit lane should be dashed for 50–100 feet in advance of the intersection.

2 Mark pavement with right-turn arrow. Install Right Lane Must Turn RighT and Except Buses signs (MUTCD R3-7R & R3-1B).

3 Install BUS ONLY signs and markings on the receiving side of the intersection.

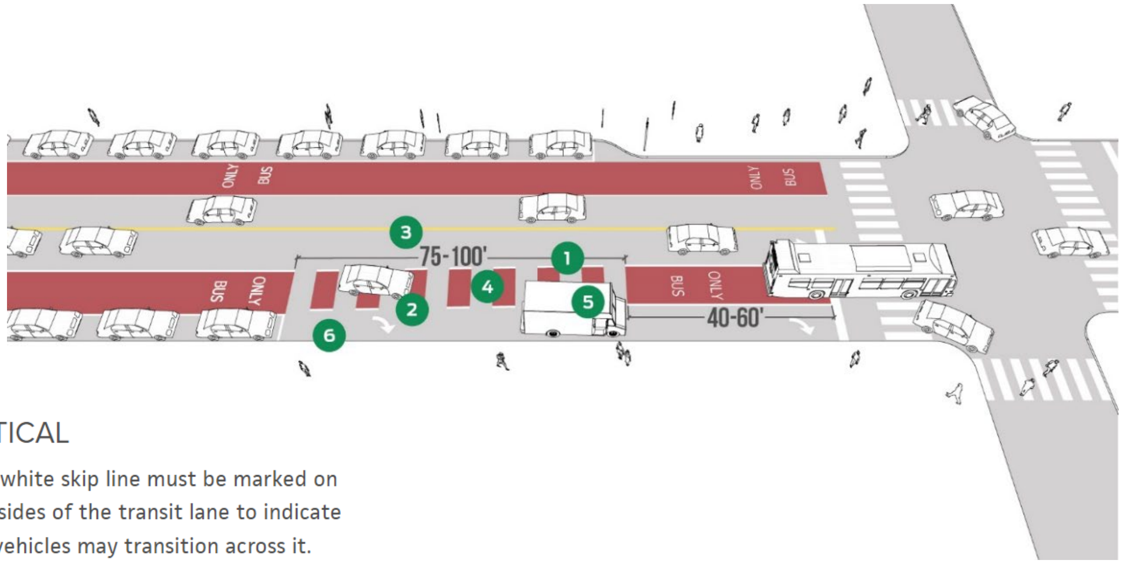
RECOMMENDED

4 Solid transit lane striping should drop to dashed striping 50–100 feet in advance of the intersection.

Source: NACTO, 2016.

Another treatment to manage this conflict is to ban right turns, which allows buses to travel unimpeded in the bus lane without needing to accommodate right turns. However, this causes issues with drivers looking to access places on side streets along a corridor with bus lanes and is therefore implemented rarely. A different method to allow right-turning traffic without sharing a lane with a bus lane is to have a right turn pocket, where the right turn lane is to the right of the bus lane, and motorists turning right must cross the bus lane. While the bus lane is not shared with right turns, there is a conflict point where traffic must cross the bus lane to make right turns. Figure 2.5 illustrates the treatment of a right-turn pocket. Another method is to have a dedicated right-turn signal for traffic turning right, where cars turn in front of the bus lane. This allows both the bus and right turn lanes to have their own lanes. This is at the expense of decreased efficiency and increased complexity, as motorists may not be used to turning from a lane that is not at the far right of a road, and signaling must be configured to effectively stop right-turning traffic when a transit vehicle is approaching. Figure 2.6 illustrates the treatment of virtual right-turn for automobiles.

Figure 2.5: Right turn pocket



CRITICAL

1. A white skip line must be marked on both sides of the transit lane to indicate that vehicles may transition across it.

RECOMMENDED

2. The right-turn pocket should be provided to the right of an offset transit lane with a transition treatment to allow vehicles to cross the dedicated transit lane.

3. The transition zone should be 50–75 feet at low traffic speeds, and the dedicated transit lane should resume to create an approach area that accommodates at least one transit vehicle prior to the stop bar. With 40-foot buses, the transition zone should typically begin at least 100 feet from the crosswalk.

4. Red dashed bars, large red squares, or elephant's feet should be provided in the transition zone, consistent with the white skip lines, to emphasize that transit vehicles retain priority use of the lane.

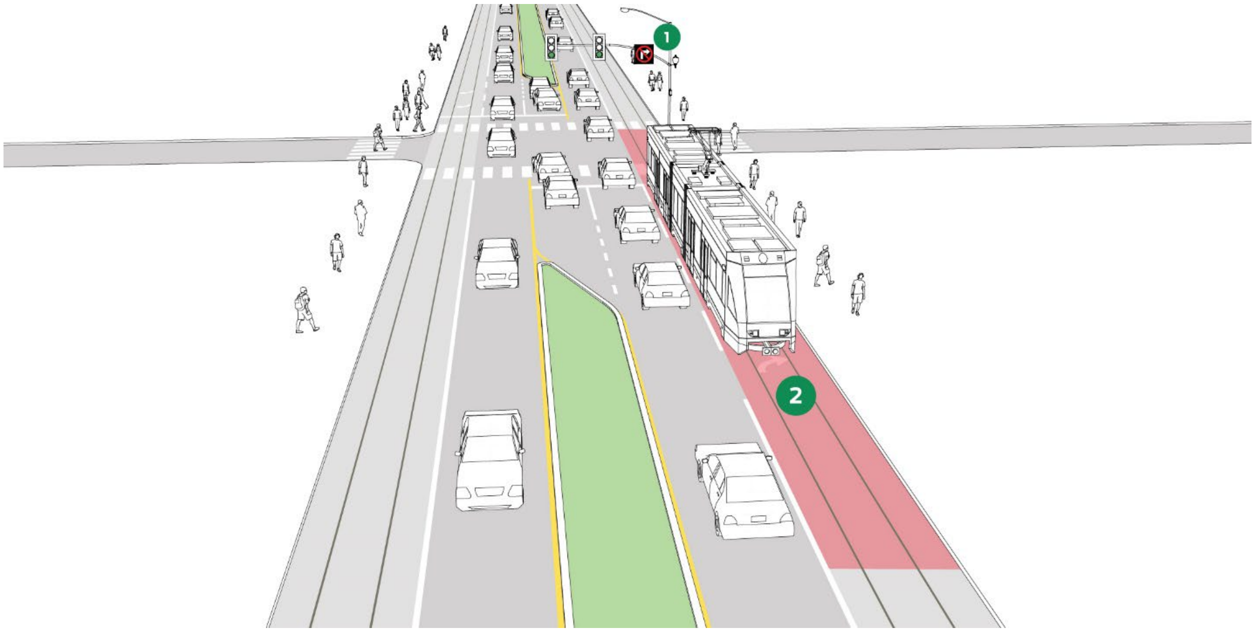
5. The turn pocket should be 10–11 feet wide if routinely used by trucks at peak periods. 9 feet of width may be sufficient if passenger cars are the primary form of turning traffic at peak periods.

Pre-existing turning conditions should be observed carefully prior to design to ensure that transit vehicles can pass at peak transit-demand periods, often corresponding to peak queue periods.

6. Turn pockets should accommodate the longest routinely occurring queue, but should be no longer than necessary to clear blockages from the transit lane. All but the first 30 feet of the transition zone can be considered as part of the storage length, as peak traffic will transition extremely slowly.

Source: NACTO, 2016.

Figure 2.6: Virtual right turn lane



CRITICAL

Traffic signals must be transit responsive, using an AVL system, an operator control, or an advance loop detector.

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1 The right-turn prohibition is communicated to drivers with a NO RIGHT TURN blank-out sign (MUTCD R3-1 or 1a) potentially accompanied by an LRV symbol blank-out sign.

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2 Signage must communicate to vehicles that they are prohibited from entering the transit lane while the transit vehicle is present.

Source: NACTO, 2016.

2.9 Bus bays

Bus bays allow buses to quickly reenter traffic lanes while ensuring that other buses in the corridor are not blocked by stopping buses. Even with the implementation of bus lanes, when multiple bus routes with differing stop patterns and scheduling use the same corridor, buses must be able to service stops while not blocking other buses from using the bus lane. With bus bays at service stops, express buses or buses servicing different areas can bypass local buses serving a stop, reducing delay, and improving average travel times, increasing transit reliability, enhancing the efficiency of transit operations, and improving the accessibility and attractiveness of transit.

2.10 Discussion

Each form of improvement can impact transit accessibility and reliability positively, reducing average travel times and advancing equitable transportation on our streets. However, these treatments, when implemented and coordinated properly with one another, are better able to serve the needs while ensuring that the most significant benefit in terms of improving travel times and increasing transit reliability is achieved. The treatments explained in this section should ideally be implemented with one another. Implementation of the treatments individually would result in limited gain. Therefore, one of the most critical steps in the implementation process is the insistence that all possible and coordinating steps are taken to ensure that money is spent efficiently and that funds contribute to significant improvements in transit reliability and travel times.

2.11 Impacts on Social Equity

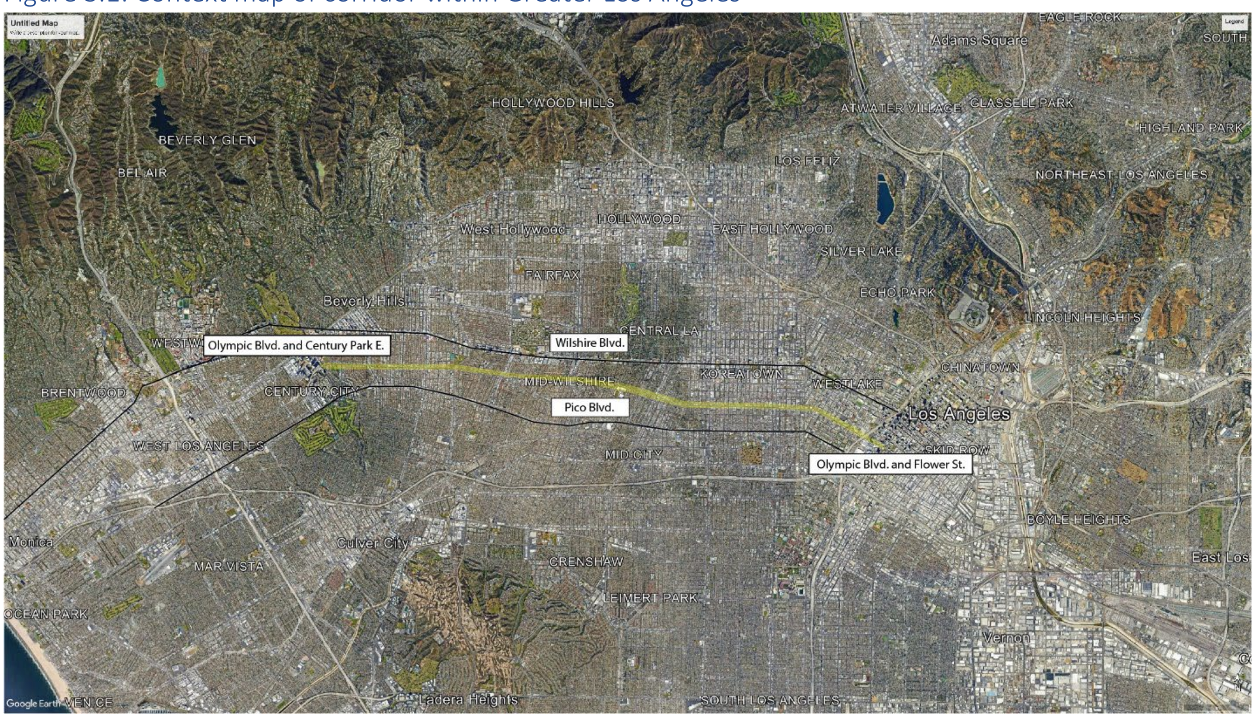
While the improvements in ridership, travel times, and reliability may induce significant increases in the efficiency of bus operations, another essential factor is equity. The VTPI study

When Are Bus Lanes Warranted? makes it clear that while bus operations efficiency is critical from a financial and environmental standpoint, there are also significant social equity benefits to consider. The study states that road space be "allocated based on a corridor's peak-period mode share" (Litman, 2016, p. 13). This means that if buses carry 50 percent of peak-period passengers, 50 percent of road space should be dedicated to buses in the form of a bus lane. This is especially important to note, as this equitable formula for allocating road space rarely happens due to motorist opposition, who are disproportionately not people of color and tend to be wealthier than average. In contrast, bus riders are more likely to be lower-income people and people of color, who must depend on transit for their trips (Litman, 2016, p. 14). When road space is allocated to buses, which carry more people, they can operate faster and more reliably. Buses are prioritized through infrastructure compared to less efficient methods for transporting people, including cars, and enable transit-dependent riders to receive a more reliable and quicker commute, as they should have if road space is allocated equitably in the first place.

3.0 Existing Conditions

The study corridor is in Los Angeles, California, on Olympic Blvd. between Flower St. in Downtown Los Angeles (DTLA) and Century Park Ave. in Century City. This east-west corridor connects the major employment centers of Downtown Los Angeles and Century City and is crucial for commuters accessing these two employment centers. The corridor also passes through Mid-Wilshire, Koreatown, and Westlake districts, which encompass other thriving centers of commercial activity. Figure 3.1 presents the corridor within a context of the greater Los Angeles area. Figure 3.2 presents a close-up view of the corridor.

Figure 3.1: Context map of corridor within Greater Los Angeles



Source: Google, 2020.

Figure 3.2: Close-up of Study Corridor

Source: Google, 2020.

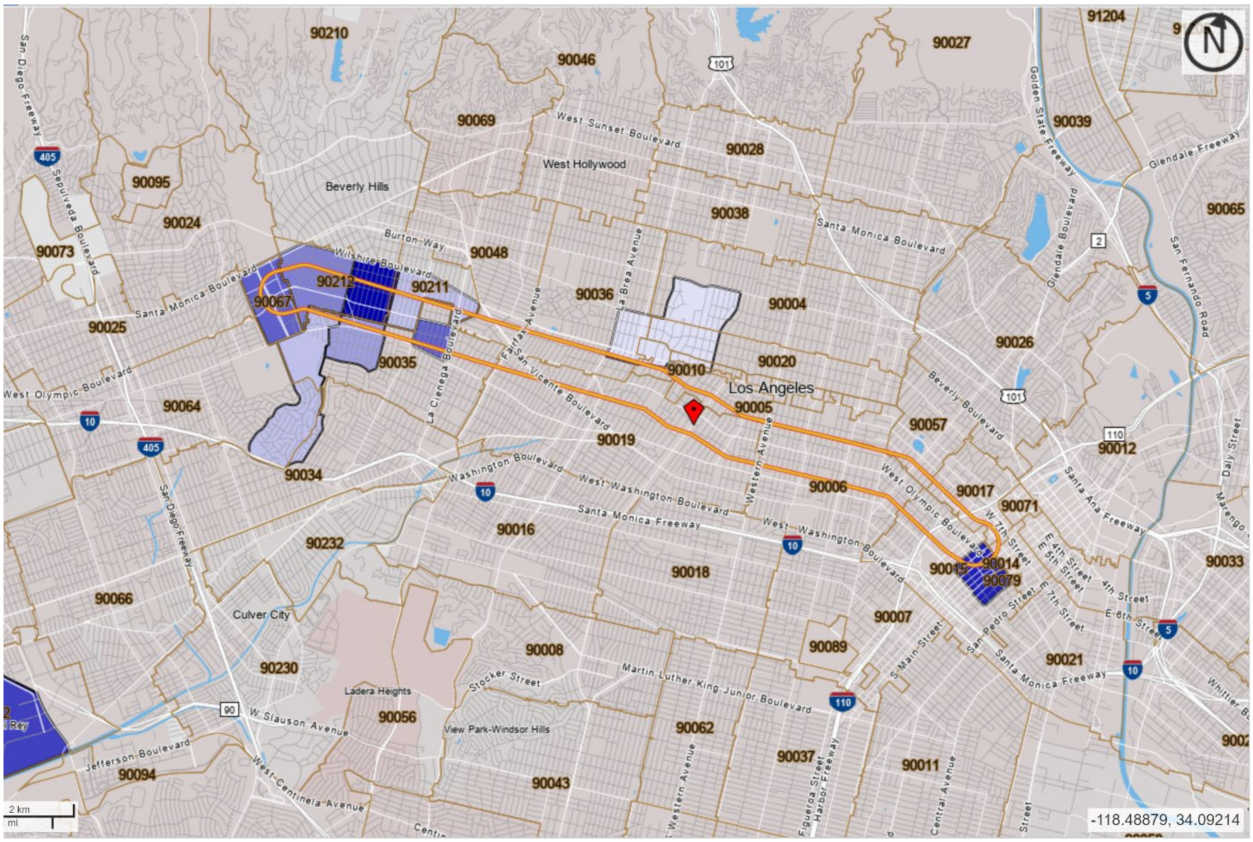
3.1 Study Corridor

3.1.1 Major Employment Centers

According to the US Census Bureau's LEHD (Longitudinal Employer-Household Dynamics) database, this corridor links the major employment centers of Century City and Downtown Los Angeles. There is a high concentration of employment in these two clusters. In connecting the two clusters, the corridor also traverses other centers and residential areas in between from which travelers may commute to the two key employment clusters for work. However, between the two employment clusters, there is also another major employment cluster halfway between the two end clusters and slightly to the north. As the LEHD maps show in Figures 3.3, 3.4, and 3.5, the middle cluster is centered around Wilshire Blvd. and Western Ave., the terminus of Metro Line D, a heavy rail line. The quarter-mile buffer zone for Olympic Blvd. in Figure 3.3 does not intersect the central employment center on Wilshire Blvd but comes close to it, providing opportunities to walk between transit services in the corridor and the

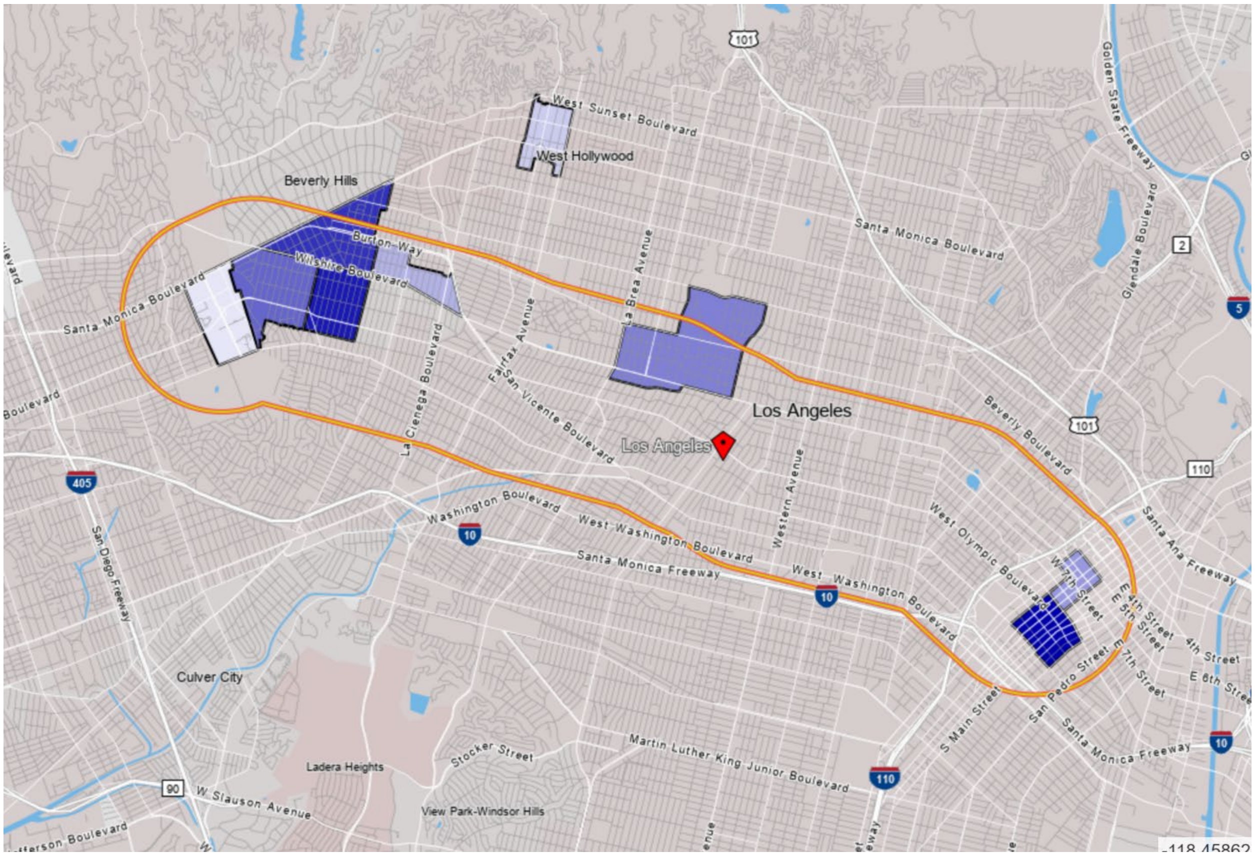
Metro Line D terminus. Figures 3.4, and 3.5 show that one-mile and one-and-a-half-mile buffers from Olympic Blvd respectively partially enclose or fully enclose all three employment clusters.

Figure 3.3: LEHD Map for Study Corridor (0.25-mile buffer)



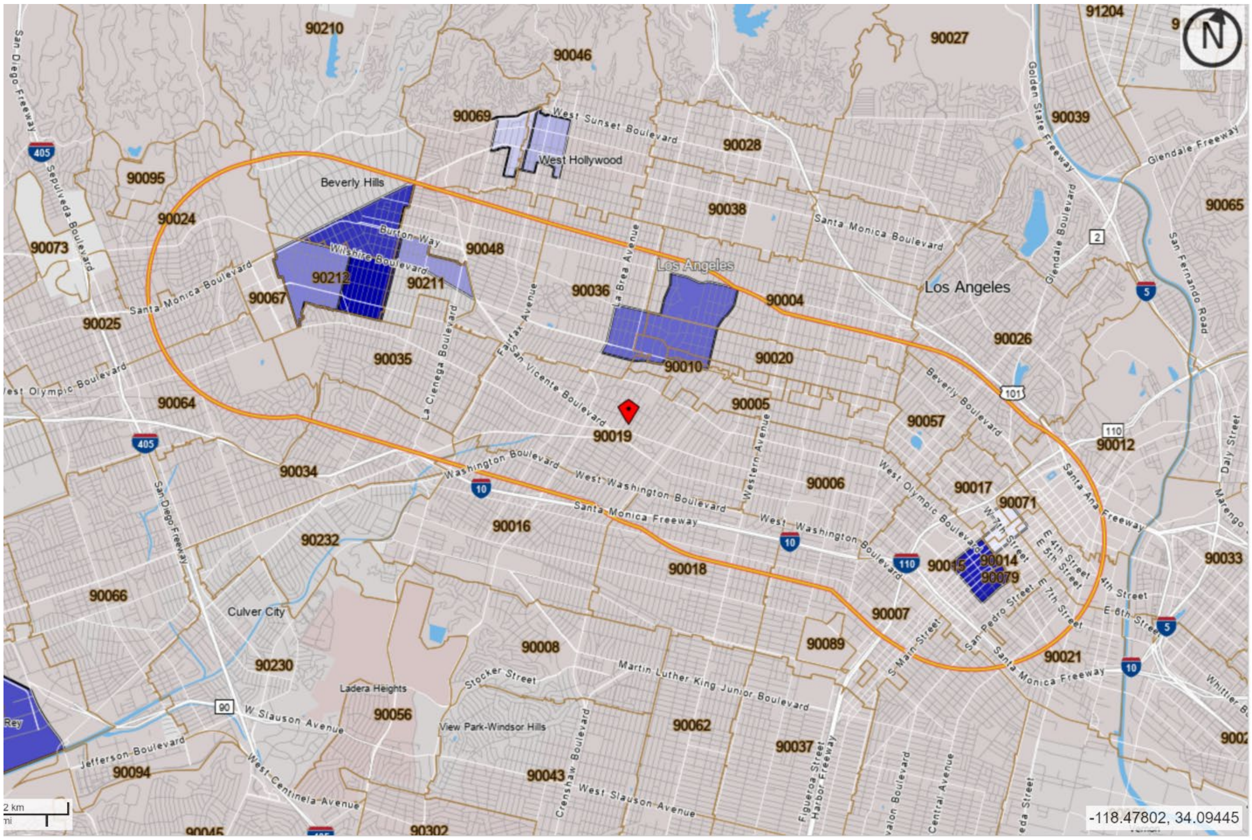
Source: U.S. Census Bureau, 2023.

Figure 3.4: LEHD Map for Study Corridor (1 mile buffer)



Source: U.S. Census Bureau, 2023.

Figure 3.5: LEHD Map for Study Corridor (1.5-mile buffer)

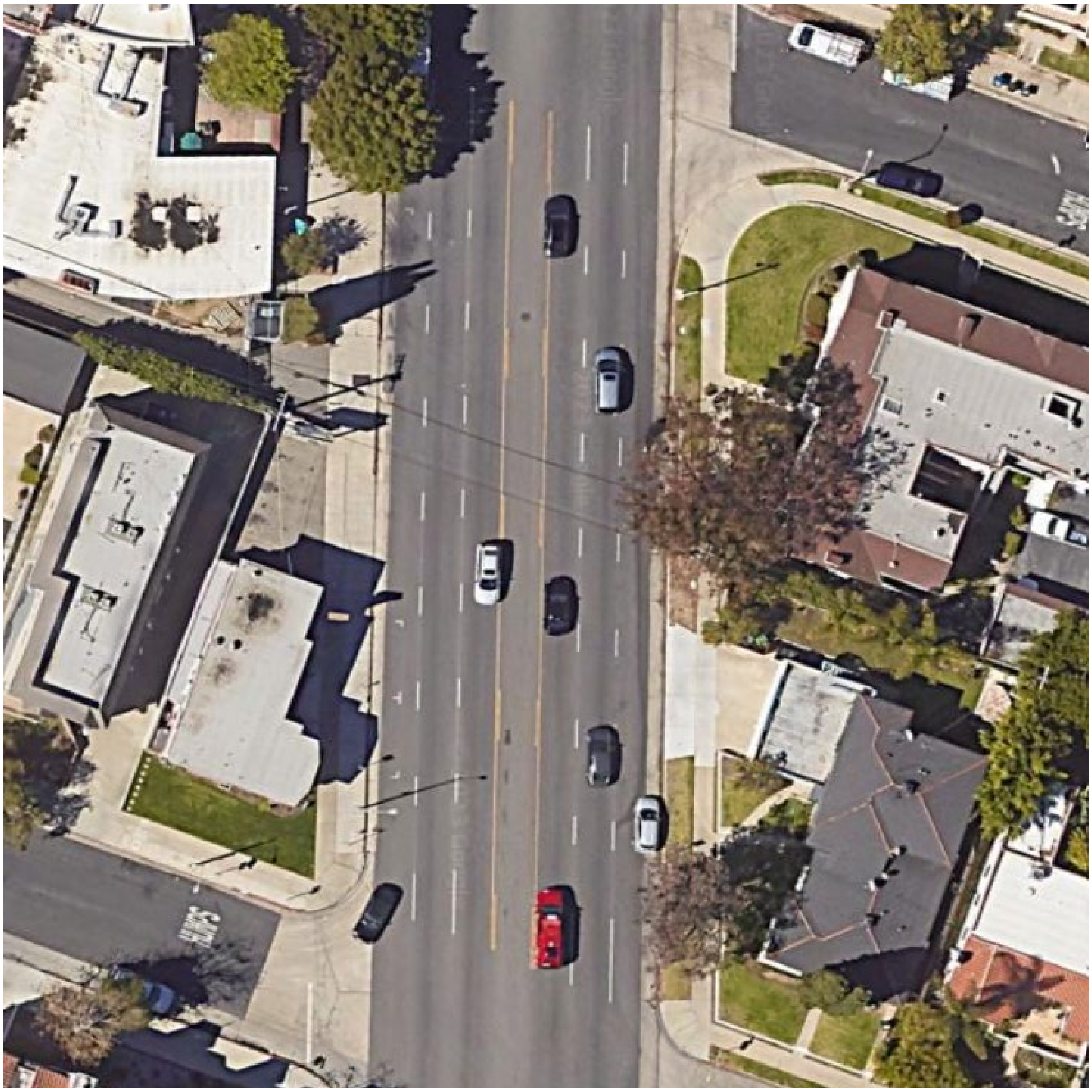


Source: U.S. Census Bureau, 2023.

3.1.2 Road Network

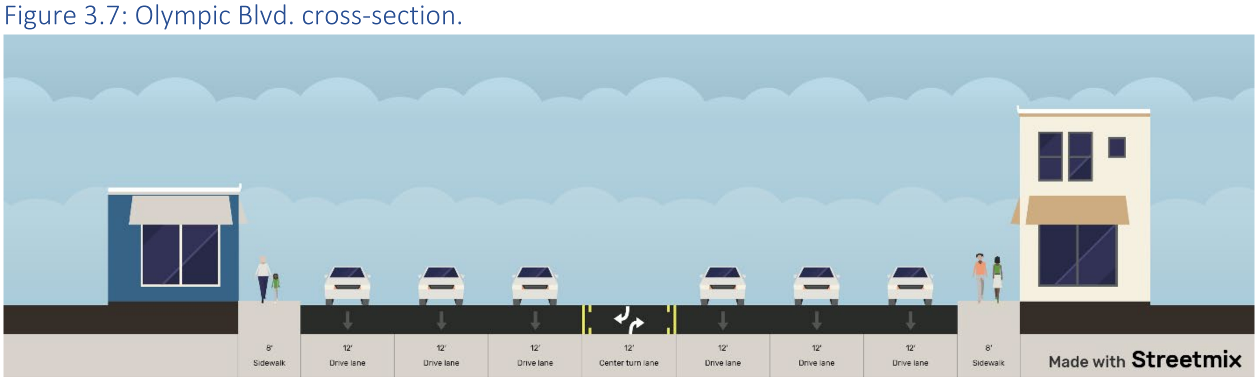
Olympic Blvd has a right-of-way of 100 feet with four lanes during the off-peak and six lanes available during commute hours from 7 am to 9 am and 3 pm to 7 pm. The two outer lanes permit parking during the off-peak and serve bus stops. Olympic Blvd also has a two-way left turn lane. Olympic Blvd is an east-west arterial corridor between Wilshire Blvd to its North and Pico Blvd to its South. Interstate 10, the major east-west freeway in the area, is further south. Figure 3.6 is an aerial view of a typical section of the roadway. Figure 3.7 shows the cross section during peak period operations.

Figure 3.6: Corridor Lane configuration.



Source: Google, 2020.

Figure 3.7: Olympic Blvd. cross-section.



Source: Author using Streetmix, 2023.

3.1.3 Operating Transit Services

Two transit lines operate along the length of the corridor, each serving a distinct role. LADOT Transit operates Commuter Express 534, a closed-door, limited-stop, commute-period service between Downtown Los Angeles and Century City. As there are boarding restrictions at most stops along the route and limited-service hours, the route is meant to serve "9-to-5" commuters who work or live in or near Century City and Downtown Los Angeles. The route only makes trips in the reverse-commute direction from Downtown Los Angeles to Century City during the morning commute hours and from Century City to Downtown Los Angeles during the evening commute hours. Closed-door means that only boarding is allowed in the first segment of the route, and only deboarding is allowed at stops at the end of the route. This reduces boarding times and delays and serves as an express service for commuters who work a fixed "9-to-5" schedule. Metro Route 28 is an all-day route and runs local service within the study area. Route 28 runs as a local bus, making frequent stops, with a mix of near-side and far-side stops.

Adjacent east-west corridors, Pico Blvd. to the south and Wilshire Blvd. to the north, also provide complementary transit services, serving east-west travel demand, along with commute traffic to and from Century City, Downtown Los Angeles, and the Mid-Wilshire employment centers. However, Olympic Blvd is the only corridor with the commuter serving LADOT Commuter Express 534. This is because Pico Blvd and Wilshire Blvd, the other corridors adjacent to Olympic Blvd, provide local, high-capacity, frequent transit service in the area.

Wilshire Blvd. provides the bulk of the transit capacity, with Metro Line D (formerly Purple Line) operating in the corridor, a heavy-rail subway line terminating at Wilshire and Western from Union Station. West of Wilshire and Western, Metro Routes 20 and 720 serve parts of Wilshire that are unserved by Metro Line D service. The two bus routes also serve as a local connector for areas between Metro Line D subway stations.

Big Blue Bus Route 7 operates along Pico Blvd., running service from the Metro Line D Wilshire and Western station to Downtown Santa Monica, west of Century City. On Pico Blvd's eastern extent, Metro Route 30 connects the Pico/Rimpau Transit Center to Downtown Los Angeles. Figure 3.8 is a map of transit routes along the study and adjacent corridors.

Figure 3.8: Map of Transit Routes along Corridor

Source: Los Angeles Metro, 2022.

3.2 Comparative Travel Times by Mode

Comparing travel times by each mode of transport and in each direction in the study corridor is essential to understand the differences in travel time for each form of transportation in the corridor and what it means for someone who wishes to traverse the corridor in terms of convenience. The travel times also provide a baseline for the improvements proposed in this report.

3.2.1 Westbound

Travel time between Olympic and Flower in Downtown Los Angeles and Olympic and Century Park East at the end of the study corridor using LADOT Route 534 is scheduled for 36 minutes, for an 8.8-mile travel distance. Still, westbound trips for the route only occur during morning hours, when peak traffic flows eastwards towards Downtown LA. The same travel on Route 28 is 53 minutes for the same commute, traveling the same distance within the corridor, but making a lot more stops along the way, serving local trips along the corridor.

3.2.2 Eastbound

During rush hour, the time to traverse the corridor from Olympic and Century Park East at 8 am takes 28 minutes by car and 53 minutes when using Metro Route 28. LADOT Route 534 is scheduled for 36 minutes, as the route conducts Eastbound runs during the afternoon hours.

3.3 Existing Bus Infrastructure

Most stops are delineated using route signs with the route number, destinations, and concrete bus pads. Major stops, such as Olympic and Western, are equipped with benches. Most stops are located nearside of intersections. Depending on the time of day, bus stops are embedded within the parking lane during non-commute hours, while bus stops are within a travel lane during commute hours, as the parking lane is repurposed as a travel lane during those hours.

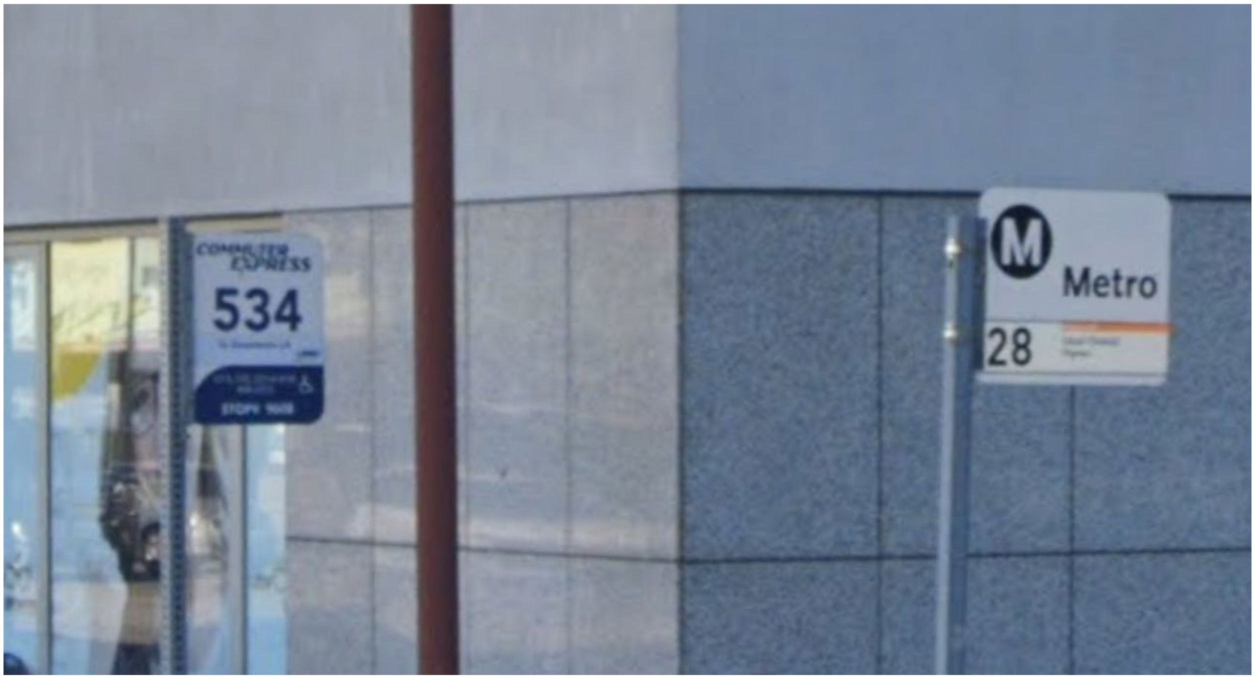
3.4 Issues Present

Passenger amenities and information need to be improved. While service stops along the study area are delineated with stop signage indicating stop numbers, and bus routes, along with directions and destinations for the bus routes, most stops lack amenities, such as benches, shelters, or lighting. As Figure 3.8 illustrates, Olympic Blvd. and Western Ave. is a significant interchange point because Western Ave. is a major North-South arterial, which connects commuters from Olympic Blvd. looking to interchange with Metro D Line services at Wilshire Blvd and Western Avenue within the central employment center. However, even major transit interchange points are only furnished with limited street furniture and conveniences as Figure 3.9 and Figure 3.10 illustrate. Most stops along the route have only signposts, one for Metro Route 28 and another for LADOT Route 534.

Figure 3.9: Olympic Blvd. and Western Ave. bus stop condition

Source: Google, 2022.

Figure 3.10: Olympic Blvd. and Western Ave. bus stop signage



Source: Google, 2022.

4.0 Analysis

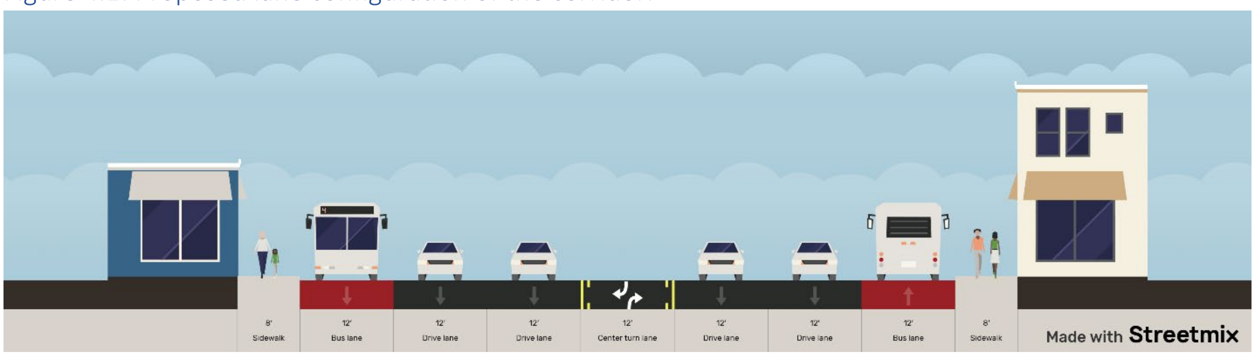
This section analyzes the data and assumptions in the Literature Review section and applies them to the Olympic Blvd. corridor in Los Angeles, California. This is not an actual bus rapid transit project but rather a case study, where established data regarding bus rapid transit projects are utilized to give an idea of potential costs, travel time improvements, and ridership increases. Therefore, results can vary with the actual implementation of bus rapid transit improvements in the corridor, Therefore, the figures provided in this report serve as a frame of reference for actual improvements. Still, this analysis seeks to serve as a projection for how transit service could look like in the corridor after improvements are made.

Using the figures retrieved in the Literature Review section, one would expect decreases in travel time and increases in ridership when a comprehensive set of improvements is implemented along the Olympic Blvd. corridor. These improvements are evaluated as a comprehensive package, utilizing a series of treatments which when used together, can provide substantial improvement in bus travel times and schedule adherence, along with the associated gains in ridership and positive impacts towards equity.

4.1 Proposed Improvements on Olympic Blvd

Proposed improvements include (a) a permanent, dedicated curbside bus lane in each direction; and (b) signal preemption at intersections to provide priority for buses. To provide space for bus lanes in the corridor, and as there is no additional right-of-way for implementing bus lanes, the two preexisting parking lanes/rush-hour lanes may be converted into two all-day bus lanes to provide for a continuous bus lane implementation along the corridor. As the right-of-way across the entire corridor is 100 feet or more, with six lanes on Olympic Blvd, three lanes in each direction during rush hour, converting the parking lane into an all-day bus lane would enable an increased allocation of road space to transit riders. This conversion does not require any change to road geometry or preexisting stop infrastructure. It only involves road reconfiguration in the form of restriping and lane coloring, reducing costs to the extent possible while gaining the benefits of a dedicated bus infrastructure. Figure 4.1 illustrates the proposed lane configuration for a dedicated bus lane in each direction.

Figure 4.1: Proposed lane configuration of the corridor.



Source: Author using Streetmix, 2023

The operational aspect of signal priority involves traffic signal systems that detect the presence of approaching buses and enable them to traverse the intersection promptly. Termed, signal preemption, the system extends the green phase or shortens the red phase when it detects an approaching bus. Besides dedicated lanes and preemption, another form of improvement that contributes to bus priority is the queue jump treatment.

4.2 Projected Outcomes

Using figures and equations from existing research on bus corridor improvements, one can estimate ridership changes, along with travel time impacts once the package of bus rapid transit improvements is completed. The package explained in the previous section, with the combined implementation of bus lanes and signal preemption are utilized for calculating the projected outcomes. Projecting outcomes for specific strategies separately, such as solely implementing bus lanes on a corridor, is difficult as bus rapid transit improvements are commonly implemented as packages to ensure that synergies with the implementation of multiple complementary treatments are realized within a given project.

4.2.1 Travel Time Improvements

For determining travel time improvements, we shall use the pre-existing scheduled travel times for each target bus route as provided in this document's "Existing Conditions" section. To calculate predicted future travel times, *Evaluation of Cost-Effective Planning and Design Options for Bus Rapid Transit in Dedicated Bus Lanes* provides a set of data regarding travel time reductions in a post-improvement scenario, with improvements of approximately 6 percent compared to pre-improvement travel times. There is also an improvement in schedule adherence, which is essential as passengers rely on the buses to arrive at specific times to board or transfer.

Adapted from *Evaluation of Cost-Effective Planning and Design Options for Bus Rapid Transit in Dedicated Bus Lanes*, one can determine future travel times for the two focus transit routes using Equation 1:

$t_{new} = (1-P_s)\ t_{old}$, **[equation 1],** where

P_s, is <u>percent savings in travel time</u>; so that with 6% savings, (1 - 0.06) = 0.94,

t_{old} is the <u>original travel time</u> derived from the "Existing Conditions" section, and

t_{new}, is <u>reduced travel time</u> in minutes.

The formula implies that bus rapid transit improvements consisting of curbside bus lanes, along with signal priority improvements, when implemented together as a comprehensive bus rapid transit improvement, can reduce bus trip times by 6 percent because of reduced intersection delay and increased average bus operating speeds. LADOT Commuter Express Route 534 is scheduled to travel the route from Olympic and Flower (in Downtown Los Angeles) to Olympic and Century Park East (in Century City) in 36 minutes. A 6 percent reduction would result in a travel time of 33.84 minutes over the same distance. However, it is also noteworthy that the ability to maintain schedule adherence is also improved, meaning that the route is much less likely to run past the 33.84 minutes as is the case currently due to traffic conditions. Also, the improvements would allow Metro Route 28 to improve travel time and ensure greater schedule adherence, reducing travel time from 53 minutes to 49.82 minutes as Figure 4.2 shows.

Maintaining schedule adherence is essential in overall bus operations when a prior delay causes cascading delays to subsequent runs. Under current operations, when a bus takes longer than its scheduled time on an assigned run, the next run departs late as well, creating cascading delays and resulting in decreased real-world transit reliability and frequency.

Figure 4.2: Travel times: before and after bus rapid transit improvements

Route	Travel time before improvements (in minutes)	Potential travel time post improvements (in minutes)
LADOT Commuter Express 534	36	33.84 (-2.16)
Metro Route 28	53	49.82 (-3.18)

4.2.2 Ridership Increases

To estimate ridership impacts post-implementation of bus rapid transit improvements, a 2012 study, "A New Model for the Secondary Benefits of Transit Priority," provides an equation to calculate ridership impacts once the package of travel time improvements is calculated. One can estimate ridership growth post-implementation of bus rapid transit improvements using equation 2 (with $R^2 = 0.7$):

$R_g = 0.205 \ln (P_s) + 0.6132$ **[equation 2],** where:

P_s is the percentage of travel time saved,

Ln is natural log, and

R_g is the corridor ridership growth as a percentage.

Using equation 2, one can determine ridership growth post-implementation using existing ridership data retrieved from LA Metro and LADOT and calculate future ridership growth and levels with proposed improvements. It is worth noting that the coefficient of determination (R^2) is 0.7 for equation 2, meaning that the travel time savings explain 70 percent of the variation in ridership gains, which indicates that the relationship between decreased travel times and increase in ridership is moderate.

Applying equation 2 reveals a potential increase in ridership of 3.6 percent. The estimated ridership figures in Figure 4.3 are calculated based on 2022 ridership data, which represent the most recent full year of ridership data available from the two transit agencies.

Figure 4.3: Ridership: before and after improvements

Route	Current annual ridership (2022)	Estimated future annual ridership with improvements
LADOT Commuter Express 534	19,014	19,699 (+685)
Metro Route 28	2,611,955	2,705,985 (+94,030)

4.3 Projected Costs

For this study, cost figures come from "Evaluation of Cost-Effective Planning and Design Options for Bus Rapid Transit in Dedicated Bus Lanes" conducted in 2009. The study surveyed bus rapid transit implementation costs nationwide on a state-to-state basis. In California, the cost per lane-mile of bus rapid transit implementation in 2002 dollars was identified to be $2,213,519. This cost is for one mile of a dedicated curbside lane in one direction with signal priority in the corridor to ensure that buses are given the green signal when they are scheduled to approach a specific intersection. This cost also includes improved bus stop infrastructure, signage, lighting, information systems such as bus arrival announcements and displays, and shelter with seating for waiting passengers. This cost figure serves as the basis for projected costs for the Olympic Blvd corridor. As the corridor is 8.8 miles in length and two lanes of bus rapid transit are proposed, the projected cost is approximately $38,957,934 in 2002 dollars.

The cost estimate serves as an approximate reference only. A wide range of variances can occur due to a range of factors, including environmental documentation and compliance, mitigation costs, and project location. Other factors, such as mobilization, preliminary engineering, and construction engineering costs, can also create variances.

4.4 Equity Implications

The objective for the allocation of road space towards a dedicated bus lane is to move people more equitably on public streets. Figure 4.4 compares the number of transit vehicle trips in the AM and PM peak hours. 5,910 auto trips occur along the study section of Olympic Blvd during the AM and PM peak periods, compared to 36 transit bus trips. Figure 4.5 shows the occupancies of both transportation modes. With 40-seat buses on Metro Route 28, and 57-seat buses on LADOT Route 534, the potential transit passenger volume is 1,542. Assuming 1.2 passengers per auto, 6,213 passengers traverse the study section during AM and PM peak hours. Figure 4.6 compares transit and auto lane usage, assuming that transit is allocated one curbside lane while general purpose traffic retains two inner lanes in each direction. The average of the combined AM & PM peak passengers per lane is 386 for transit, and 777 for autos. This allocation would appear that the number of transit passengers per lane is only half that of auto passengers per lane. Transit is not appealing due to higher travel times than auto trips.

Reallocating road space towards transit vehicles would enable more equitable travel times on public streets. Figure 4.7 compares estimates of travel times with and without BRT improvements. Without improvements, transit trips take approximately 60 percent longer than the equivalent auto trips. With the addition of BRT improvements, which includes a curbside bus lane and traffic signal preemption, transit trip times are estimated to take as long as auto trips. Under such a scenario, the travel times between transit riders and auto users would become equitable.

Figure 4.4: Estimates of vehicle trips in the study corridor during morning and evening peak hours

Vehicle Estimates	Seats / Persons per Vehicle	AM Peak Hour Runs		PM Peak Hour Runs		Combined AM & PM Peak Directions
Travel Mode		Eastbound	Westbound	Eastbound	Westbound	Total
Metro Route 28	40	9	9	6	6	30
LADOT Route 534	57		3	3		6
Subtotal Transit Vehicles		9	12	9	6	36
General purpose autos	1.2	1,515	1,284	1,556	1,555	5,910

Sources: Appendix A: Olympic Blvd at Western Ave Traffic Volume (2004), Appendix B: Los Angeles Metro Route 28 Schedule (2022), Appendix C: LADOT Route 534 Schedule (2021)

Figure 4.5: Estimates of person trips in the study corridor during morning and evening peak hours

Person Estimates	Seats / Persons per Vehicle	AM Peak Hour Runs		PM Peak Hour Runs		Combined AM & PM Peak Directions
Travel Mode		Eastbound	Westbound	Eastbound	Westbound	Total
Metro Route 28 (on 1 lane)	40	360	360	240	240	1,200
LADOT Route 534 (on 1 lane)	57	0	171	171	0	342
Subtotal Potential Transit Passengers		360	531	411	240	1,542
General purpose autos (on 2 lanes)	1.2	1,818	1,284	1,556	1,555	6,213

Sources: Appendix A: Olympic Blvd at Western Ave Traffic Volume (2004), Appendix B: Los Angeles Metro Route 28 Schedule (2022), Appendix C: LADOT Route 534 Schedule (2021)

Figure 4.6: Comparative efficiencies of transit and auto lane use in the study corridor during peak hour

Efficiency Estimates (Lane Use)	**AM Peak Hour Lanes**		**PM Peak Hour Lanes**		**Combined AM & PM Peak Directional Lanes**	**Total AM & PM Passengers**	**Average AM & PM Passengers per Lane**
	Eastbound	**Westbound**	**Eastbound**	**Westbound**	**Total**		
Transit passengers	1	1	1	1	4	1,542	386
Auto passengers	2	2	2	2	8	6,213	777
Transit as percent of auto					50%	25%	50%

Sources: Appendix A: Olympic Blvd at Western Ave Traffic Volume (2004), Appendix B: Los Angeles Metro Route 28 Schedule (2022), Appendix C: LADOT Route 534 Schedule (2021)

Figure 4.7: Comparative efficiencies of transit and auto travel times across the study corridor

Comparative Efficiency Estimates (Travel Time)	Average Travel Time (Minutes)
Before BRT[1]	
Transit passengers (Google)	65
Auto passengers (Google)	41
Transit as percent of auto	159%
After BRT[2]	
Transit passengers (weighted average with BRT improvements)	46
Auto passengers (degraded by 15% with reallocation of 3rd lane to BRT)	47
Transit as percent of auto	98%

Sources: [1]Google Maps (2023)

[2]Estimates from Figure 4.6

The reallocation of road space is a step towards ensuring equity on public streets, where streets serve people in the most equitable way possible regardless of one's mode of transportation. Both the enhancements in service that riders would experience post-improvement, along with the attraction of ridership to transit from other modes of transportation can add up to tangible benefits for the people who most require enhancements to the transportation system to ensure that they are not left behind economically and socially in the utilization of the public roads which are meant to serve all people.

5.0 Lessons Learned

It is crucial to understand the range of potential costs, along with its impacts on ridership, bus travel times, and equity when implementing bus rapid transit projects. Even as the analysis focuses on efforts that are quick-build and require less complicated and comprehensive planning and construction work, clear information on project benefits and costs are essential when considering such projects.

5.1 Implementation Lessons

The analysis shows the importance of implementing a full set of improvements when considering projects to improve bus performance and ridership. Uncoordinated and piecemeal improvements do not improve bus operations in the way that complete and comprehensive bus rapid transit projects do, even as substantial funds are spent in the planning, design, engineering, and construction phases for less comprehensive projects. While piecemeal improvements appear more time and cost-effective, the sorts of improvements proposed in the Analysis section, including bus lanes and signal preemption, produce ideal results only when implemented and coordinated together, with proper design and engineering decisions matching a prospective corridor.

5.2 Cost Analysis

Cost optimization is one of the main lessons of this study, to ensure that maximization of benefits towards bus operations with the lowest cost possible to retain the full benefits of typical bus rapid transit projects. Therefore, design decisions such as retaining a curbside bus lane was made, as this allows for the utilization of current bus stop infrastructure, along with reducing costs associated with roadwork, as comprehensive reworking of street infrastructure is time and cost extensive, and introduces additional risk in the design, planning, and construction process.

The total figure estimated for the project is $38,957,934 in 2002 dollars for the 8.8-mile corridor, at a cost of $2,213,519 per lane, per mile in 2002 dollars (Li, et al. 2009). This figure is comprehensive, including all design, preconstruction, preliminary engineering, and construction costs. This figure also includes costs relating to environmental analysis and mitigation.

5.3 Time Savings

The most direct impact of the improvements made is the time savings for bus trips after the implementation of bus rapid transit improvements. Using data from Evaluation of Cost-Effective Planning and Design Options for Bus Rapid Transit in Dedicated Bus Lanes (Li, et al., 2009), bus rapid transit improvements as proposed within the study could result in a 6 percent decrease in travel times for buses. LADOT Route 534 is estimated to have a travel time of 33.84 minutes, a reduction of 2.16 minutes as opposed to the current 36 minutes. Metro Route 28 is estimated to have a 49.82-minute travel time, a 3.18-minute reduction compared to the current 53-minute travel time.

Another impact is the increased schedule punctuality after the implementation of the improvements. Increased schedule punctuality means that buses run more frequently according to scheduled times, as they would have the infrastructure possible to run on time and are not stuck in traffic. This would improve the rider’s experience, as users are able to depart and arrive from bus stops at predictable times and are also able to plan trips and bus transfers more easily.

5.4 Ridership Impacts

Projected increases in ridership are expected to occur because of the improvements made to decreased travel time and increased schedule adherence. Using data from "A New Model for the Secondary Benefits of Transit Priority" (Currie and Sarvi, 2012), which provides an equation to estimate ridership increases after bus travel times are reduced as part of improvements. Using the equation, one can estimate an increase in ridership by 3.6 percent after the proposed implementation of the improvements. In the context of the transit routes analyzed in the study, we expect increased annual ridership of 94,715, with an R^2 of 0.7, as calculated using 2022 ridership data for the two routes.

5.5 Equity Impacts

With BRT improvements, travel times for transit passengers would become similar to auto travel times, which would enhance equity. Improvements to resiliency, reliability, and speed of bus service in the corridor offer existential benefits to disadvantaged communities. The implementation of a dedicated bus lanes provides the ability for transit agencies to reliably implement more frequent service, attracting potential transit riders who may currently be discouraged by limited frequencies and excessive wait times of existing transit service.

Transit-dependent populations rely on transit to reach destinations, whether travel is for work, school, or recreation. Reallocating valuable road space towards transit, which carries more people, and people who rely on such forms of transportation to earn a living is a step to ensuring that streets serve people equitably, regardless of the form of transportation.

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Appendices

Appendix A: Olympic Blvd at Western Ave Traffic Volume

24 HOURS TRAFFIC VOLUME

City of Los Angeles

Department of Transportation

Counter	HUGO
Date	7/30/2004
Start Time	12 AM

Location	OLYMPIC BL AT WESTERN AV	**Day of Week**	FRIDAY	**Prepared**	8/4/2004
Direction	E/W STREET	**DOT District**	HOLLYWOOD	**Sensor Layout**	11
Description	5581078500	**Weather**	CLEAR	**Sensor Spacing**	160

Time	WEST BOUND					EAST BOUND					Total
	1ST	2ND	3RD	4TH	HOUR TOTAL	1ST	2ND	3RD	4TH	HOUR TOTAL	
12 AM	51	49	51	24	175	51	45	36	34	166	341
1 AM	26	44	35	26	131	32	30	31	30	123	254
2 AM	32	24	24	13	93	26	22	16	9	73	166
3 AM	14	12	7	15	48	13	11	12	16	52	100
4 AM	11	16	22	28	77	14	20	15	18	67	144
5 AM	28	36	44	52	160	24	41	47	39	151	311
6 AM	88	112	150	236	586	56	78	122	148	404	990
7 AM	276	342	343	323	1284	206	253	326	427	1212	2496
8 AM	337	302	305	283	1227	344	367	372	432	1515	2742
9 AM	308	289	274	253	1124	422	381	346	296	1445	2569
10 AM	253	226	222	246	947	296	300	270	286	1152	2099
11 AM	246	254	265	286	1051	279	280	288	290	1137	2188
12 NN	285	288	320	316	1209	272	278	250	318	1118	2327
1 PM	307	265	287	308	1167	298	286	298	292	1174	2341
2 PM	287	293	272	303	1155	274	292	334	277	1177	2332
3 PM	339	323	332	318	1312	324	344	342	350	1360	2672
4 PM	323	326	368	360	1377	324	349	382	355	1410	2787
5 PM	378	383	402	392	1555	352	393	404	368	1517	3072
6 PM	357	358	353	369	1437	407	382	388	379	1556	2993
7 PM	311	331	310	304	1256	360	326	304	260	1250	2506
8 PM	232	214	182	187	815	240	224	233	197	894	1709
9 PM	184	210	189	180	763	185	202	188	180	755	1518
10 PM	186	193	171	145	695	178	168	165	164	675	1370
11 PM	144	120	94	98	456	126	116	96	82	420	876

FIRST 12-HOUR PEAK QUARTER COUNT	343	7 AM	3RD	432	8 AM	4TH
LAST 12-HOUR PEAK QUARTER COUNT	402	5 PM	3RD	407	6 PM	1ST
24 HOUR VEHICLES TOTAL		20100			20803	40903
TOTAL VEHICLES STANDARD DEVIATION (STD)		– 491.25			– 533.03	– 1,019.23

PEAK HOURS VOLUME

	WEST BOUND		EAST BOUND		BOTH DIRECTIONS	
	Peak Hour	Volume Vehicles	Peak Hour	Volume Vehicles	Peak Hour	Volume Vehicles
First 12H Peak	7 AM	1284	8 AM	1515	1515	2799
Last 12H Peak	5 PM	1555	6 PM	1556	1556	3111
First 12H Peak STD		– 27.18		– 32.51		– 59.68
Last 12H Peak STD		– 9.15		– 10.89		– 20.03

Appendix B: Los Angeles Metro Route 28 Schedule

Monday through Friday — Effective Oct 23 2022 — **28**

Eastbound (Approximate Times) — CENTURY CITY: 7 Santa Monica & Avenue of the Stars	LOS ANGELES: 6 Olympic & Fairfax B	5 Olympic & Western	4 Olympic & Figueroa	DOWNTOWN LOS ANGELES: 2 Hill & 7th	1 Cesar E. Chavez & Vignes	Westbound (Approximate Times) — DOWNTOWN LOS ANGELES: 1 Cesar E. Chavez & Vignes	3 Spring & 7th	LOS ANGELES: 4 Olympic & Figueroa	5 Olympic & Western	6 Olympic & Fairfax C	CENTURY CITY: 7 Santa Monica & Avenue of the Stars
4:24A	4:41A	4:51A	5:02A	5:07A	5:17A	4:24A	4:33A	4:38A	4:49A	5:01A	5:17A
4:50	5:07	5:17	5:30	5:35	5:45	4:48	4:57	5:02	5:13	5:25	5:41
5:15	5:32	5:43	5:56	6:01	6:12	5:06	5:15	5:20	5:31	5:43	5:59
—	5:42	5:53	6:06	6:12	6:23	5:21	5:30	5:35	5:48	6:00	6:16
5:32	5:49	6:00	6:14	6:20	6:31	5:32	5:41	5:46	5:59	6:11	6:27
—	5:56	6:07	6:21	6:27	6:38	5:41	5:50	5:56	6:09	6:21	6:38
5:46	6:03	6:15	6:29	6:35	6:46	5:49	5:58	6:04	6:17	6:30	—
—	6:10	6:22	6:36	6:42	6:53	5:56	6:05	6:11	6:24	6:38	6:55
6:01	6:18	6:30	6:44	6:50	7:01	6:04	6:13	6:19	6:32	6:45	—
—	6:25	6:37	6:51	6:57	7:08	6:11	6:20	6:26	6:40	6:54	7:12
6:16	6:33	6:45	6:59	7:05	7:16	6:18	6:28	6:34	6:49	7:02	—
6:22	6:40	6:52	7:06	7:12	7:23	6:25	6:35	6:41	6:56	7:12	7:30
—	6:47	6:59	7:14	7:20	7:31	6:31	6:43	6:49	7:05	7:19	—
6:35	6:53	7:06	7:21	7:27	7:39	6:38	6:50	6:56	7:12	7:29	7:49
—	7:01	7:14	7:29	7:35	7:47	6:46	6:58	7:04	7:21	7:39	7:59
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7:04	7:23	7:36	7:52	7:58	8:10	7:07	7:19	7:26	7:43	8:02	8:24
—	7:30	7:44	8:00	8:06	8:18	7:15	7:27	7:34	7:51	8:11	8:33
7:19	7:38	7:52	8:08	8:14	8:26	7:21	7:34	7:41	7:58	8:18	8:40
7:26	7:46	8:00	8:16	8:22	8:34	7:28	7:42	7:49	8:06	8:26	8:48
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7:58	8:18	8:32	8:48	8:55	9:07	7:58	8:12	8:19	8:36	8:51	—
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8:14	8:35	8:49	9:05	9:12	9:24	8:12	8:26	8:34	8:51	9:06	—
8:23	8:44	8:58	9:14	9:21	9:33	8:20	8:34	8:42	8:59	9:17	9:38
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8:42	9:03	9:18	9:34	9:41	9:53	8:38	8:52	9:00	9:17	9:35	9:56
—	9:13	9:28	9:44	9:51	10:03	8:47	9:02	9:10	9:27	9:42	—
9:02	9:23	9:38	9:54	10:01	10:13	8:57	9:12	9:20	9:37	9:54	10:15
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—	10:12	10:28	10:44	10:52	11:04	9:46	10:01	10:10	10:28	10:43	—
10:01	10:22	10:38	10:54	11:02	11:14	9:55	10:11	10:20	10:38	10:54	11:15
—	10:32	10:48	11:04	11:12	11:24	10:05	10:21	10:30	10:48	11:03	—
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—	10:51	11:07	11:24	11:32	11:45	10:24	10:41	10:50	11:08	11:23	—
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—	11:11	11:27	11:44	11:52	12:05P	10:44	11:01	11:10	11:28	11:43	—
10:59	11:21	11:37	11:54	12:02P	12:15	10:54	11:11	11:20	11:38	11:54	12:15P
—	11:31	11:47	12:04P	12:12	12:25	11:03	11:20	11:30	11:49	12:04P	—
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—	12:10P	12:26	12:44	12:52	1:05	11:43	11:59	12:10P	12:29	12:44	—
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—	12:30	12:46	1:04	1:12	1:25	12:03P	12:20	12:30	12:49	1:04	—
12:16P	12:40	12:56	1:14	1:22	1:35	12:13	12:30	12:40	12:59	1:15	1:36
—	12:50	1:06	1:24	1:32	1:45	12:23	12:40	12:50	1:09	1:24	—
12:36	1:00	1:16	1:34	1:42	1:55	12:33	12:50	1:00	1:19	1:35	1:56
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12:55	1:20	1:36	1:54	2:02	2:15	12:53	1:10	1:20	1:39	1:55	2:16
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1:15	1:40	1:56	2:14	2:22	2:35	1:13	1:30	1:40	1:59	2:15	2:36
—	1:50	2:06	2:24	2:32	2:45	1:23	1:40	1:50	2:09	2:24	—
1:34	2:00	2:16	2:34	2:42	2:55	1:33	1:50	2:00	2:19	2:35	2:56
—	2:10	2:26	2:44	2:52	3:05	1:43	2:00	2:10	2:29	2:44	—
1:54	2:20	2:36	2:54	3:02	3:15	1:53	2:10	2:20	2:39	2:55	3:16
—	2:28	2:44	3:02	3:10	3:23	2:02	2:19	2:29	2:48	3:03	—
2:10	2:36	2:52	3:10	3:18	3:31	2:11	2:28	2:38	2:57	3:13	3:34
—	2:44	3:00	3:18	3:26	3:39	2:19	2:36	2:46	3:05	3:20	—
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—	3:00	3:16	3:34	3:42	3:55	2:35	2:52	3:02	3:21	3:36	—
2:41	3:08	3:24	3:42	3:50	4:03	2:43	3:00	3:10	3:29	3:45	4:06
—	3:16	3:32	3:50	3:58	4:11	2:51	3:08	3:18	3:37	3:52	—
2:57	3:24	3:40	3:58	4:06	4:19	2:59	3:16	3:26	3:45	4:01	4:22
—	3:32	3:48	4:06	4:14	4:27	3:07	3:24	3:34	3:53	4:08	—
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—	4:04	4:20	4:38	4:46	4:59	3:35	3:52	4:02	4:20	4:35	—
3:41	4:10	4:26	4:44	4:52	5:05	3:42	3:59	4:09	4:27	4:43	5:04
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5:05	5:34	5:50	6:08	6:15	6:27	5:15	5:32	5:41	5:59	6:14	—
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5:36	6:03	6:18	6:36	6:43	6:54	5:45	6:02	6:11	6:29	6:44	7:05
5:47	6:13	6:28	6:46	6:53	7:04	5:56	6:13	6:22	6:40	6:54	—
5:57	6:23	6:38	6:56	7:03	7:14	6:11	6:28	6:37	6:55	7:10	7:30
6:13	6:37	6:52	7:09	7:16	7:27	6:27	6:43	6:52	7:09	7:24	7:44
6:30	6:54	7:08	7:25	7:32	7:43	6:42	6:58	7:07	7:24	7:39	7:59
6:51	7:15	7:29	7:45	7:52	8:03	7:02	7:16	7:25	7:42	7:57	8:16
7:18	7:40	7:54	8:09	8:15	8:26	7:29	7:42	7:50	8:07	8:22	8:41
7:44	8:06	8:19	8:34	8:40	8:51	8:00	8:13	8:20	8:36	8:50	9:09
8:16	8:37	8:49	9:04	9:10	9:21	8:30	8:43	8:50	9:06	9:20	9:38
8:46	9:07	9:19	9:34	9:40	9:51	9:03	D 9:12	9:20	9:35	9:49	10:07
9:18	9:37	9:49	10:04	10:10	10:21	9:33	9:44	9:50	10:05	10:18	10:35
9:49	10:08	10:20	10:34	10:40	10:51	10:03	D 10:12	10:20	10:34	10:46	11:03
10:19	10:38	10:50	11:04	11:10	11:20	10:34	10:44	10:50	11:03	11:15	11:32
10:50	11:09	11:21	11:34	11:40	11:50	11:03	D 11:12	11:20	11:32	11:44	12:01A
11:21	11:40	11:52	12:04A	12:10A	12:20A	11:34	11:44	11:50	12:02A	12:13A	12:28
11:55	12:13A	12:23A	12:34	12:40	12:50	12:03A	D 12:12A	12:20A	12:32	12:43	12:58
12:25A	12:43	12:53	1:04	1:10	1:20	12:34	12:44	12:50	1:02	1:13	1:28
12:59	1:16	1:25	1:36	1:42	1:52	1:03	D 1:12	1:20	1:32	1:43	1:58

Appendix C: LADOT Route 534 Schedule

COMMUTER EXPRESS 534

EFFECTIVE SEPTEMBER 29, 2021
A PATIR DEL 29 DEL SEPTIEMBRE, 2021

TO WEST LOS ANGELES

Union Station (A)	Hope & 1st (B)	Flower & Olympic (C)	Century Park East & Constellation (D)	Wilshire & Beverly Glen (E)	Wilshire & Veteran (F)
6:50	6:57	7:04	7:40	7:52	8:02
7:15	7:22	7:29	8:05	8:17	8:27
7:40	7:47	7:54	8:30	8:37	8:47
8:10	8:17	8:24	9:00	9:07	9:17

For this AM commuter service, no drop-offs in Downtown LA and no pick-ups except in Downtown LA. Use DASH or Metro Bus for local trips.

TO DOWNTOWN LOS ANGELES

Wilshire & Veteran (F)	Wilshire & Beverly Glen (E)	Century Park East & Constellation (D)	Figueroa & Olympic (C)	Hope & 1st (B)	Union Station (A)
3:43	**3:52**	**4:00**	**4:45**	**4:59**	**5:07**
4:13	**4:22**	**4:30**	**5:15**	**5:29**	**5:37**
4:33	**4:42**	**4:50**	**5:35**	**5:49**	**5:57**
5:13	**5:22**	**5:30**	**6:15**	**6:29**	**6:37**

PM times are indicated in bold type.
For this PM commuter service, no pick-ups in Downtown LA and no drop-offs except in Downtown LA.
Use DASH or Metro Bus for local trips.

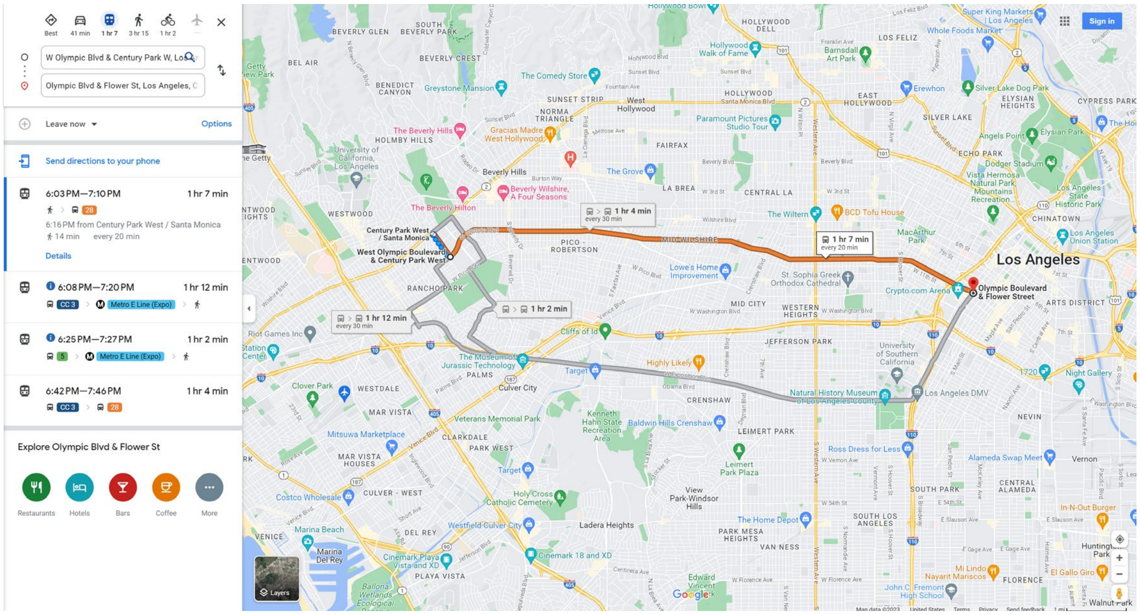
Times are approximate and may vary due to traffic and weather conditions.
Please plan your trip accordingly.

LADOT TRANSIT

City of Los Angeles
Department of Transportation

(213, 310, 323 or/o 818) 808-2273
www.ladottransit.com

Appendix D: Corridor Travel Times via Transit



Appendix E: Corridor Travel Times via Auto