

Appendix G: Transit Reliability



MEMORANDUM

Date: November 8, 2017
To: Brent Pearse, VTA
From: Carrie Modi, Matt Haynes, and Steve Davis
Subject: Transit Reliability Evaluation Memorandum

OK16-0122

The purpose of this analysis is to evaluate the current performance of VTA bus service on Route 25 along the Story-Keyes Complete Streets corridor. Route 25 traverses the entire length of the project corridor, which begins at Willow Street east of the Guadalupe Freeway and continues east along Graham Avenue, Goodyear Street, Keyes Street, and Story Road, terminating at Capitol Expressway.

An initial step is to identify locations where low transit speeds occur so that these can be assessed further for potential improvements. The ultimate goal of this analysis is to develop a recommended list of prioritized improvements that could be implemented to improve transit efficiency.

METHODOLOGY

Identifying the low speed zones and recommendations for improvements will ultimately involve the following four steps:

1. Evaluation of segment-level transit speed data using the Reliability+ tool,
2. Identification of locations where average transit speeds may be significantly lower than prevailing vehicle speeds due to external factors,
3. Site visits, and
4. Development of a prioritized list of potential improvements to reduce transit delays.

The results of the first two steps above are presented in this memorandum. Based upon feedback from VTA staff, we will conduct site visits at key locations to evaluate causes of delay identified through these analyses and develop potential remedies for consideration.



CORRIDOR SEGMENTATION

The system was broken down into segments for analysis. Segments were initially defined by the project team, and refined based on consultation with VTA staff. A map of the segment identification numbers is shown in **Figure 1**. The speed limit along a majority of the corridor is generally 25 mph west of 3rd Street and a mix of 35 mph and 40 mph east of 3rd Street.

VTA ROUTE 25 RELIABILITY+ BUS SPEED RESULTS

Automatic Vehicle Location (AVL) data for bus service along the corridor were provided by VTA for this analysis. AVL units are located on all VTA transit vehicles and record the vehicle's GPS location at intervals throughout each vehicle run. This data is saved by VTA in large files for up to a month after being collected. This analysis is based on data for March 2016, the best data set available at the time that this study began.

Performance metrics were calculated using the Fehr & Peers proprietary Reliability+ tool, which processes the AVL GPS data. The tool aggregates data within user-defined segments to calculate a variety of performance metrics, by route direction and time of day.

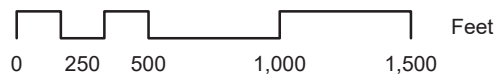
Average speed was the key performance metric calculated and evaluated for this analysis. The mean speed was determined by dividing the travel time of each Route 25 bus trip in each segment by the length of that segment. The following time periods were evaluated: AM Peak Period (6:00 am – 9:00 am), Midday (9:00 am – 2:00 pm), School (2:00 pm – 4:00 pm), and PM Peak Period (4:00 pm – 7:00 pm).

Table 1 indicates the average Route 25 bus travel speeds for each corridor segment during these respective peak hours, which are also reflected in **Figures 2A-2D**. As can be seen, transit vehicle travel speeds are relatively low along the corridor during the peak hours, with average bus speeds significantly lower than the speed limit in most segments.

STATE ROUTE 87 TO MCLAUGHLIN AVENUE



MCLAUGHLIN AVENUE TO CAPITOL EXPRESSWAY



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Figure 1 - Story-Keys Corridor Study Segments

XX Story-Keys Study Segment

Bus Stop

Traffic Control

Signal



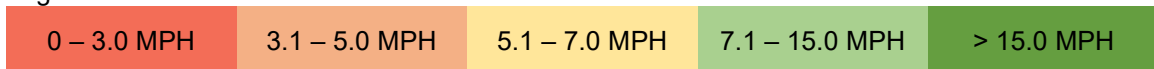


Table 1: Average Bus Travel Speeds for VTA Route 25 (in MPH)

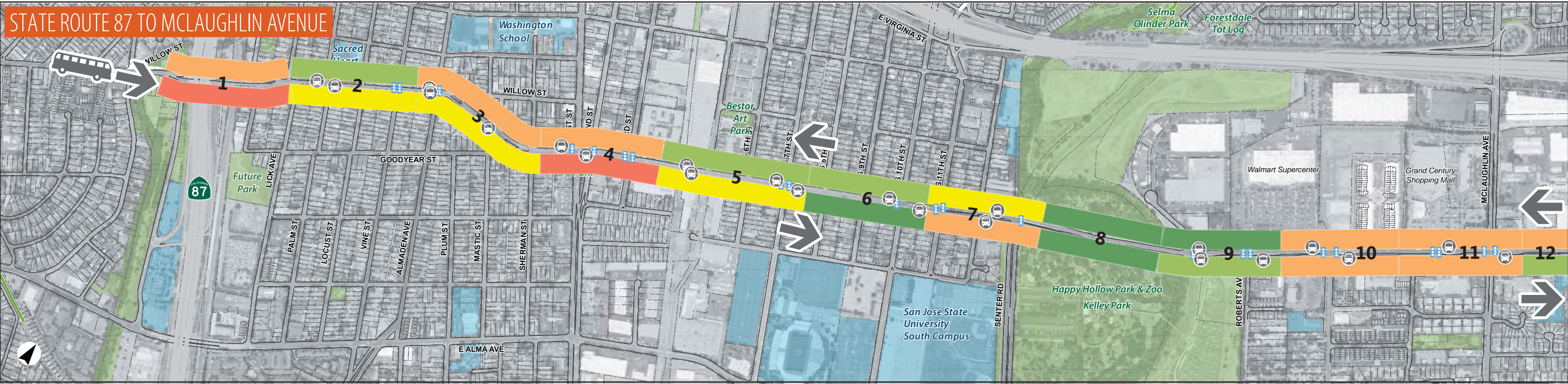
Segment	Major Cross Streets	Direction	AM	Midday	School	PM
1	Lelong Street, Harliss Avenue, Lick Avenue	Westbound	3.1	5.8	3.8	1.9
		Eastbound	1.7	5.5	2.2	3.6
2	Palm Street, Locust Street, Vine Street	Westbound	9.1	10.5	8.7	5.0
		Eastbound	6.5	7.2	6.2	4.0
3	Almaden Avenue, Graham Avenue, Sherman Street	Westbound	3.4	8.1	6.0	3.2
		Eastbound	5.4	6.1	6.5	6.1
4*	1st Street, 2nd Street	Westbound	4.2	3.6	3.4	4.3
		Eastbound	2.6	2.0	2.1	2.2
5	5th Street, 6th Street, 7th Street	Westbound	7.8	6.7	6.6	6.5
		Eastbound	5.7	6.6	5.8	5.0
6	8th Street, 9th Street, 10th Street	Westbound	8.1	10.3	6.7	6.7
		Eastbound	22.4	10.2	3.9	4.8
7	11th Street, 12th Street, Senter Road	Westbound	5.1	4.6	4.5	5.2
		Eastbound	3.6	3.7	3.1	3.0
8		Westbound	18.0	24.7	30.5	29.8
		Eastbound	28.3	32.8	31.3	8.5
9	Remillard Court	Westbound	21.3	13.7	12.7	10.9
		Eastbound	12.2	5.1	3.5	3.0
10	Roberts Avenue	Westbound	4.8	3.0	3.0	3.4
		Eastbound	3.6	3.1	3.0	3.1
11	Lucretia Avenue, McLaughlin Avenue	Westbound	3.4	3.5	3.9	3.8
		Eastbound	4.2	3.8	3.7	3.6
12	Olinder Court, US-101 SB Ramps	Westbound	4.3	4.6	3.5	5.1
		Eastbound	14.5	24.2	21.9	16.7
13	US-101 NB Ramps, Knox Avenue	Westbound	21.2	27.9	27.7	20.6
		Eastbound	22.8	11.8	7.7	4.9
14*	King Road	Westbound	3.1	3.7	3.3	2.7
		Eastbound	2.9	3.3	2.7	2.7
15	McCreery Avenue	Westbound	4.8	3.6	3.8	3.0
		Eastbound	11.6	5.1	10.0	6.2
16	Sunset Avenue, Hopkins Drive	Westbound	7.6	7.5	9.0	10.0
		Eastbound	9.6	9.2	5.3	9.8
17	Diana Avenue, Karl Street, Adrian Way, Jackson Avenue	Westbound	5.4	5.6	4.7	4.8
		Eastbound	12.1	7.3	5.6	5.0
18	Leeward Drive, Wenlock Drive-Galahad Avenue	Westbound	10.8	9.9	16.4	7.1
		Eastbound	10.7	8.5	11.1	10.6
19	Capitol Expressway	Westbound	3.3	3.5	3.1	4.0
		Eastbound	3.5	3.0	4.0	3.8

* Segment containing timepoint schedule stop

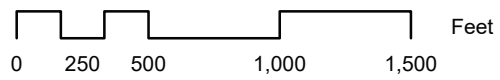
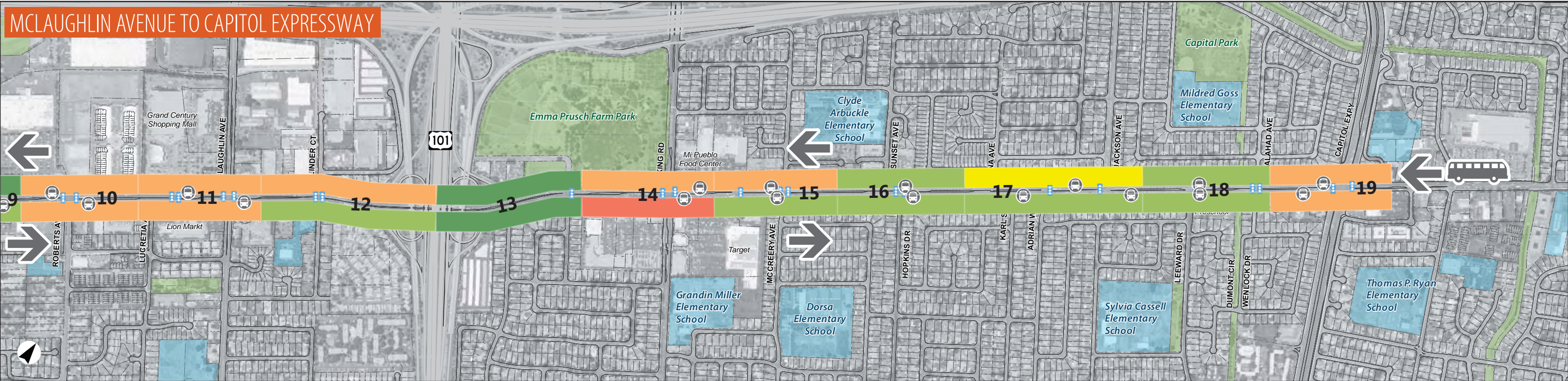
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STATE ROUTE 87 TO MCLAUGHLIN AVENUE



MCLAUGHLIN AVENUE TO CAPITOL EXPRESSWAY



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Figure 2A - AM Average Bus Speeds

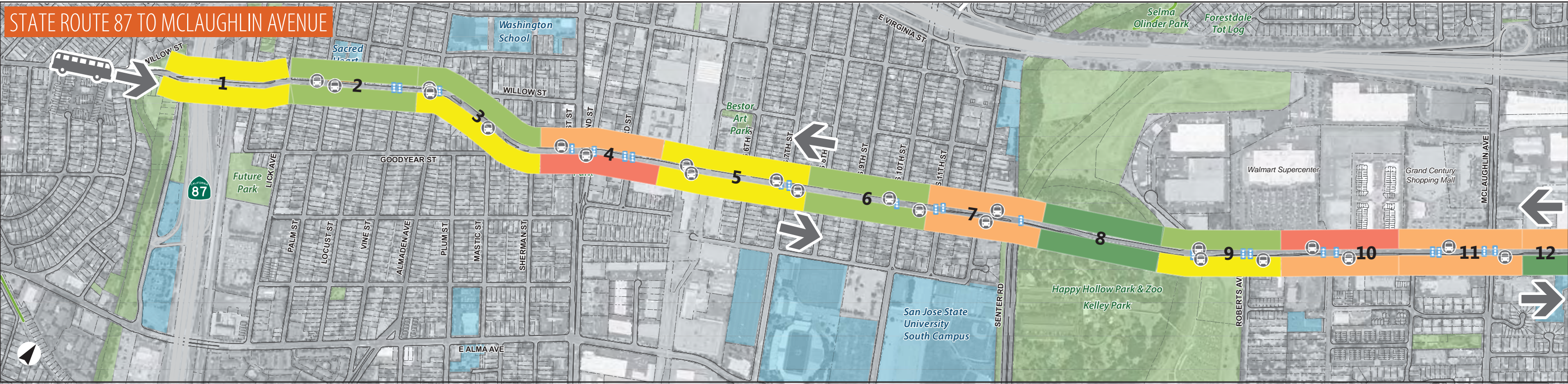
Transit Speeds (MPH)

- ≤ 3
- 3.1 - 5.0
- 5.1 - 7.0
- 7.1 - 15.0
- > 15

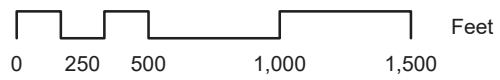
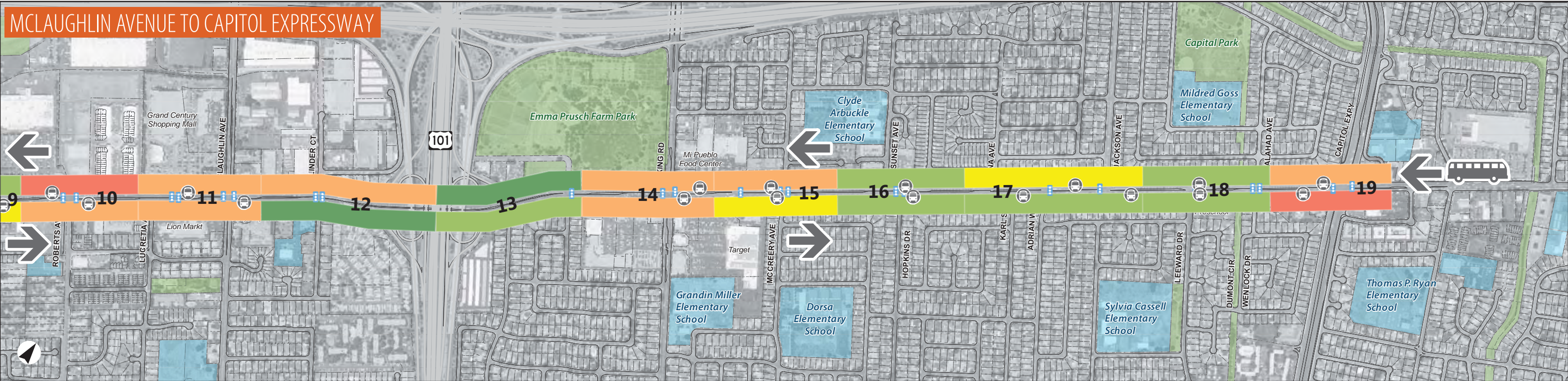
Traffic Control

- Bus Stop
- Signal

STATE ROUTE 87 TO MCLAUGHLIN AVENUE



MCLAUGHLIN AVENUE TO CAPITOL EXPRESSWAY



November 2017

Figure 2B - Midday Average Bus Speeds

Transit Speeds (MPH)

- Red: ≤ 3
- Orange: 3.1 - 5.0
- Yellow: 5.1 - 7.0
- Light Green: 7.1 - 15.0
- Dark Green: > 15

Traffic Control

- Bus Stop: Bus icon
- Signal: Signal icon

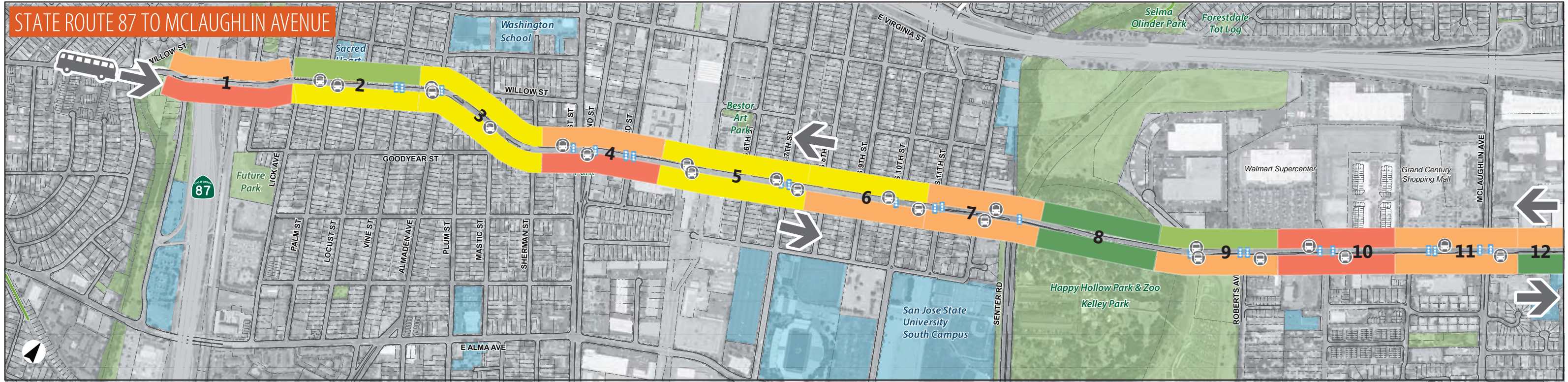
Valley Transportation Authority

CITY OF SAN JOSE
CAPITAL OF SILICON VALLEY

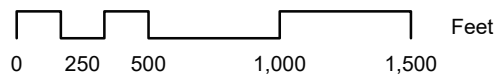
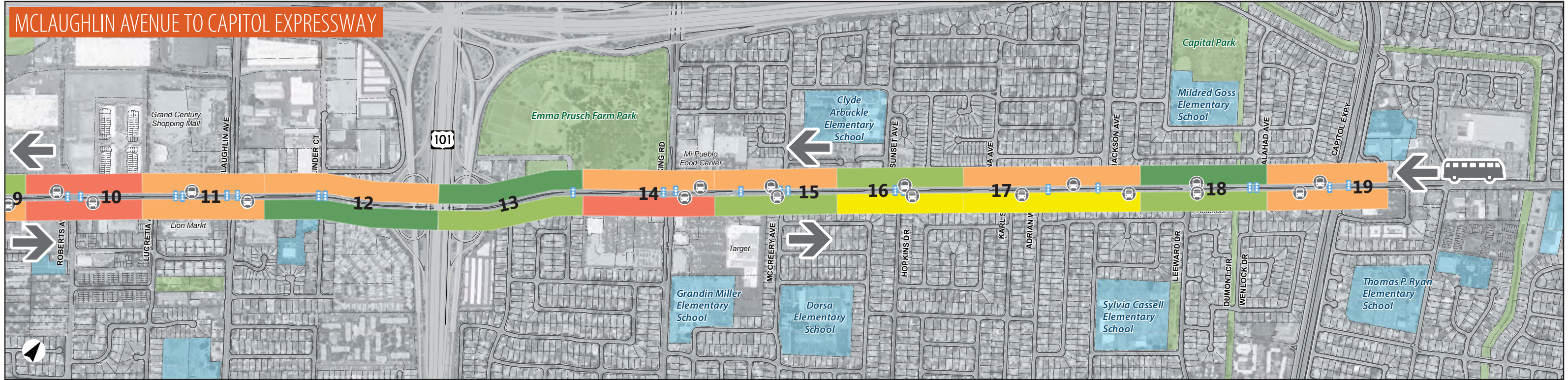
FEHR & PEERS

cd+a
COMMUNITY DESIGN ARCHITECTURE

STATE ROUTE 87 TO MCLAUGHLIN AVENUE

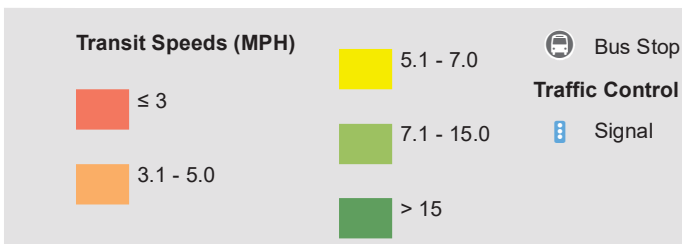


MCLAUGHLIN AVENUE TO CAPITOL EXPRESSWAY

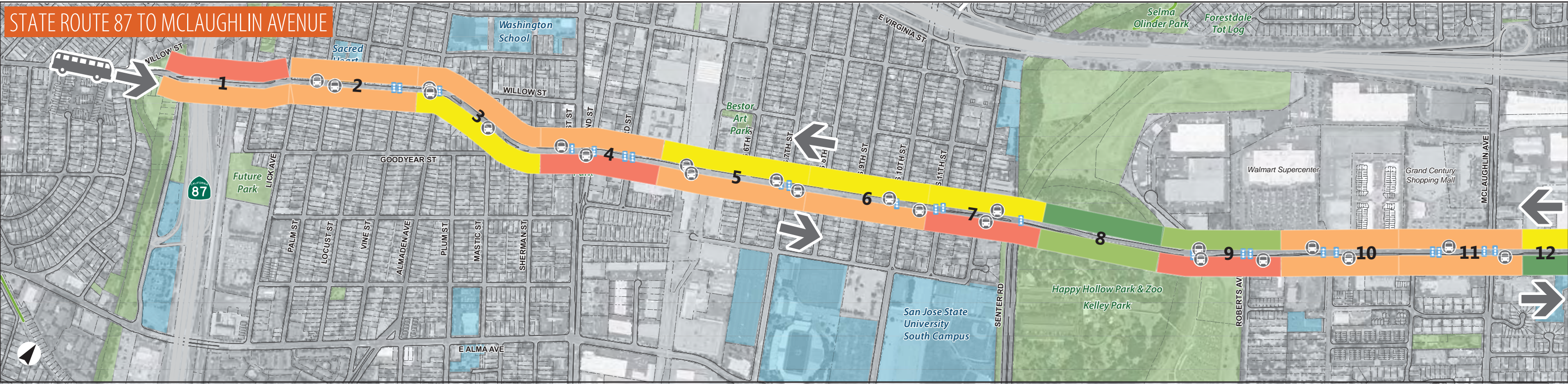


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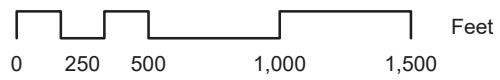
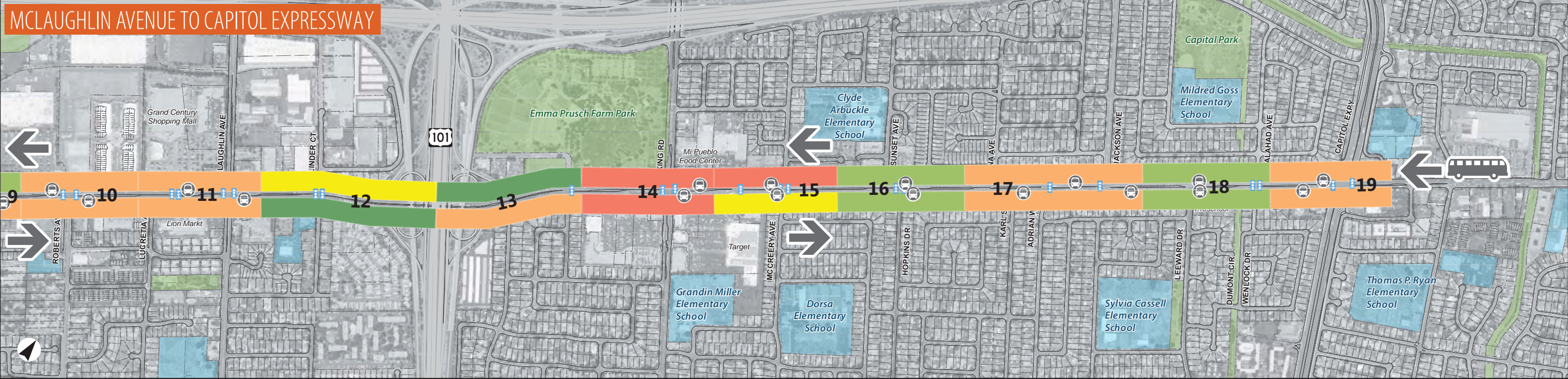
Figure 2C - School Peak Average Bus Speeds



STATE ROUTE 87 TO MCLAUGHLIN AVENUE



MCLAUGHLIN AVENUE TO CAPITOL EXPRESSWAY



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Figure 2D - PM Average Bus Speeds

Transit Speeds (MPH)	5.1 - 7.0	Bus Stop
≤ 3	7.1 - 15.0	Traffic Control
3.1 - 5.0	> 15	Signal



COMPARISON OF BUS SPEEDS TO PREVAILING SPEEDS

INRIX travel speed data was obtained through VTA for the project corridor in order to identify prevailing vehicle speeds. Weighted averages were used to adjust the available INRIX travel speed data to match the segmentation utilized along the Story-Keyes corridor. The average bus speeds were then compared to the average prevailing speeds for vehicles in each segment to determine the relative level of delay being encountered within the segment. Note that INRIX data does not exist for corridor Segments 1-3, which were therefore excluded for the purpose of this comparison.

The speeds calculated using the Reliability+ tool consider the entire travel time from the start to the end of a segment; therefore, they include any delay caused by stopping at bus stops. As a result, the average number of hourly boardings/alightings at bus stops within each segment was also identified during the analysis of the results as the duration of stops within a segment can significantly impact the overall average bus travel times. Bus travel time and ridership data, including AVL data, were provided by VTA.

Table 2 and **Figures 3A-3D** reflect average bus speeds as a percentage of prevailing vehicle speeds for the respective AM, Midday, School, and PM Peak Periods. The figures also indicate the average number of boardings/alightings at each bus stop along the route during those same time periods.

In general, the segments with the most depressed bus travel speeds correspond with those which contain the bus stops with the greatest activity levels, including near 1st Street, adjacent to Walmart, at McLaughlin Avenue, and near King Road. Additionally, average speeds in Segments 4 and 14 are significantly reduced due to the schedule timepoints at 1st Street and King Road, which can sometimes result in buses waiting more than five minutes to match scheduled departure times.

However, bus speeds are consistently lower than prevailing vehicle speeds in multiple segments on either side of McLaughlin Avenue regardless of boarding/alighting activity. Additionally, bus speeds are also frequently below prevailing vehicle speeds along multiple segments between 3rd Street and Senter Road despite relatively little boarding activity at many of the stops.

Note that some variation in the relative speeds is the result of the weighted averages used for prevailing vehicle speeds across multiple analysis segments. Prevailing speeds in Segment 8, for example, are likely understated given that it contains no intersections and is relatively less congested than other adjacent segments represented by the same weighted average. As a result, the bus speeds within Segment 8 appear to be abnormally high compared to prevailing speeds.

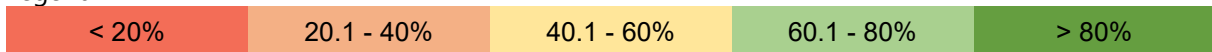


Table 2: Average Bus Travel Speed as a Percent of Prevailing Vehicle Speeds

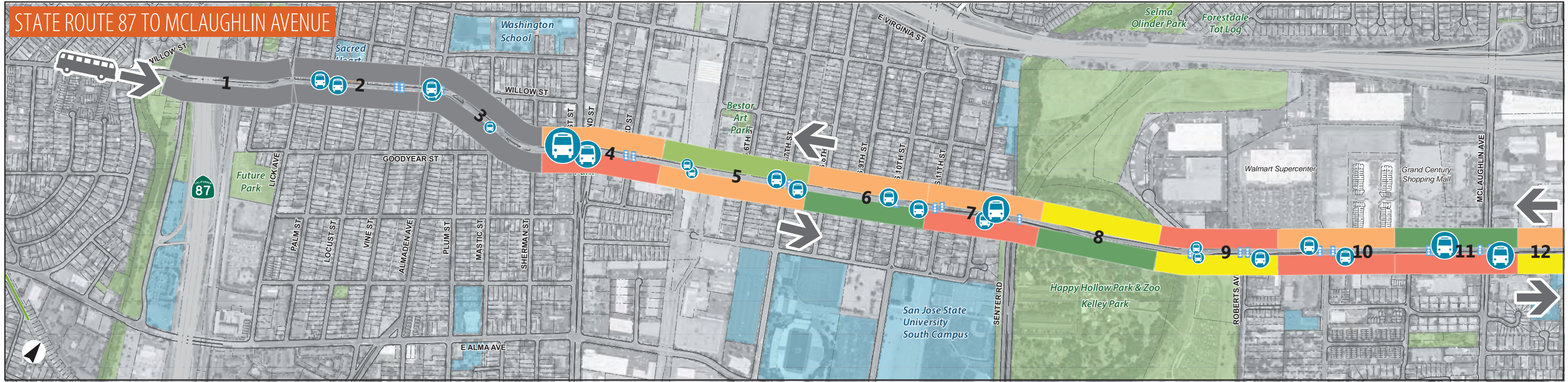
Segment	Major Cross Streets	Direction	AM	Midday	School	PM
1	Lelong Street, Harliss Avenue, Lick Avenue	Westbound	Inrix travel time data does not exist for Segments 1-3.			
		Eastbound				
2	Palm Street, Locust Street, Vine Street	Westbound				
		Eastbound				
3	Almaden Avenue, Graham Avenue, Sherman Street	Westbound				
		Eastbound				
4*	1st Street, 2nd Street	Westbound	27%	29%	26%	33%
		Eastbound	20%	15%	16%	16%
5	5th Street, 6th Street, 7th Street	Westbound	63%	42%	41%	39%
		Eastbound	38%	40%	37%	31%
6	8th Street, 9th Street, 10th Street	Westbound	30%	60%	43%	40%
		Eastbound	140%	60%	27%	35%
7	11th Street, 12th Street, Senter Road	Westbound	27%	24%	25%	26%
		Eastbound	20%	21%	20%	21%
8		Westbound	52%	123%	154%	143%
		Eastbound	108%	198%	223%	69%
9	Remillard Court	Westbound	19%	68%	65%	52%
		Eastbound	47%	31%	25%	24%
10	Roberts Avenue	Westbound	38%	15%	15%	16%
		Eastbound	14%	19%	21%	25%
11	Lucretia Avenue, McLaughlin Avenue	Westbound	94%	21%	24%	22%
		Eastbound	16%	22%	24%	25%
12	Olinder Court, US-101 SB Ramps	Westbound	24%	24%	18%	26%
		Eastbound	51%	95%	94%	77%
13	US-101 NB Ramps, Knox Avenue	Westbound	21%	114%	114%	82%
		Eastbound	96%	51%	38%	28%
14*	King Road	Westbound	25%	18%	17%	15%
		Eastbound	17%	20%	19%	21%
15	McCreery Avenue	Westbound	223%	20%	21%	18%
		Eastbound	57%	26%	52%	34%
16	Sunset Avenue, Hopkins Drive	Westbound	20%	41%	50%	58%
		Eastbound	47%	46%	27%	54%
17	Diana Avenue, Karl Street, Adrian Way, Jackson Avenue	Westbound	27%	30%	26%	28%
		Eastbound	60%	36%	30%	29%
18	Leeward Drive, Wenlock Drive-Galahad Avenue	Westbound	37%	51%	86%	40%
		Eastbound	56%	41%	63%	75%
19	Capitol Expressway	Westbound	16%	20%	18%	25%
		Eastbound	23%	18%	27%	30%

* Segment containing timepoint schedule stop

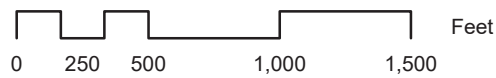
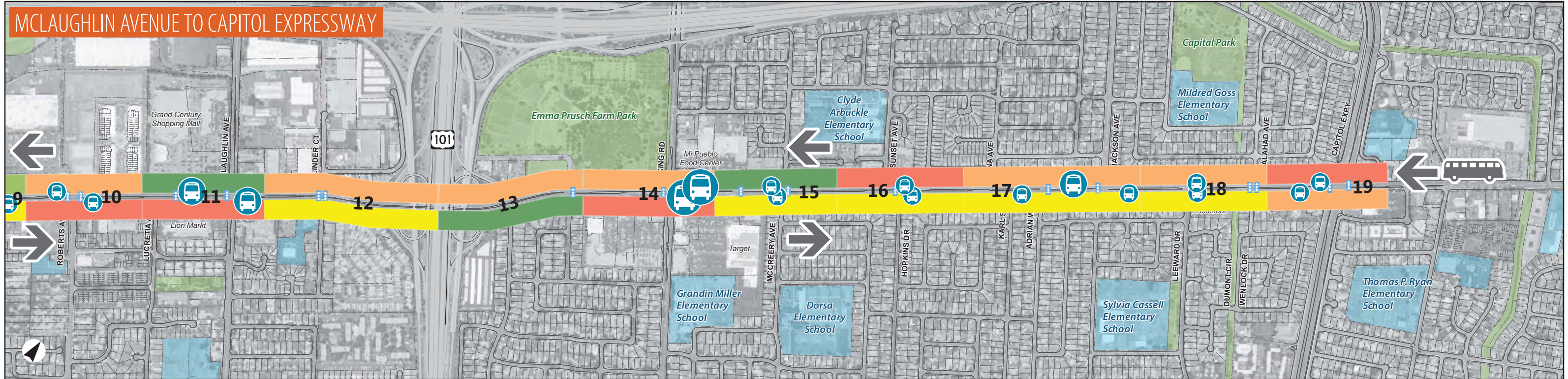
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STATE ROUTE 87 TO MCLAUGHLIN AVENUE



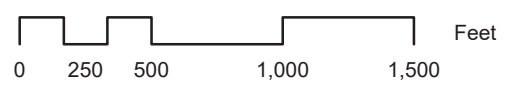
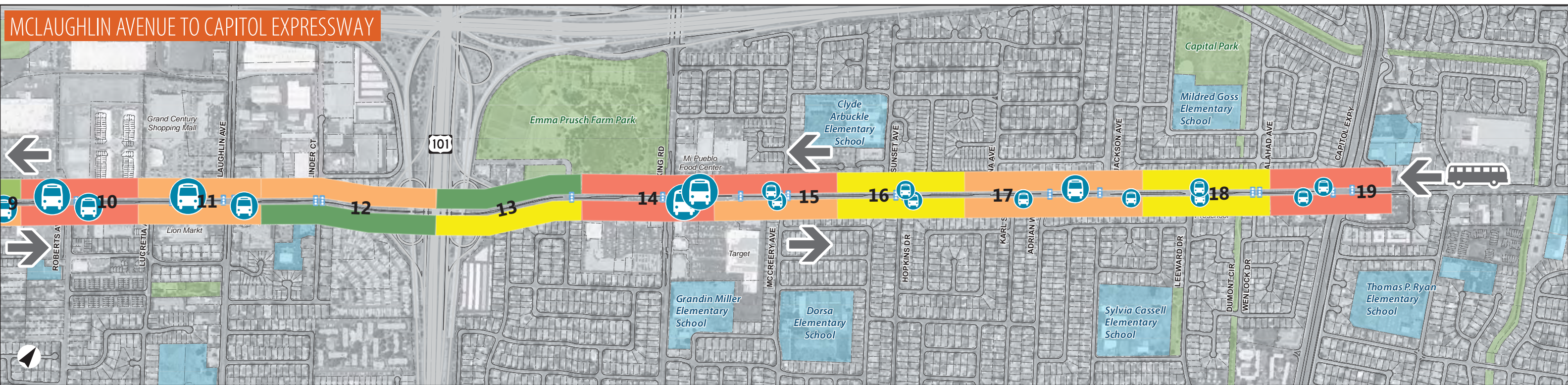
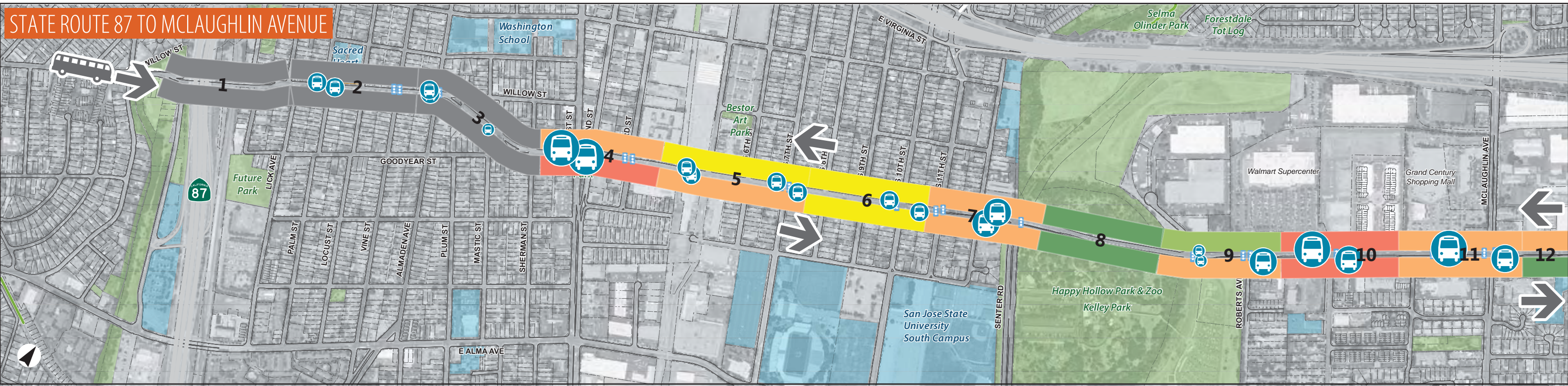
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Figure 3A - AM Average Bus Speed as a Percent of Prevailing Travel Speed

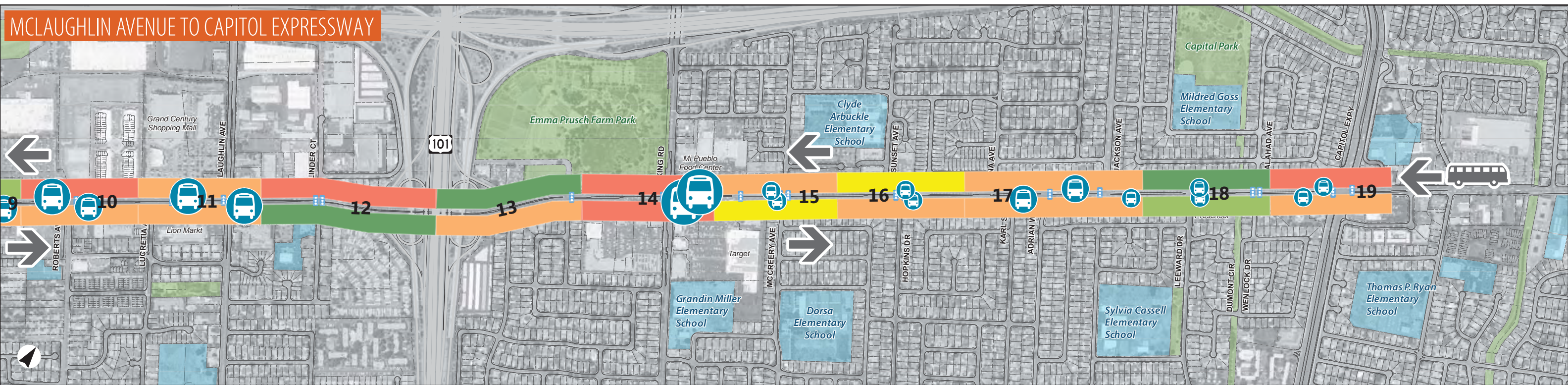
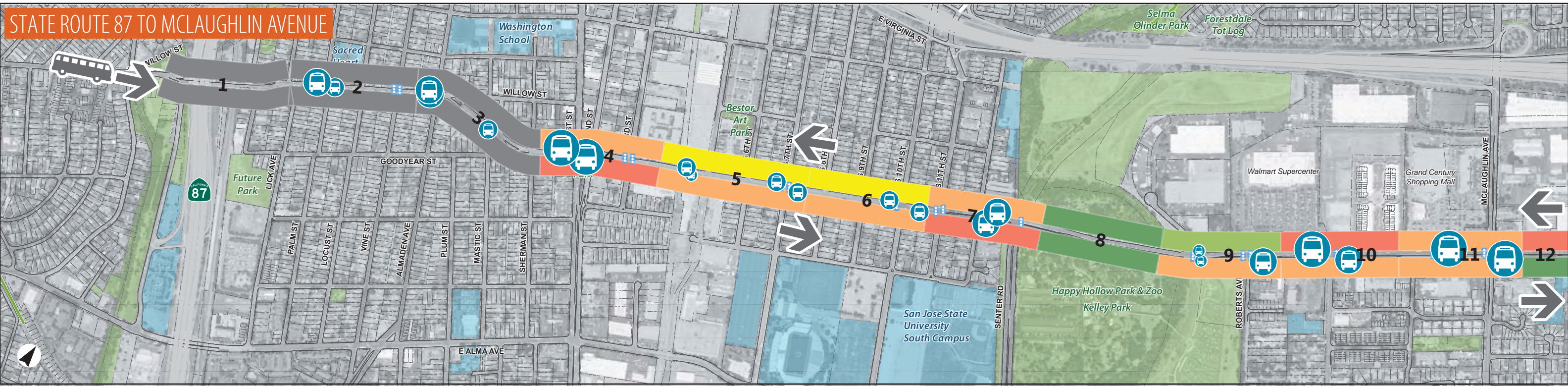
Transit Speeds as a Percent of Prevailing Speed	40.1% - 60%	No Data	Bus Stops Total On-Offs/Hour	11 - 20	Traffic Control
≤ 20%	60.1% - 80%		< 1	Signal	
20.1% - 40%	> 80%		2 - 5		
			6 - 10	> 20	



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Figure 3B - Midday Average Bus Speed as a Percent of Prevailing Travel Speed

Transit Speeds as a Percent of Prevailing Speed ≤ 20 % 20.1% - 40% 40.1% - 60% 60.1% - 80% > 80% No Data	Bus Stops Total On-Offs/Hour < 1 2 - 5 6 - 10	Traffic Control Signal 11 - 20 > 20	

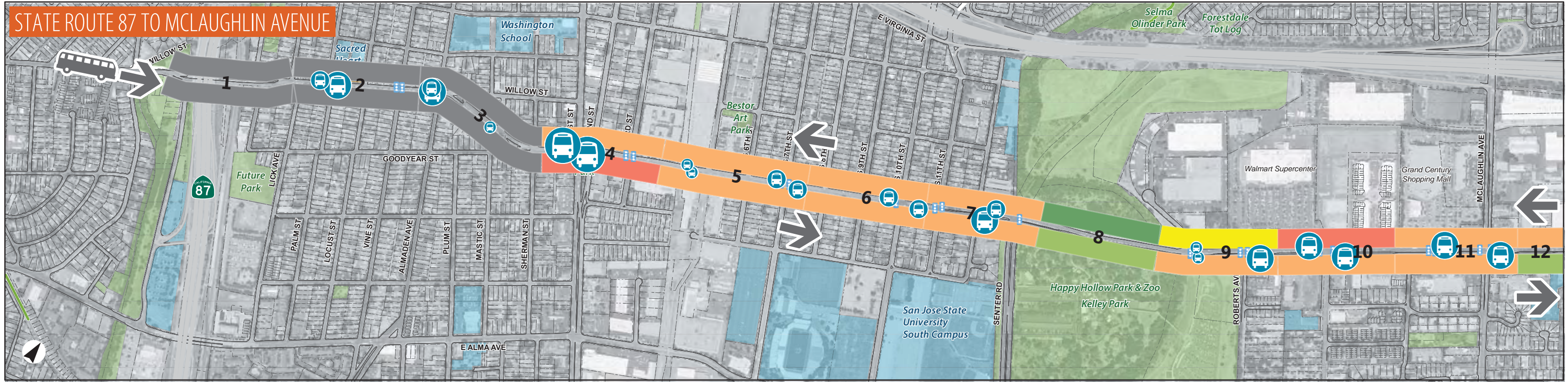


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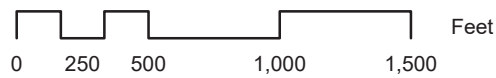
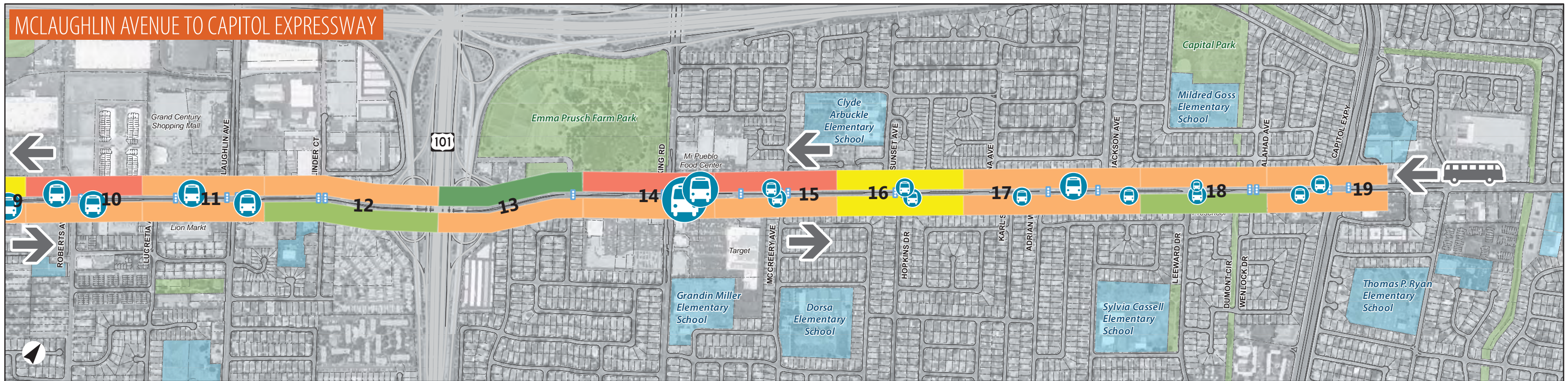
Figure 3C - School Peak Average Bus Speed as a Percent of Prevailing Travel Speed

Transit Speeds as a Percent of Prevailing Speed ≤ 20 % 20.1% - 40% 40.1% - 60% 60.1% - 80% > 80% No Data	Bus Stops Total On-Offs/Hour < 1 2 - 5 6 - 10	Traffic Control Signal 11 - 20 > 20			

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Figure 3D - PM Average Bus Speed as a Percent of Prevailing Travel Speed

Transit Speeds as a Percent of Prevailing Speed	40.1% - 60%	No Data	Bus Stops Total On-Offs/Hour	11 - 20	Traffic Control
≤ 20%	60.1% - 80%		< 1	Signal	
20.1% - 40%	> 80%		2 - 5		
			6 - 10	> 20	



FIELD INVESTIGATION AND POTENTIAL SOLUTIONS

Based upon the results of the bus speed evaluations and coordination with VTA, three areas were identified for further investigation along the Story-Keyes corridor:

- Story Road in the vicinity of King Road
- Story Road in the vicinity of McLaughlin Avenue
- Keyes Street between 7th Street and Senter Road, with emphasis on the 7th Street, 10th Street, 11th Street, and Senter Road intersections

The purpose of the field investigation was to assess how the data from the speed analysis aligns with real world insights, including review of existing roadway geometry, traffic conditions, and traffic signal operations which may be the cause of existing transit delay. Subsequently, potential solutions to observed operational challenges at each location were identified for further investigation during the design development process. The results of the field investigation are described in **Table 3**.



Table 3: Field Observation Summary

Observation Area	Operational Challenges Observed	Potential Solutions
Story Road / King Road	<ul style="list-style-type: none"> Eastbound and westbound bus pads are in the travel lane, so the stopped bus blocks traffic; vehicles have trouble passing stopped bus (see Figure 4) King Road is a timepoint stop, which can lead to extended stops of 5+ minutes at some times Westbound bus had trouble crossing King in the right lane due to the right-turn lane queues exceeding storage Bus bunching during AM and PM peak hours for eastbound buses 	<ul style="list-style-type: none"> Converting the right-most into a bus-only lane along the Story-Keyes corridor would improve bus operations and reduce bus conflicts with other vehicles Altering the VTA Route 25 headways could increase reliability by reducing bus bunching
Story Road / McLaughlin Avenue	<ul style="list-style-type: none"> Westbound bus pad is in the travel lane, so the stopped bus blocks traffic; vehicles have trouble passing stopped bus Bus bunching during AM and PM peak hours for eastbound buses 	<ul style="list-style-type: none"> Converting the right-most into a bus-only lane along the Story-Keyes corridor would improve bus operations and reduce bus conflicts with other vehicles Altering the VTA Route 25 headways could increase reliability by reducing bus bunching
Keyes Street between 7 th Street and 12 th Street	<ul style="list-style-type: none"> Eastbound and westbound buses generally are stopped at red lights when departing near-side bus stops due to boarding/alighting delays Bus bunching during AM and PM peak hours for eastbound buses 	<ul style="list-style-type: none"> Improving transit signal priority would reduce signal delay for buses Relocating bus stops to the far side of signalized intersections where feasible Converting the right-most into a bus-only lane along the Story-Keyes corridor would improve bus operations and reduce bus conflicts with other vehicles Altering the VTA Route 25 headways could increase reliability by reducing bus bunching

Source: Fehr & Peers.



Figure 4: Story Road at King Road Observations

